M402100BP/FP

4×4 CROSSPOINT SWITCH WITH CONTROL MEMORY

DESCRIPTION

The M402100B is a semiconductor integrated circuit consisting of a 4×4 crosspoint switch capable of selecting 16 analog switches in a 4×4 array with 4 address inputs as well as 2 types of control signals.

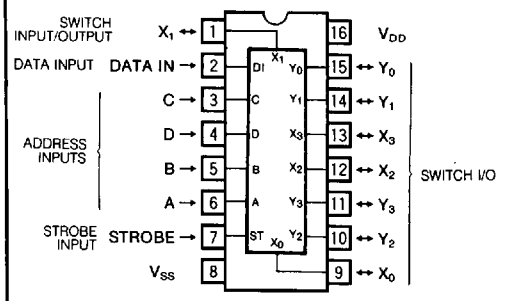
FEATURES

- Internal 16-bit latch circuit
- Has power on/reset function
- Low on-state resistance 60Ω typical (V_{DD}=15V)
- High off-state resistance more than 10^9Ω typical
- Good linearity transfer characteristics
  distortion 0.07% typical (R_L=1kΩ, V_{DD}=5V, V_{SS}=−5V)

APPLICATION

Line switching of telephone and communications equipments.

PIN CONFIGURATION (TOP VIEW)

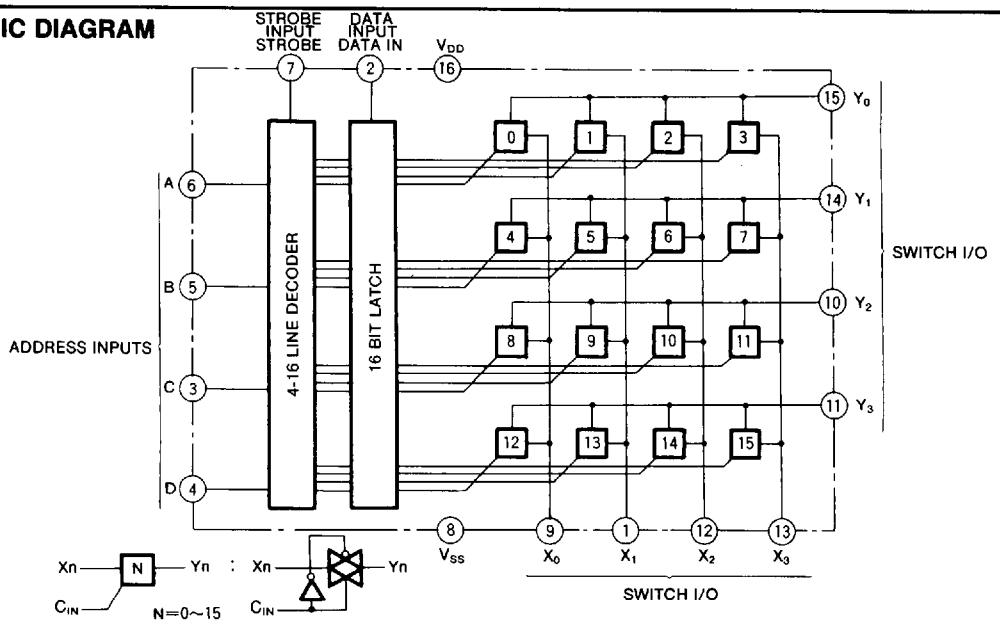


Outline 16P4
16P2N-A

FUNCTIONAL DESCRIPTION

The input address signals (A, B, C, D) are four-bit binary coded. When the strobe input is high-state the switch that corresponds to the value of the input address signals is selected. If, at this time, the data-in signal becomes high-state, the switch is turned on and for the duration of the input/output period remains in low-impedance state. If the data-in signal becomes low-state then the switch is turned off and for the duration of the input/output period remains in high-impedance state. When the strobe becomes low-state, the switch condition that existed immediately prior to the strobe signal is maintained. As there is an internal power on/reset function, all switches can be set to the off-state when the power is applied.

