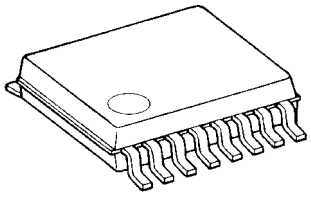
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MZ4051FK,TC7MZ4052FK,TC7MZ4053FK

TC7MZ4051FK 8-Channel Analog Multiplexer/Demultiplexer

TC7MZ4052FK Dual 4-Channel Analog Multiplexer/Demultiplexer

TC7MZ4053FK Triple 2-Channel Analog Multiplexer/Demultiplexer



VSSOP16-P-0030-0.50

Weight: 0.02 g (typ.)

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 × 2 configuration, and the 4053 has a 2-channel × 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 V, GND = 0 V, and V_{EE} = −3 V, signals between −3 V and +3 V can be switched from the logical circuit using a single 3 V power supply.

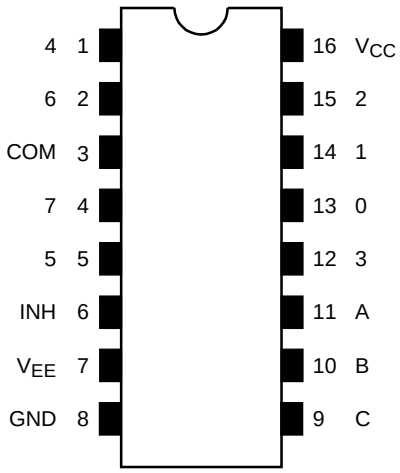
All input pins are equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the V_{CC}). As a result, for example, 5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off. As 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.

Features

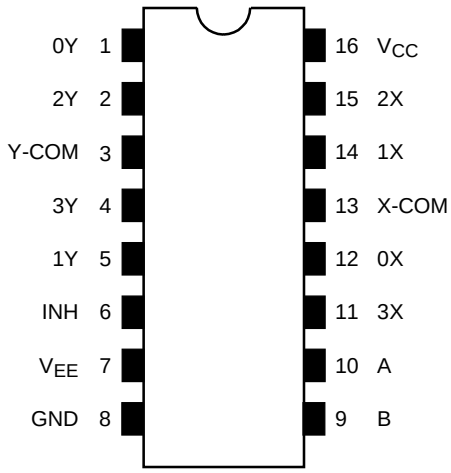
- Low ON resistance: R_{on} = 22 Ω (typ.) (V_{CC} − V_{EE} = 3 V)
  R_{on} = 15 Ω (typ.) (V_{CC} − V_{EE} = 6 V)
- High speed: t_{pd} = 3 ns (typ.) (V_{CC} = 3.0 V)
- Low power dissipation: I_{CC} = 4 μA (max) (Ta = 25°C)
- Input level: V_{IL} = 0.8 V (max) (V_{CC} = 3 V)
  V_{IH} = 2.0 V (min) (V_{CC}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

Pin Assignment (top view)

