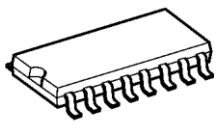
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VHC4051AF, TC74VHC4051AFK
TC74VHC4052AF, TC74VHC4052AFK
TC74VHC4053AF, TC74VHC4053AFK

TC74VHC4051AF/AFK
8-Channel Analog Multiplexer/Demultiplexer
TC74VHC4052AF/AFK
Dual 4-Channel Analog Multiplexer/Demultiplexer
TC74V4053AF/AFK
Triple 2-Channel Analog Multiplexer/Demultiplexer

TC74VHC4051AF, TC74VHC4052AF, TC74VHC4053AF



SOP16-P-300-1.27A

TC74VHC4051AFK, TC74VHC4052AFK, TC74VHC4053AFK

VSSOP16-P-0030-0.50

SOP16-P-300-1.27A : 0.18 g (typ.)
VSSOP16-P-0030-0.50 : 0.02 g (typ.)

The TC74VHC4051A/4052A/4053A 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 TC74VHC4051A/4052A/4053A offer analog/digital signal selection as well as mixed signals. The 4051A has an 8-channel configuration, the 4052A has an 4-channel × 2 configuration, and the 4053A has a 2-channel × 3 configuration.

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

All control inputs 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, 5.5 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 TC74VHC4051A/4052A/4053A can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

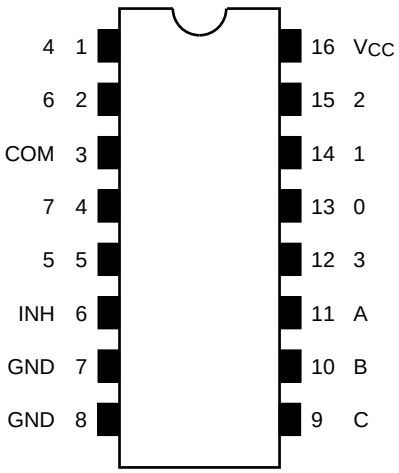
Features

- Low ON-resistance: R_{on} = 45 Ω (typ.) (V_{CC} = 3 V)
  R_{on} = 24 Ω (typ.) (V_{CC} = 4.5 V)
- Low power dissipation: I_{CC} = 2.0 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

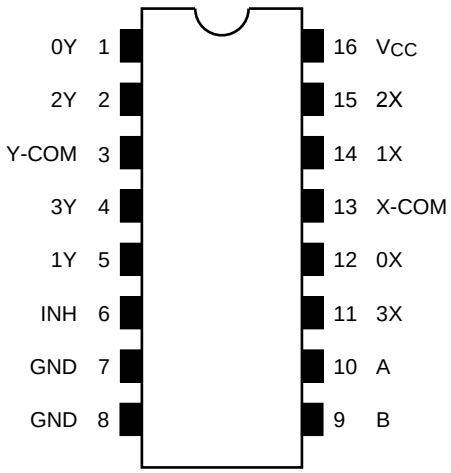
Start of commercial production
2007-01

Pin Assignment (top view)

