

## TC7MZ4051FK, TC7MZ4052FK, TC7MZ4053FK

TC7MZ4051FK 8-Channel Analog Multiplexer/Demultiplexer

TC7MZ4052FK Dual 4-Channel Analog Multiplexer/Demultiplexer

TC7MZ4053FK Triple 2-Channel Analog Multiplexer/Demultiplexer

The TC7MZ4051/4052/4053FK are high-speed, low-voltage drive analog multiplexer/demultiplexers using silicon gate CMOS technology. In 3 V and 5 V systems these can achieve high-speed operation with the low power dissipation that is a feature of CMOS.

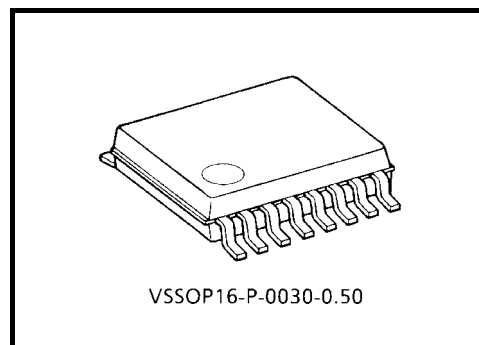
The TC7MZ4051/4052/4053FK offer analog/digital signal selection as well as mixed signals. The 4051 has an 8-channel configuration, the 4052 has an 4-channel  $\times$  2 configuration, and the 4053 has a 2-channel  $\times$  3 configuration.

The switches for each channel are turned ON by the control pin digital signals.

Although the control signal logical amplitude ( $V_{CC} - GND$ ) is small, the device can perform large-amplitude ( $V_{CC} - V_{EE}$ ) signal switching.

For example, if  $V_{CC} = 3\text{ V}$ ,  $GND = 0\text{ V}$ , and  $V_{EE} = -3\text{ V}$ , signals between  $-3\text{ V}$  and  $+3\text{ V}$  can be switched from the logical circuit using a single 3 V power supply.

All input pins are equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the  $V_{CC}$ ). As a result, for example, 5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off. As a result of this input power protection, the TC7MZ4051/4052/4053FK can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

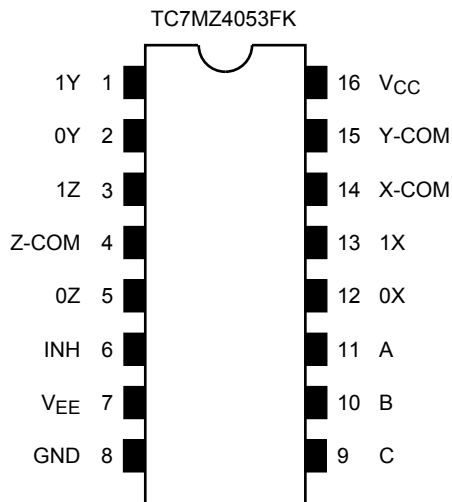
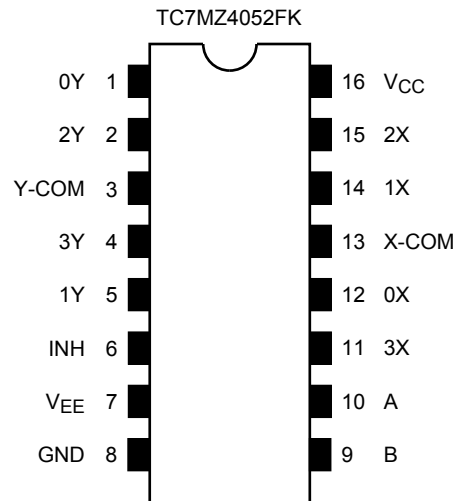
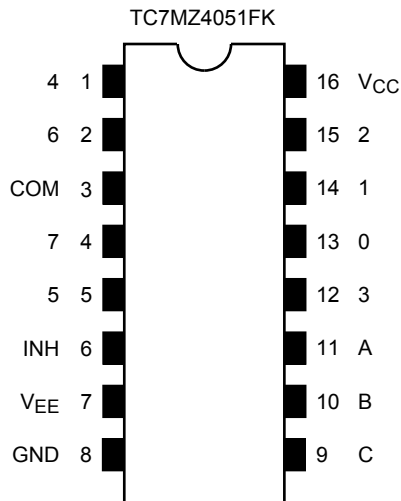


Weight: 0.02 g (typ.)