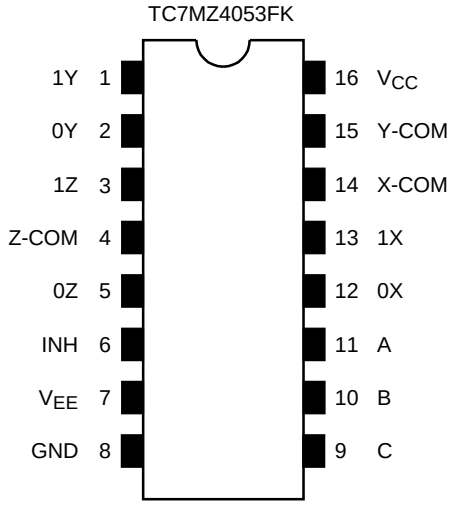
TC7MZ4051FK



TC7MZ4052FK



TC7MZ4053FK



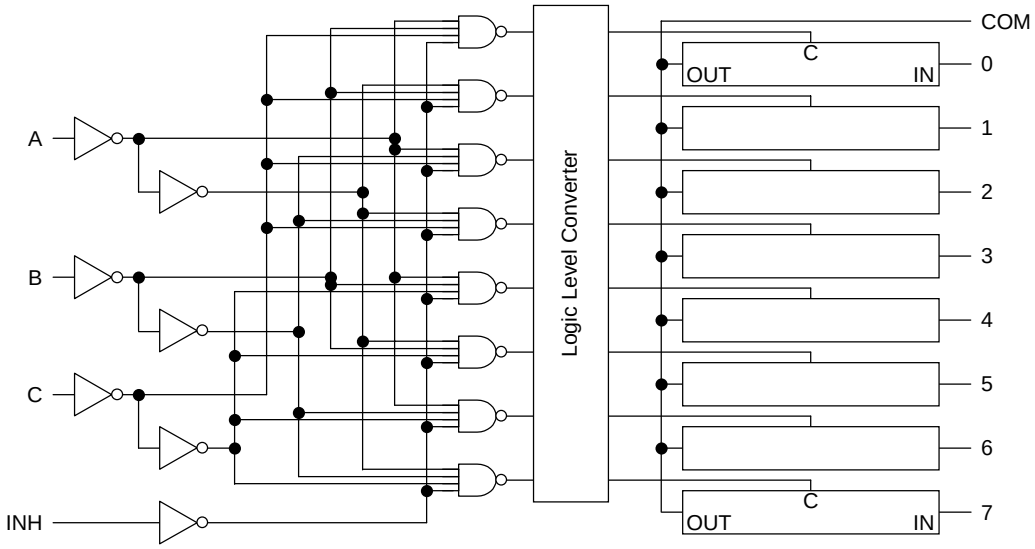
Truth Table

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

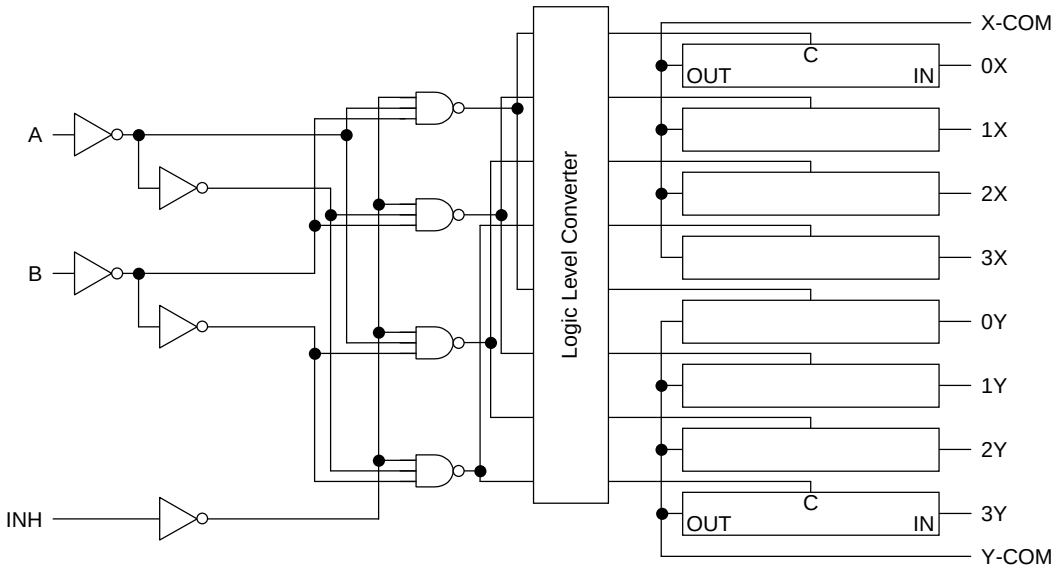
X: Don't care, *: Except MZ4052FK

System Diagram

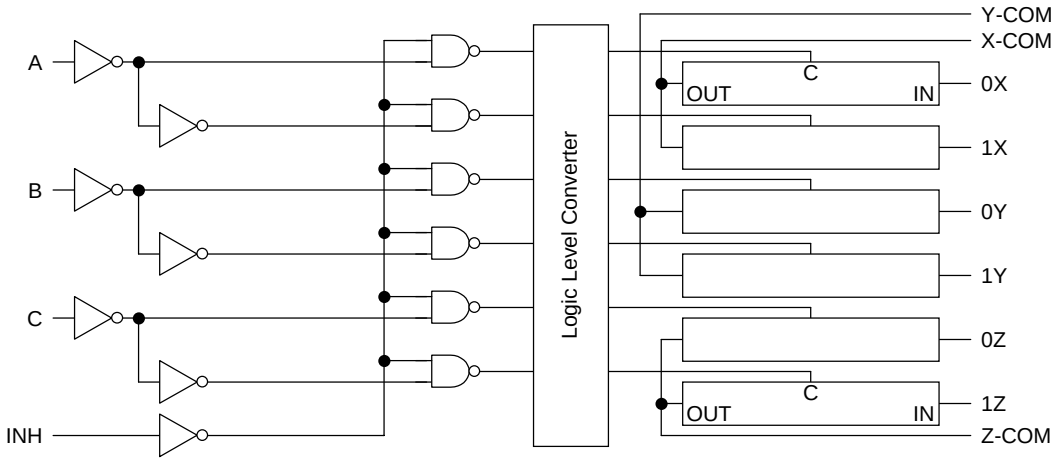
TC7MZ4051FK



TC7MZ4052FK



TC7MZ4053FK



Absolute Maximum Ratings

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

Recommended Operating Conditions

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

Electrical Characteristics

DC Electrical Characteristics

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

AC Electrical Characteristics (C_L = 50 pF, Input: $t_r = t_f$ = 3 ns, GND = 0 V)

Characteristics	Symbol	Test Condition		V_{EE} (V)	V_{CC} (V)	Ta = 25°C Min	Ta = 25°C Typ.	Ta = 25°C Max	Ta = −40~85°C Min	Ta = −40~85°C Max	Unit
Phase difference between input and output	ϕI/O	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_{pZL} t_{pZH}	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_{pLZ} t_{pHZ}	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_{in}	All types (Note 2)		—	—	—	5	10	—	10	pF
COMMON terminal capacitance	C_{IS}	4051	Figure 2 (Note 2)	−3.0	3.0	—	11	25	—	25	pF
		4052					9	20		20	
		4053					7	15		15	
SWITCH terminal capacitance	C_{OS}	4051	Figure 2 (Note 2)	−3.0	3.0	—	6	13	—	13	pF
		4052					6	13		13	
		4053					6	13		13	
Feedthrough capacitance	C_{IOS}	4051	Figure 2 (Note 2)	−3.0	3.0	—	3	6	—	6	pF
		4052					3	6		6	
		4053					3	6		6	
Power dissipation capacitance	C_{PD}	4051	Figure 2 (Note 3)	GND	6.0	—	14	—	—	—	pF
		4052					24				
		4053					18				

Note1: R_L = 1 kΩ

Note2: C_{in}, C_{IS}, C_{OS} and C_{IOS} are guaranteed by the design.