LOGIC DIAGRAM



FUNCTION TABLE

Strobe input	Address input				Data input	Selection channels														
						Y_0				Y_1				Y_2				Y_3			
ST	D	C	B	A	DI	X_0	X_1	X_2	X_3	X_0	X_1	X_2	X_3	X_0	X_1	X_2	X_3	X_0	X_1	X_2	X_3
L	X	X	X	X	X	←							NC								→
H	L	L	L	L	L	OFF	←						NC								→
H	L	L	L	L	H	ON	←						NC								→
H	L	L	L	H	L	NC	OFF	←					NC								→
H	L	L	L	H	H	NC	ON	←					NC								→
H	L	L	H	L	L	NC	NC	OFF	←				NC								→
H	L	L	H	L	H	NC	NC	ON	←				NC								→
H	L	L	H	H	L	←	NC	→	OFF	←			NC								→
H	L	L	H	H	H	←	NC	→	ON	←			NC								→
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
H	H	H	H	H	L	←							NC							→	OFF
H	H	H	H	H	H	←							NC							→	ON

Note 1 : X : Either high-or low-state
ON : Low impedance during Xn-Yn(n : 0~3)
OFF : High impedance during Xn-Yn(n : 0~3)
NC : No change, maintanins prior condition
←NC→ : While ↔ all are NC

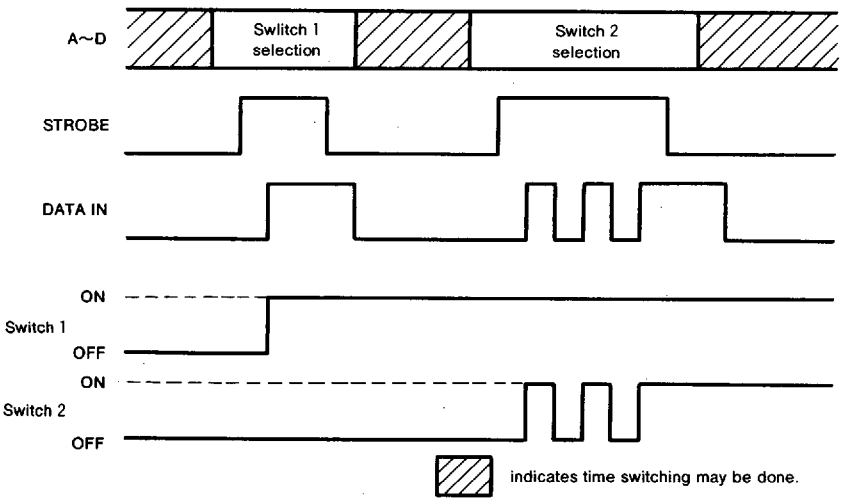
POWER ON/RESET FUNCTION

The M402100BP/BFP has an internal power on/reset function that turns all switches off. This function was made possible by internally fabricated capacity. When the power on/reset function is used it is nesessary that power supply rise-time satisfy the specifications given in Table 1 (see application example). If, while some switch is in the on-state, the supply voltage should be turned off, the power on/reset function can be avoided by reapplying the supply voltage within approximately 10 seconds. In such a case set all switches to off prior to turning the supply voltage off.
When using the power on/reset function, give careful consideration as to whether or not the supply voltage should be used to activate this function.

Table 1 SUPPLY VOLTAGE RISE-TIME REQUIREMENT

Symbol	Parameter	Conditions	Limits		Unit
			Min	Max	
$t_r(V_{DD})$	Supply voltage rise-time	Data in=low-state		25	ms/V

OPERATING TIMING DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a = −40∼+85℃, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V_{DD}	Supply voltage		−0.5∼20	V
V_I	Input voltage		V_{SS}−0.5∼V_{DD}+0.5	V
$V_{I/O}$	On-state voltage difference between input and output		±0.5	V
V_O	Output voltage		V_{SS}−0.5∼V_{DD}+0.5	V
I_I	Input current	A∼D, STROBE, DATA IN	±10	mA
I_O	Output current	Switch off	±10	mA
Tstg	Storage temperature range		−65∼+150	℃

RECOMMENDED OPERATING CONDITIONS (T_a = −40∼+85℃, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min	Typ	Max	
V_{DD}	Supply voltage	3		18	V
V_I	Input voltage	V_{SS}		V_{DD}	V
V_O	Output voltage	V_{SS}		V_{DD}	V
Topr	Operating temperature range	−40		85	℃

ELECTRICAL CHARACTERISTICS (V_{SS} = 0V)