### Features

- Low ON resistance:  $R_{on} = 22\ \Omega$  (typ.) ( $V_{CC} - V_{EE} = 3\text{ V}$ )  
 $R_{on} = 15\ \Omega$  (typ.) ( $V_{CC} - V_{EE} = 6\text{ V}$ )
- High speed:  $t_{pd} = 3\text{ ns}$  (typ.) ( $V_{CC} = 3.0\text{ V}$ )
- Low power dissipation:  $I_{CC} = 4\ \mu\text{A}$  (max) ( $T_a = 25^\circ\text{C}$ )
- Input level:  $V_{IL} = 0.8\text{ V}$  (max) ( $V_{CC} = 3\text{ V}$ )  
 $V_{IH} = 2.0\text{ V}$  (min) ( $V_{CC} = 3\text{ V}$ )
- Power down protection is provided on all control inputs
- Pin and function compatible with 74HC4051/4052/4053

## Pin Assignment (top view)



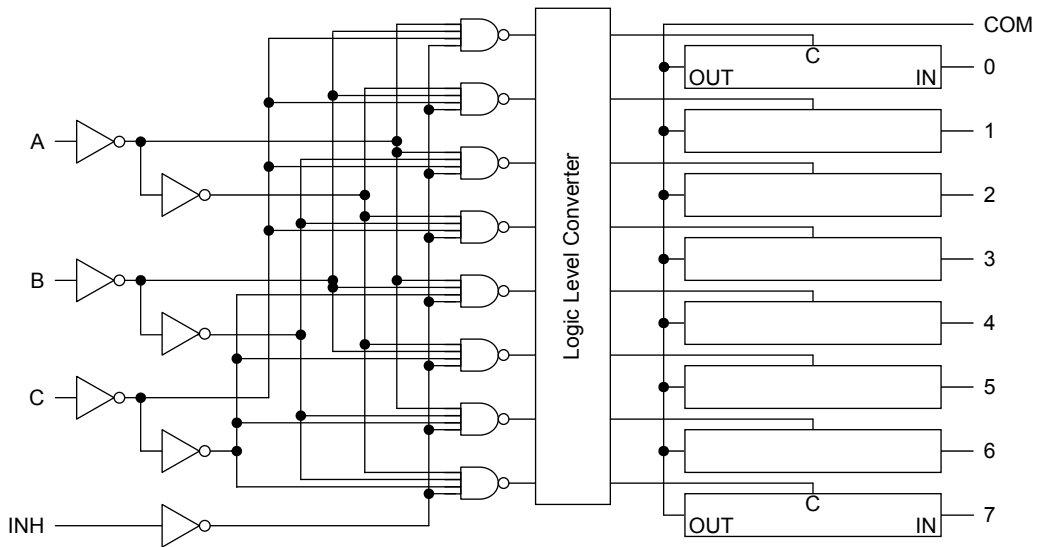
## Truth Table

Control Inputs				"ON" Channel		
Inhibit	C*	B	A	MZ4051FK	MZ4052FK	MZ4053FK
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H	L	L	4	—	0X, 0Y, 1Z
L	H	L	H	5	—	1X, 0Y, 1Z
L	H	H	L	6	—	0X, 1Y, 1Z
L	H	H	H	7	—	1X, 1Y, 1Z
H	X	X	X	None	None	None