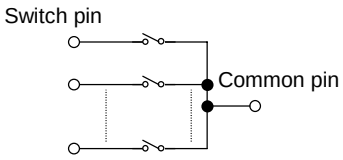
Note3: C_{PD} is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.
Average operating current can be obtained by the equation:

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

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

Characteristics	Symbol	Test Condition		V_{EE} (V)	V_{CC} (V)	Typ.	Unit
Sine Wave Distortion (T.H.D)		R_L = 10 kΩ, C_L = 50 pF, f_{IN} = 1 kHz	V_{IN} = 2.0 V_{p-p}	0	3.0	0.100	%
			V_{IN} = 4.0 V_{p-p}	0	4.5	0.030	
			V_{IN} = 6.0 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 Ω, C_L = 10 pF, f_{IN} = 1 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 Ω, C_L = 50 pF, f_{IN} = 1 MHz, sine wave Figure 4		0	3.0	−45	dB
				0	4.5	−45	
				−3.0	3.0	−45	
		R_L = 50 Ω, C_L = 10 pF, f_{IN} = 1 MHz, sine wave		0	3.0	−60	
				0	4.5	−60	
				−3.0	3.0	−60	
Crosstalk (control input to signal output)		R_L = 600 Ω, C_L = 50 pF, f_{IN} = 1 MHz, square wave (t_r = t_f = 6 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 Ω, C_L = 50 pF, f_{IN} = 1 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

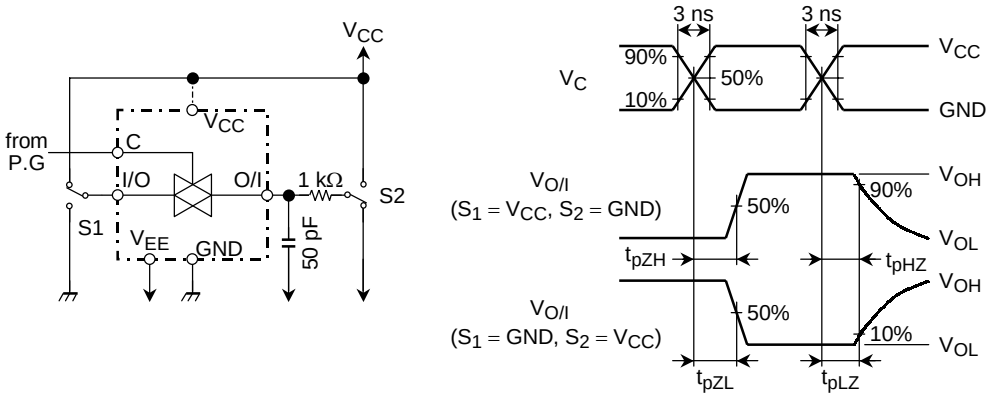


Figure 1 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

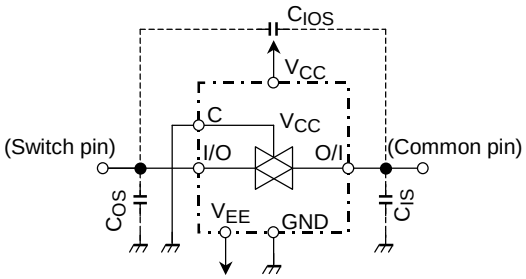


Figure 2 C_{IOS}, C_{IS}, C_{OS}

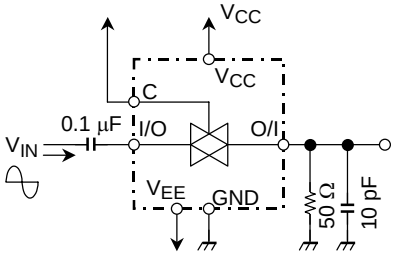


Figure 3 Frequency Response (switch on)

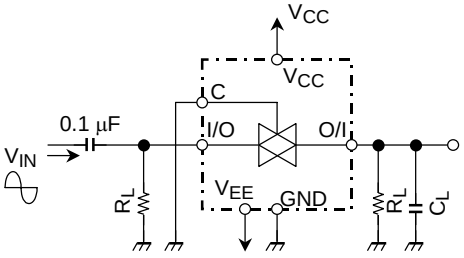


Figure 4 Feedthrough

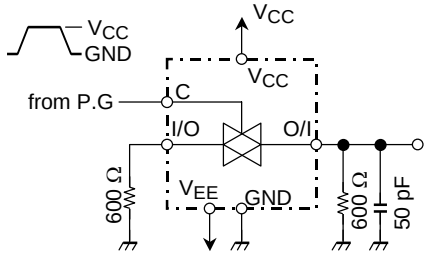


Figure 5 Cross Talk (control input to output signal)