Symbol	Parameter	Test conditions		Limits							Unit
				−40℃		25℃			85℃		
			V_{DD}(V)	Min	Max	Min	Typ	Max	Min	Max	
V_{IH}	High-level input voltage (A∼D, STROBE, DATA IN)	Switch on R_{ON}<$R_{ON\ MAX}$	5	3.5		3.5			3.5		V
			10	7.0		7.0			7.0		
			15	11.0		11.0			11.0		
V_{IL}	Low-level input voltage (A∼D, STROBE, DATA IN)	Switch off I_L<0.2μA	5		1.5			1.5		1.5	V
			10		3.0			3.0		3.0	
			15		4.0			4.0		4.0	
R_{ON}	On resistance Measurement circuit 1	$V_I=\frac{V_{DD}-V_{SS}}{2}$	5		520			650		820	Ω
			10		125			150		185	
			12		105			125		160	
			15		95			115		145	
ΔR_{ON}	On resistance difference (between switches of the 16 switches)	$V_I=\frac{V_{DD}-V_{SS}}{2}$	5				35				Ω
			10				20				
			12				18				
			15				15				
I_{OFF}	Input-to-output off-state leakage current	All switches off	18		±300			±300		±1000	nA
I_{DD}	Quiescent supply current	V_I=V_{DD}, V_{SS}	5		5			5		150	μA
			10		10			10		300	
			15		20			20		600	
I_{IH}	High-level input current (A∼D, ST, DI)	V_{IH}=18V	18		0.3			0.3		1.0	μA
I_{IL}	Low-level input current (A∼D, ST, DI)	V_{IL}=0V	18		−0.3			−0.3		−1.0	μA

SWITCHING CHARACTERISTICS (T_a = 25℃)

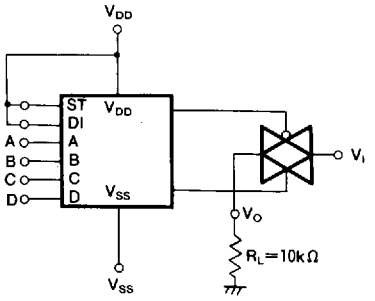
Symbol	Parameter	Test conditions	V_{SS}(V)	V_{DD}(V)	Limits Min	Limits Typ	Limits Max	Unit
f_{max}(I/O)	Maximum transfer frequency	R_L=1kΩ Measurement circuit 2	−5	5		50		MHz
f_{max}(C_{IN})	Maximum control frequency	R_L=1kΩ C_L=50pF Measurement circuit 3	0	5	0.6			MHz
			0	10	1.6			
			0	15	2.5			
t_{PLH}	Low-level to high-level and high-level to low-level output propagation time (Xn/Yn−Yn/Xn)	R_L=10kΩ C_L=50pF Measurement circuit 4	0	5			60	ns
			0	10			30	
			0	15			20	
t_{PHL}			0	5			60	ns
			0	10			30	
			0	15			20	
t_{PHZ}	Output disable time from high-level (STROBE−Yn/Xn)	R_L=1kΩ C_L=50pF Measurement circuit 5	0	5			330	ns
			0	10			170	
			0	15			140	
t_{PZH}	Output enable time to high-level (STROBE−Yn/Xn)		0	5			600	ns
			0	10			250	
			0	15			160	
t_{PZH}	Output enable time to high-level and low-level (DATA IN−Yn/Xn)	R_L=1kΩ C_L=50pF Measurement circuit 6	0	5			420	ns
			0	10			220	
			0	15			150	
t_{PZL}			0	5			420	ns
			0	10			220	
			0	15			150	
t_{PHZ}	Output disable time from high-level (A~D−Yn/Xn)	R_L=1kΩ C_L=50pF Measurement circuit 7	0	5			870	ns
			0	10			420	
			0	15			320	
t_{PZH}	Output enable time to high-level (A~D−Yn/Xn)		0	5			700	ns
			0	10			270	
			0	15			180	
—	Sinewave distortion	R_L=1kΩ f_I=1kHz Measurement circuit 2	−5	5		0.07		%
—	Feedthrough (switch off)	R_L=1kΩ Measurement circuit 8	−5	5		−100		dB
—	Crosstalk	R_L=10kΩ Measurement circuit 9	0	10		150		mV
—	Crosstalk frequency	R_L=1kΩ SW(A)=On SW(B)=Off Measurement circuit 10 $20\log\frac{V_O(B)}{V_I(A)}$=−40dB	−5	5		1.5		MHz
		$20\log\frac{V_O(B)}{V_I(A)}$=−110dB	−5	5		0.1		kHz
C_I	Input capacitance	A~D, STROBE, DATA IN					7.5	pF
		Signal input Xn				40		pF
		Signal input Yn				40		
$C_{Xn/Yn}$	Input/output capacitance					0.4		pF