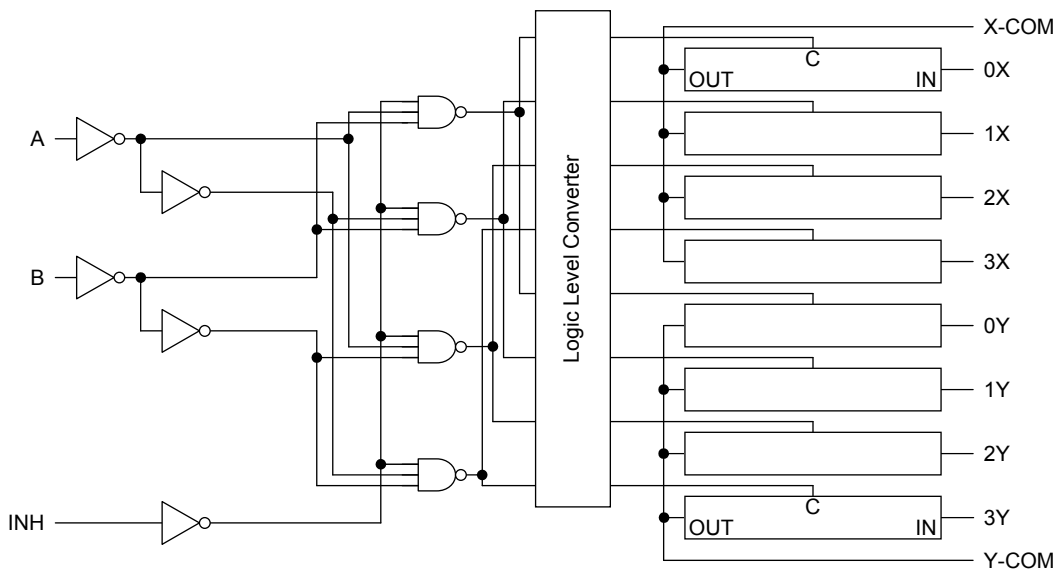
X: Don't care, \*: Except MZ4052FK

## System Diagram

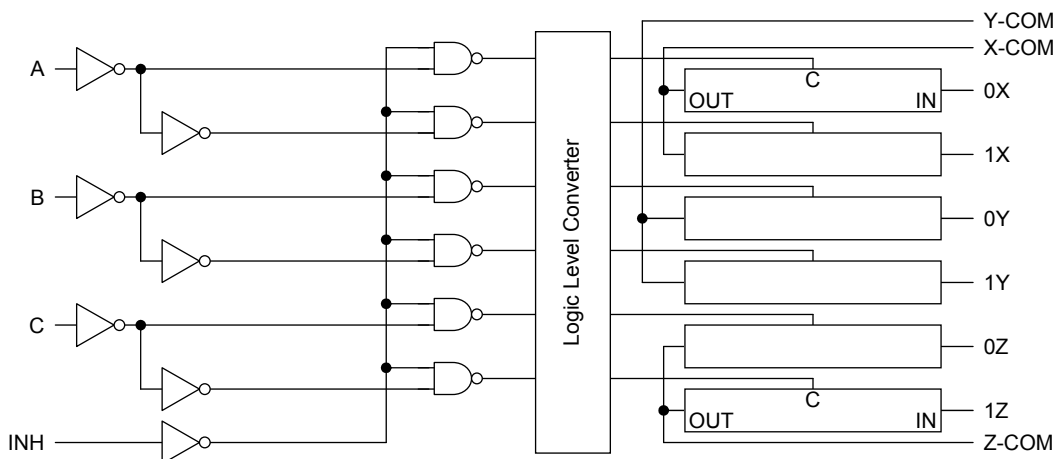
### TC7MZ4051FK



### TC7MZ4052FK



### TC7MZ4053FK



## Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	-0.5~7.0	V
	$V_{CC}\sim V_{EE}$	-0.5~7.0	
Control input voltage	$V_{IN}$	-0.5~7.0	V
Switch I/O voltage	$V_{I/O}$	$V_{EE} - 0.5\sim V_{CC} + 0.5$	V
Input diode current	$I_{IK}$	-20	mA
I/O diode current	$I_{IOK}$	$\pm 20$	mA
Switch through current	$I_T$	$\pm 25$	mA
DC $V_{CC}$ or ground current	$I_{CC}$	$\pm 50$	mA
Power dissipation	$P_D$	180	mW
Storage temperature	$T_{stg}$	-65~150	°C

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

## Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	2~6	V
	$V_{EE}$	-4~0	
	$V_{CC}\sim V_{EE}$	2~6	
Input voltage	$V_{IN}$	0~6.0	V
Switch I/O voltage	$V_{I/O}$	$V_{EE}\sim V_{CC}$	V
Operating temperature	$T_{opr}$	-40~85	°C
Input rise and fall time	dt/dv	0~100 ( $V_{CC} = 3.3 \pm 0.3$ V)	ns/V
		0~20 ( $V_{CC} = 5 \pm 0.5$ V)	

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused control inputs must be tied to either  $V_{CC}$  or GND.