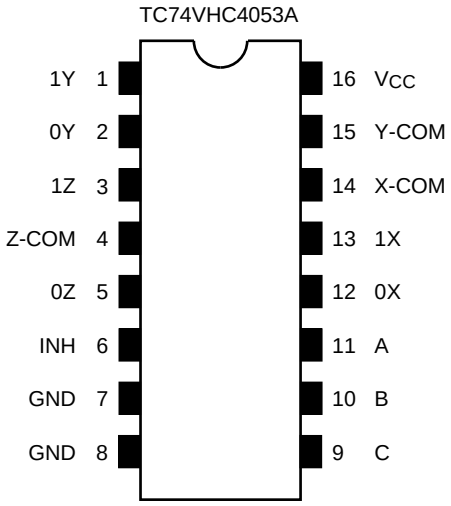
TC74VHC4051A



TC74VHC4052A



TC74VHC4053A



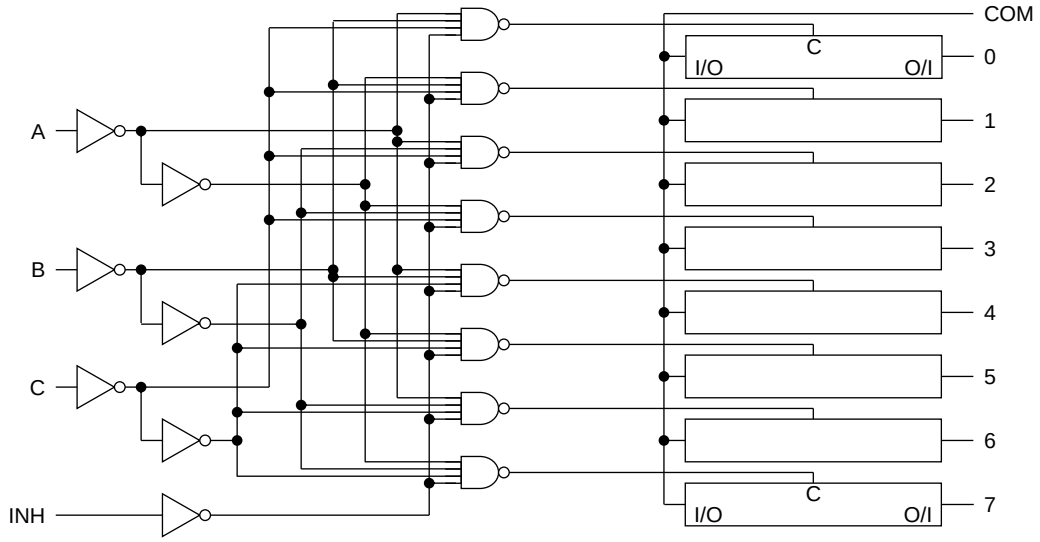
Truth Table

Control Inputs				"ON" Channel		
Inhibit	C*	B	A	VHC4051A	VHC4052A	VHC4053A
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