TIMING REQUIREMENTS (T_a = 25℃, V_{SS} = 0V)

Symbol	Parameter	Test conditions	V_{DD}(V)	Limits Min	Limits Typ	Limits Max	Unit
$t_{W(ST)}$	Strobe pulse width		5	600			ns
			10	240			
			15	190			
t_{SU}	Data setup time respect to A~D, strobe		5	190			ns
			10	50			
			15	30			
t_h	Data hold time respect to A~D, strobe		5	360			ns
			10	220			
			15	120			

MEASUREMENT CIRCUIT (Capacitance C_L includes stray probe and wiring capacitance)

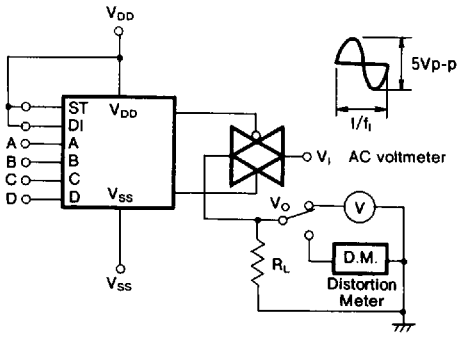
1 On-state resistance (R_{ON})



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

See function table for condition of address inputs A through D.

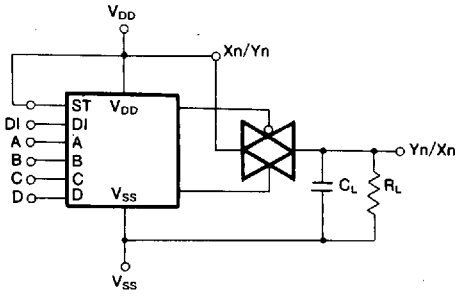
2 Maximum transfer frequency (f_{max}(I/O)) Sinewave distortion



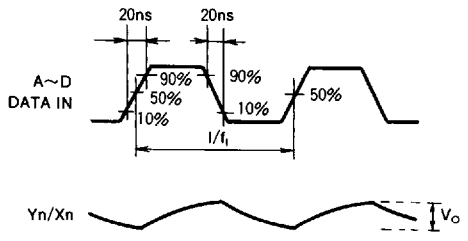
With an input sinewave of $\pm 2.5V_{P\text{-}P}$, f_{max}(I/O) is equal to frequency (f_I) when $20\log_{10}\frac{V_O}{V_I}=-3dB$.

See function table for condition of address inputs A through D.

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



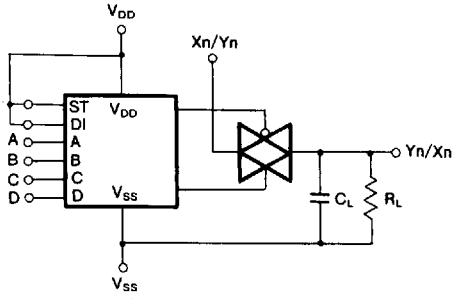
Timing diagram



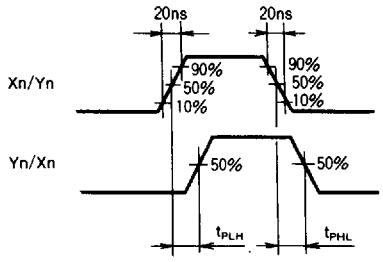
$f_{max}(C_{IN})$ is the value of f_I when output amplitude has become half value of its original value at the time the input frequency f_I=1kHz.

See function table for condition of address inputs A through D.