## Electrical Characteristics

### DC Electrical Characteristics

Characteristics		Symbol	Test Condition	Ta = 25°C			Ta = -40~85°C		Unit			
				V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Min	Typ.	Max		Min	Max	
Input voltage	High-level	V <sub>IH</sub>	—		2.0	1.5	—	—	1.5	—	V	
					3.0	2.0	—	—	2.0	—		
					4.5	3.15	—	—	3.15	—		
					6.0	4.2	—	—	4.2	—		
	Low-level	V <sub>IL</sub>	—			2.0	—	—	0.5	—		0.5
						3.0	—	—	0.8	—		0.8
						4.5	—	—	1.35	—		1.35
						6.0	—	—	1.8	—		1.8
ON resistance	R <sub>ON</sub>	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub> I <sub>I/O</sub> = 2 mA	GND		2.0	—	200	—	—	—	Ω	
					3.0	—	45	86	—	108		
					4.5	—	24	37	—	46		
					-3.0	3.0	—	17	26	—		33
			GND		2.0	—	28	73	—	84		
					3.0	—	22	38	—	44		
					4.5	—	17	27	—	31		
					-3.0	3.0	—	15	24	—		28
Difference of ON resistance between switches	ΔR <sub>ON</sub>	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub> I <sub>I/O</sub> = 2 mA	GND		2.0	—	10	25	—	35	Ω	
					3.0	—	5	15	—	20		
					4.5	—	5	13	—	18		
					-3.0	3.0	—	5	10	—		15
Input/Output leakage current (switch OFF)	I <sub>OFF</sub>	V <sub>OS</sub> = V <sub>CC</sub> or GND V <sub>IS</sub> = GND to V <sub>CC</sub> V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub>	GND		3.0	—	—	±0.25	—	±2.5	μA	
					-3.0	3.0	—	—	±0.5	—		±5.0
Input/Output leakage current (switch ON, output open)	I <sub>IN</sub>	V <sub>OS</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub>	GND		3.0	—	—	±0.25	—	±2.5	μA	
					-3.0	3.0	—	—	±0.5	—		±5.0
Control input current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	GND		6.0	—	—	±0.1	—	±0.1	μA	
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	GND		3.0	—	—	4.0	—	40.0	μA	
					-3.0	3.0	—	—	8.0	—		80.0

## AC Electrical Characteristics (C<sub>L</sub> = 50 pF, Input: t<sub>r</sub> = t<sub>f</sub> = 3 ns, GND = 0 V)

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40~85°C		Unit		
				V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Min	Typ.	Max		Min	Max
Phase difference between input and output	φ <sub>I/O</sub>	All types		GND	2.0	—	3.2	6.0	—	6.9	ns
				GND	3.0	—	1.8	3.0	—	3.5	
				GND	4.5	—	1.3	1.8	—	2.1	
				-3.0	3.0	—	1.1	1.3	—	1.5	
Output enable time	t <sub>pZL</sub> t <sub>pZH</sub>	Figure 1 (Note 1)		GND	2.0	—	9.0	17	—	20	ns
				GND	3.0	—	5.7	9.0	—	11	
				GND	4.5	—	4.5	6.0	—	7.0	
				-3.0	3.0	—	5.8	8.0	—	10	
Output disable time	t <sub>pLZ</sub> t <sub>pHZ</sub>	Figure 1 (Note 1)		GND	2.0	—	13.5	21	—	25	ns
				GND	3.0	—	11.3	15	—	18	
				GND	4.5	—	10.3	12	—	14	
				-3.0	3.0	—	10.9	13	—	15	
Control input capacitance	C <sub>in</sub>	All types (Note 2)		—	—	—	5	10	—	10	pF
COMMON terminal capacitance	C <sub>IS</sub>	Figure 2 (Note 2)		-3.0	3.0	—	11	25	—	25	pF
							9	20		20	
							7	15		15	
SWITCH terminal capacitance	C <sub>OS</sub>	Figure 2 (Note 2)		-3.0	3.0	—	6	13	—	13	pF
							6	13		13	
							6	13		13	
Feedthrough capacitance	C <sub>IOS</sub>	Figure 2 (Note 2)		-3.0	3.0	—	3	6	—	6	pF
							3	6		6	
							3	6		6	
Power dissipation capacitance	C <sub>PD</sub>	Figure 2 (Note 3)		GND	6.0	—	14	—	—	—	pF
							24				
							18				

Note 1: R<sub>L</sub> = 1 kΩ

Note 2: C<sub>in</sub>, C<sub>IS</sub>, C<sub>OS</sub> and C<sub>IOS</sub> are guaranteed by the design.