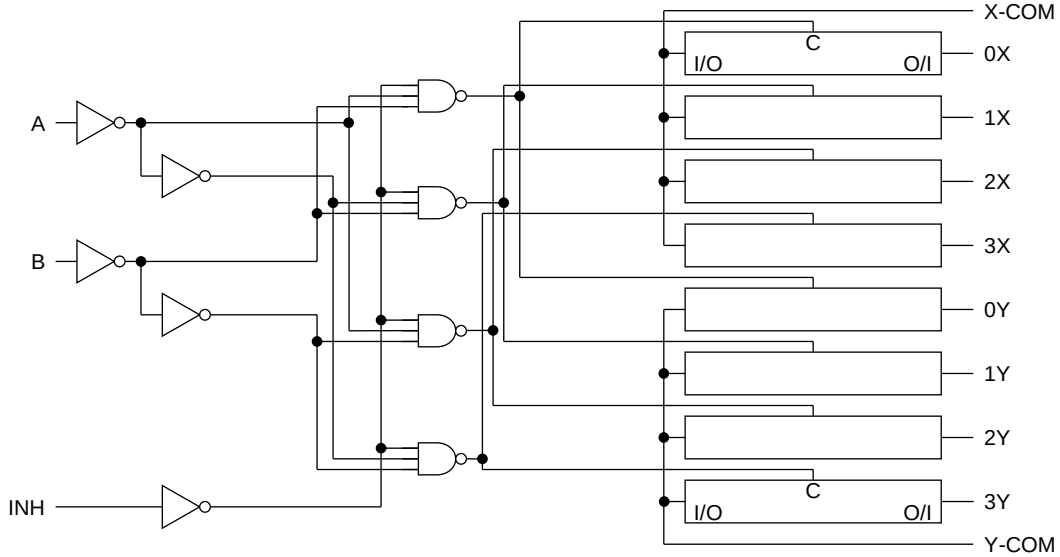
X: Don't care, *: Except VHC4052A

System Diagram

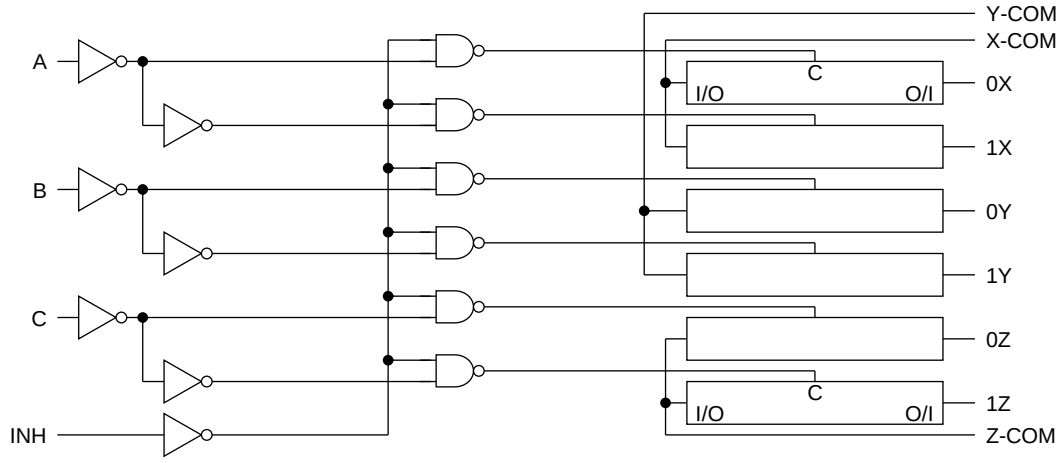
TC74VHC4051A



TC74VHC4052A



TC74VHC4053A



Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	−0.5 to 7.0	V
Control input voltage	V_{IN}	−0.5 to 7.0	V
Switch I/O voltage	$V_{I/O}$	− 0.5 to V_{CC} + 0.5	V
Input diode current	I_{IK}	−20	mA
I/O diode current	I_{IOK}	±25	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 to 150	°C

Note : Exceeding any of the absolute maximum ratings, even briefly, may 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 to 5.5	V
Input voltage	V_{IN}	0 to 5.5	V
Switch I/O voltage	$V_{I/O}$	0 to V_{CC}	V
Operating temperature	T_{opr}	−40 to 85	°C
Input rise and fall time	dt/dv	0 to 200 (V_{CC} = 2.5 ± 0.2 V)	ns/V
		0 to 100 (V_{CC} = 3.3 ± 0.3 V)	
		0 to 20 (V_{CC} = 5 ± 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 to 85°C		Unit
				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	—	
				5.5	3.85	—	—	3.85	—	
	Low-level	V_{IL}	—	2.0	—	—	0.5	—	0.5	
				3.0	—	—	0.8	—	0.8	
				4.5	—	—	1.35	—	1.35	
				5.5	—	—	1.65	—	1.65	
ON resistance		R_{ON}	V_{IN} = V_{IL} or V_{IH} $V_{I/O}$ = V_{CC} to GND $I_{I/O}$ = 2 mA	2.3	—	200	—	—	—	Ω
				3.0	—	45	86	—	108	
				4.5	—	24	37	—	46	
			V_{IN} = V_{IL} or V_{IH} $V_{I/O}$ = V_{CC} or GND $I_{I/O}$ = 2 mA	2.3	—	28	73	—	84	
				3.0	—	22	38	—	44	
				4.5	—	17	27	—	31	
Difference of ON resistance between switches		ΔR_{ON}	V_{IN} = V_{IL} or V_{IH} $V_{I/O}$ = V_{CC} to GND $I_{I/O}$ = 2 mA	2.3	—	10	25	—	35	Ω
				3.0	—	5	15	—	20	
				4.5	—	5	13	—	18	
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}	5.5	—	—	±0.1	—	±1.0	μA
Input/Output leakage current (switch ON, output open)		$I_{I/O}$	V_{OS} = V_{CC} or GND V_{IN} = V_{IL} or V_{IH}	5.5	—	—	±0.1	—	±1.0	μA
Control input current		I_{IN}	V_{IN} = V_{CC} or GND	5.5	—	—	±0.1	—	±1.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND	5.5	—	—	2.0	—	20.0	μA