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

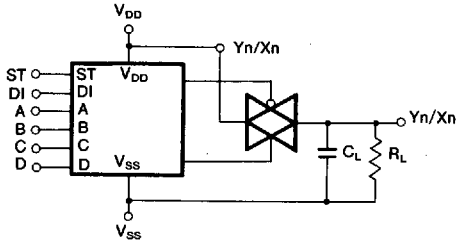


Timing diagram

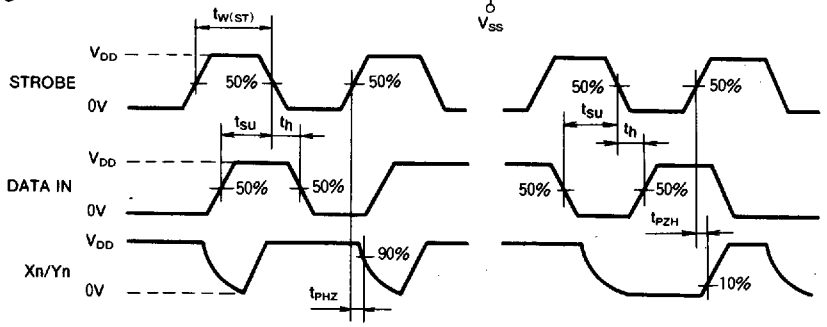


See function table for condition of address inputs A through D.

5 **Output disable/enable time from/to high-level (STROBE—Yn/Xn)**

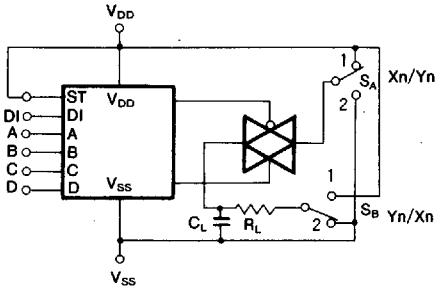


Timing diagram



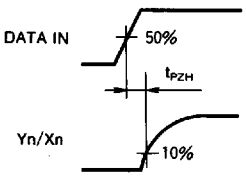
See function table for condition of address inputs A through D.

6 **Output enable time to high-level and low-level (DATA IN—Yn/Xn)**

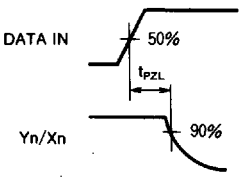


Timing diagram

S_A=1, S_B=2

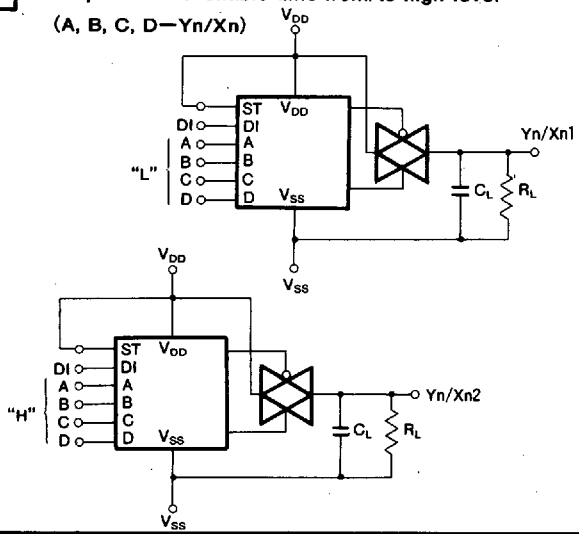


S_A=2, S_B=1

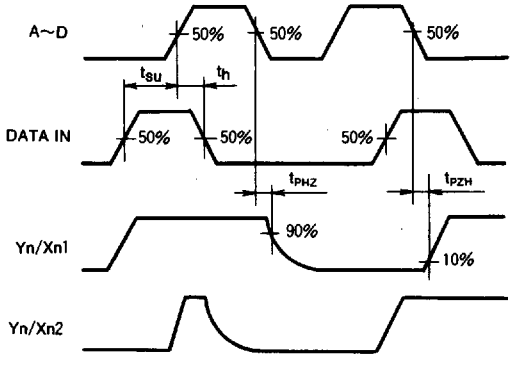


See function table for condition of address inputs A through D.