Note 3: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.

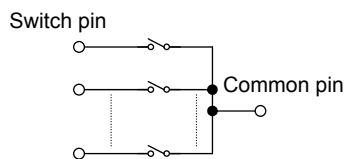
Average operating current can be obtained by the equation:

$$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

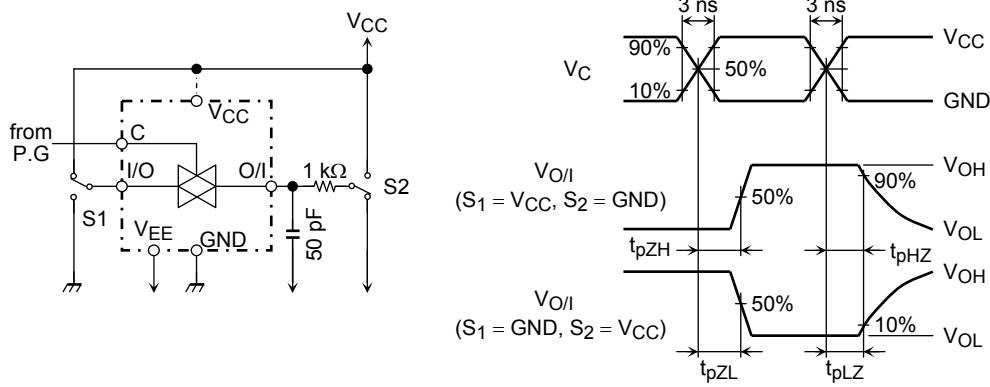
## \*Analog Switch Characteristics (GND = 0 V, Ta = 25°C)

Characteristics	Symbol	Test Condition		Typ.	Unit		
		$V_{EE}$ (V)	$V_{CC}$ (V)				
Sine Wave Distortion (T.H.D)		$R_L = 10\text{ k}\Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ kHz}$	$V_{IN} = 2.0\text{ V}_{p-p}$	0	3.0	0.100	%
			$V_{IN} = 4.0\text{ V}_{p-p}$	0	4.5	0.030	
			$V_{IN} = 6.0\text{ V}_{p-p}$	-0.3	3.0	0.020	
Frequency response (switch ON)	$f_{max}$	Adjust $f_{IN}$ voltage to obtain 0dBm at $V_{OS}$ . Increase $f_{IN}$ frequency until dB meter reads -3dB. $R_L = 50\ \Omega$ , $C_L = 10\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave Figure 3	4051	0	3.0	150	MHz
			4052			180	
			4053			200	
			4051	0	4.5	150	
			4052			180	
			4053			200	
			4051	-3.0	3.0	150	
			4052			180	
			4053			200	
Feed through attenuation (switch OFF)		$V_{IN}$ is centered at $(V_{CC} - V_{EE})/2$ . Adjust input for 0dBm. $R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave Figure 4	0	3.0	-45	dB	
			0	4.5	-45		
			-3.0	3.0	-45		
			0	3.0	-60		
			0	4.5	-60		
			-3.0	3.0	-60		
Crosstalk (control input to signal output)		$R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , square wave ( $t_r = t_f = 6\text{ ns}$ ) Figure 5	0	3.0	90	mV	
			0	4.5	150		
			-3.0	3.0	120		
Crosstalk (between any switches)		Adjust $V_{IN}$ to obtain 0dBm at input. $R_L = 600\ \Omega$ , $C_L = 50\text{ pF}$ , $f_{IN} = 1\text{ MHz}$ , sine wave Figure 6	0	3.0	-45	dB	
			0	4.5	-45		
			-3.0	3.0	-45		

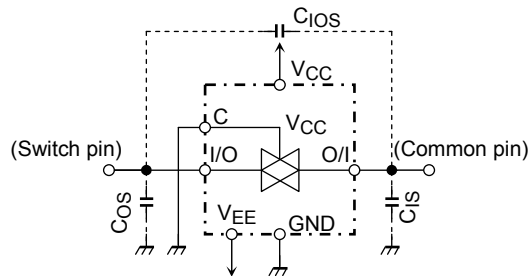
\*: These characteristics are determined by design of devices.