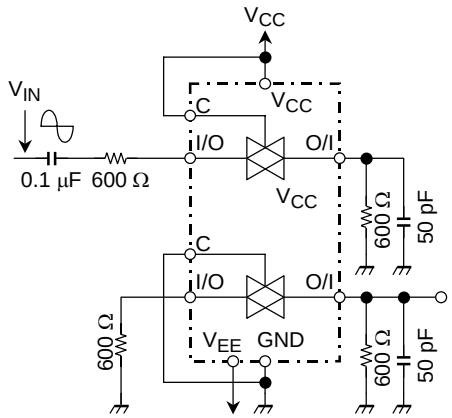
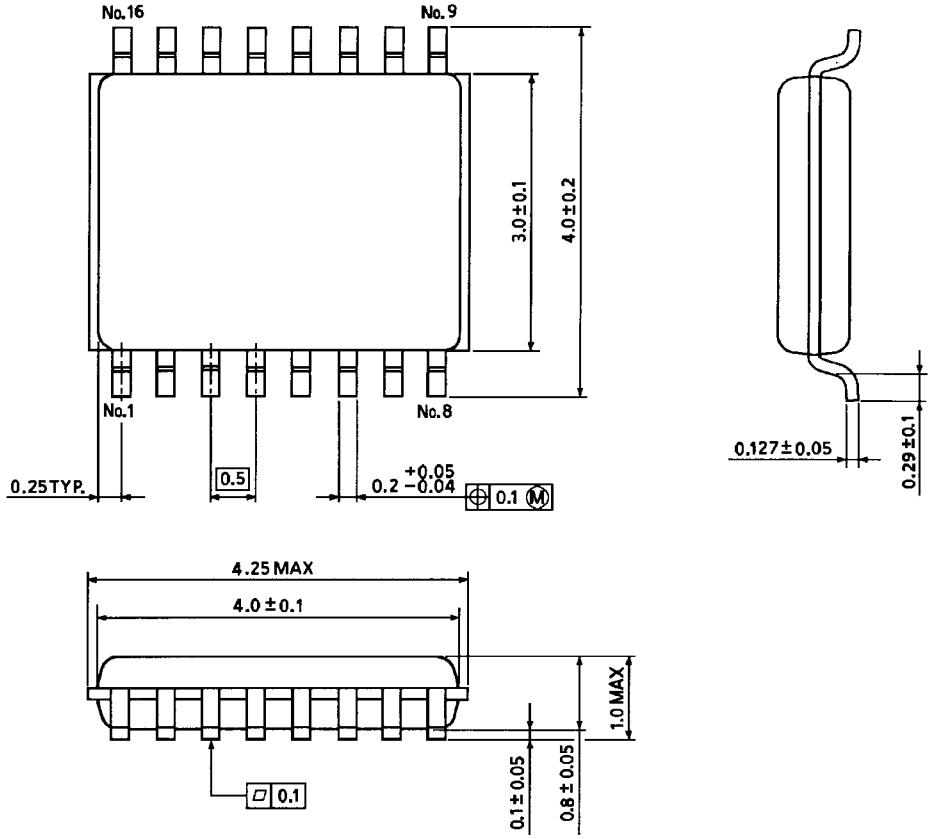


Figure 6 Cross Talk (between any two switches)

Package Dimensions

VSSOP16-P-0030-0.50 Unit : mm



Weight: 0.02 g (typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury (“Unintended Usage”). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer’s own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.