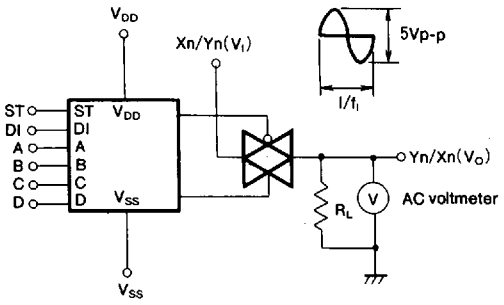
7 **Output disable/enable time from/to high-level (A, B, C, D—Yn/Xn)**



Timing diagram

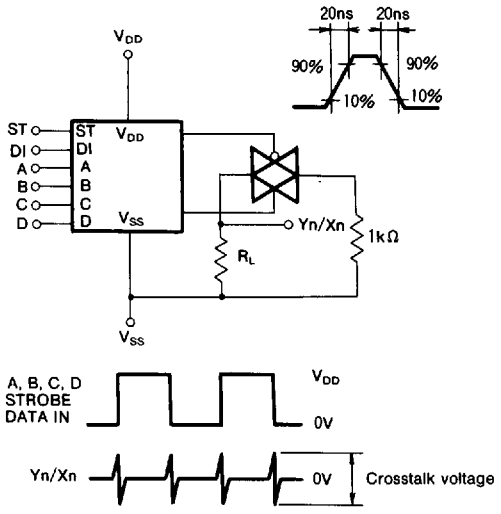


8 Feedthrough

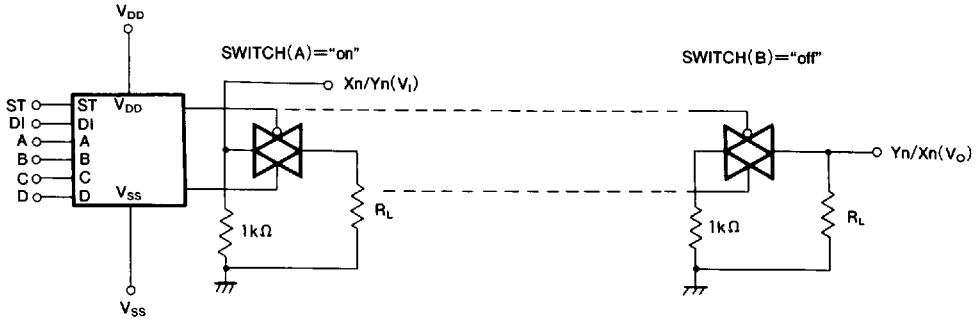


Using a $\pm 2.5V_{P-P}$ sinewave input, feed through is $20 \log_{10} \frac{V_O}{V_I}$ when f_I=1.6kHz.
See function table for condition of address inputs A through D, strobe and DATA IN.

9 Crosstalk



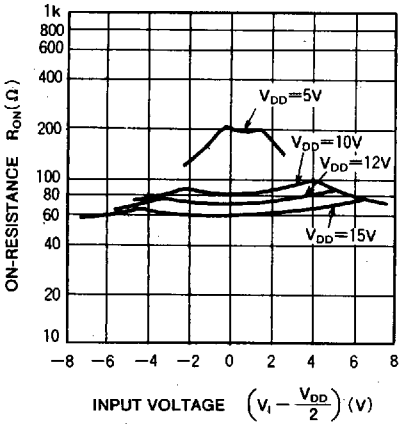
10 Crosstalk frequency



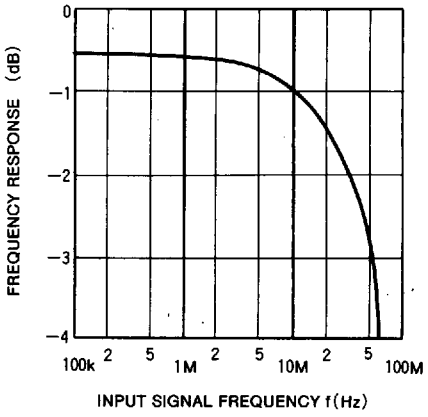
Using a $\pm 2.5V_{P-P}$ sinewave input, crosstalk frequency is the frequency at −110dB and when $20 \log_{10} \frac{V_O}{V_I}$ = −40dB.
See function table for condition of address inputs A through D, strobe and data in.

TYPICAL CHARACTERISTICS

R_{ON} VS. INPUT VOLTAGE $\left(V_I - \frac{V_{DD}}{2}\right)$



FREQUENCY RESPONSE



TYPICAL APPLICATION

Power on/reset usage