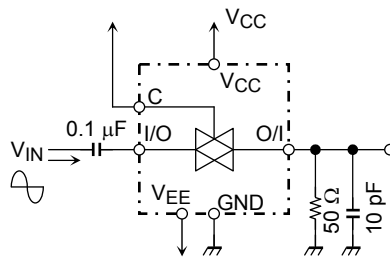
**AC Test Circuit**



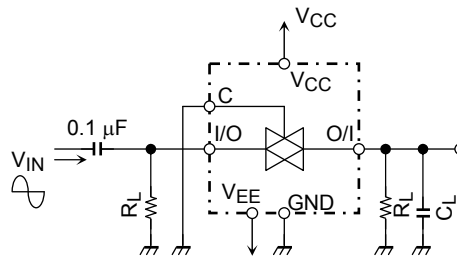
**Figure 1**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$



**Figure 2**  $C_{10S}$ ,  $C_{0S}$ ,  $C_{0S}$

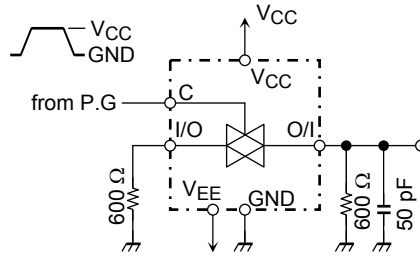


**Figure 3** Frequency Response (switch on)

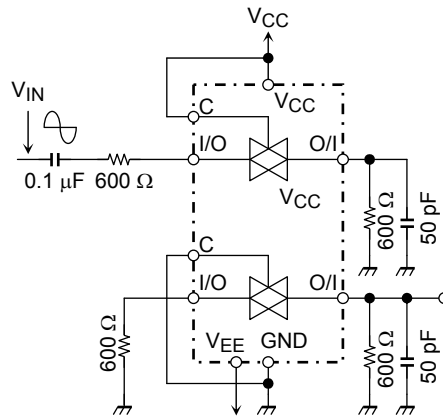


**Figure 4** Feedthrough





**Figure 5 Cross Talk (control input to output signal)**

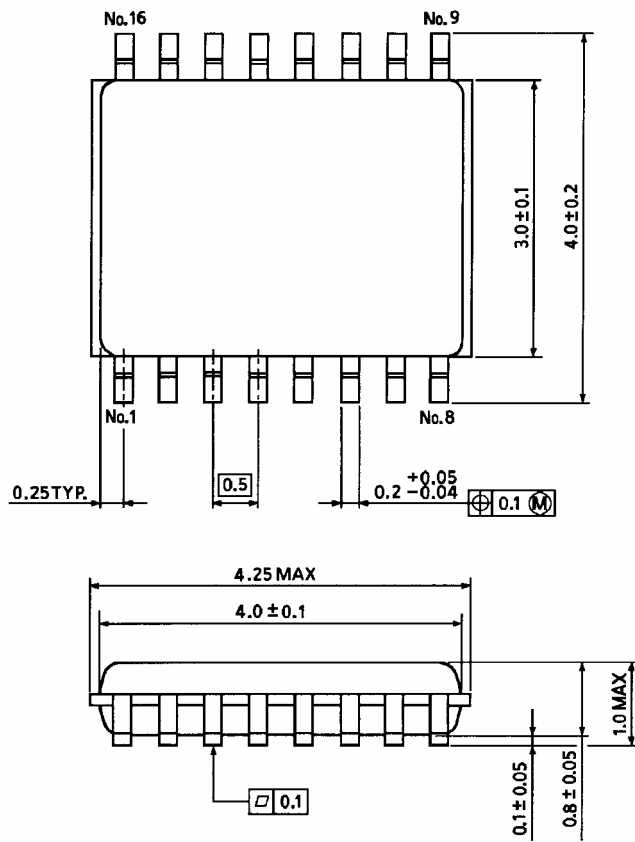


**Figure 6 Cross Talk (between any two switches)**

**Package Dimensions**

VSSOP16-P-0030-0.50

Unit : mm



Weight: 0.02 g (typ.)

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20070701-EN GENERAL

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