AC Electrical Characteristics (Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Ta = 25°C Min	Ta = 25°C Typ.	Ta = 25°C Max	Ta = −40 to 85°C Min	Ta = −40 to 85°C Max	Unit
Phase difference between input and output	ϕI/O	C_L = 15 pF, R_L = 1 kΩ		2.5±0.2	—	1.2	10	—	16	ns
				3.3±0.3	—	0.8	6	—	10	
				5.0±0.5	—	0.3	4	—	7	
		C_L = 50 pF, R_L = 1 kΩ		2.5±0.2	—	2.6	12	—	18	
				3.3±0.3	—	1.5	9	—	12	
				5.0±0.5	—	0.6	6	—	8	
Output enable time	t_{pZL} t_{pZH}	C_L = 15 pF, R_L = 1 kΩ	Figure 1	2.5±0.2	—	3.3	15	—	20	ns
				3.3±0.3	—	2.3	11	—	15	
				5.0±0.5	—	1.6	7	—	10	
		C_L = 50 pF, R_L = 1 kΩ	Figure 1	2.5±0.2	—	4.2	25	—	32	
				3.3±0.3	—	3.0	18	—	22	
				5.0±0.5	—	2.1	12	—	16	
Output disable time	t_{pLZ} t_{pHZ}	C_L = 15 pF, R_L = 1 kΩ	Figure 1	2.5±0.2	—	6	15	—	23	ns
				3.3±0.3	—	4.5	11	—	15	
				5.0±0.5	—	3.2	7	—	10	
		C_L = 50 pF, R_L = 1 kΩ	Figure 1	2.5±0.2	—	9.6	25	—	32	
				3.3±0.3	—	7.2	18	—	22	
				5.0±0.5	—	5.1	12	—	16	
Control input capacitance	C_{IN}	All types		—	—	2	—	—	10	pF
COMMON terminal capacitance	C_{IS}	4051A	Figure 2	—	—	23.4	—	—	—	pF
		4052A				13.1				
		4053A				8.2				
SWITCH terminal capacitance	C_{OS}	4051A	Figure 2	—	—	5.7	—	—	—	pF
		4052A				5.6				
		4053A				5.6				
Feedthrough capacitance	C_{IOS}	4051A	Figure 2	—	—	0.5	—	—	—	pF
		4052A				0.5				
		4053A				0.5				
Power dissipation capacitance	C_{PD}	4051A	Figure 2 (Note)	—	—	15	—	—	—	pF
		4052A				24				
		4053A				12				

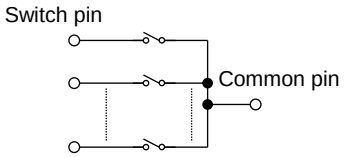
Note: C_{PD} is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.
Average operating current can be obtained by the equation:

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

Analog Switch Characteristics (Ta = 25°C) (Note)

Characteristics	Test Condition		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}	3.0	0.1	%
		V_{IN} = 4.0 V_{p-p}	4.5	0.03	
Frequency response (switch ON)	V_{IN} is centered at (V_{CC}/2). Adjust input for 0dBm. Increase f_{IN} frequency until dB meter reads −3dB. R_L = 50 Ω, C_L = 10 pF,sine wave Figure 3	4051A	3.0	150	MHz
		4052A		200	
		4053A		240	
		4051A	4.5	180	
		4052A		230	
		4053A		280	
Feed through attenuation (switch OFF)	V_{IN} is centered at (V_{CC}/2). Adjust input for 0dBm. R_L = 600 Ω, C_L = 50 pF, f_{IN} = 1 MHz, sine wave Figure 4		3.0	-45	dB
			4.5	-45	
	R_L = 50 Ω, C_L = 10 pF, f_{IN} = 1 MHz, sine wave		3.0	-65	
			4.5	-65	
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		3.0	60	mV
			4.5	100	
Crosstalk (between any switches)	V_{IN} is centered at (V_{CC}/2). Adjust input for 0dBm. R_L = 600 Ω, C_L = 50 pF, f_{IN} = 1 MHz, sine wave Figure 6		3.0	-45	dB
			4.5	-45	

Note: These characteristics are determined by design of devices.



AC Test Circuit

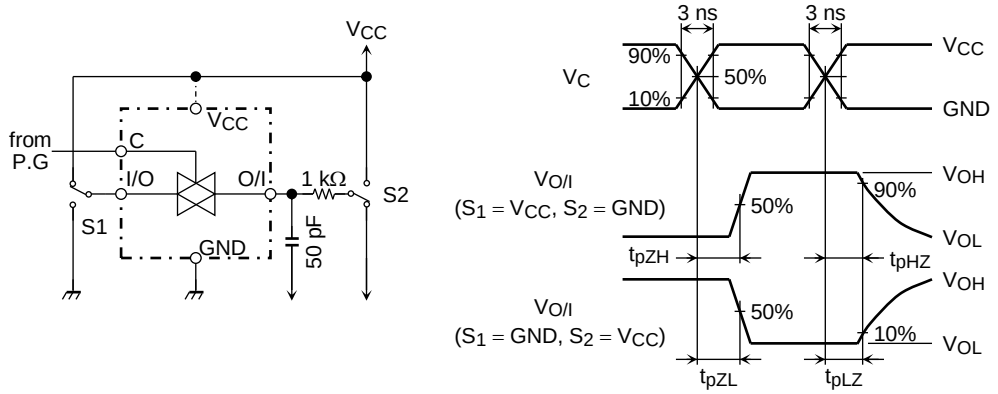


Figure 1 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

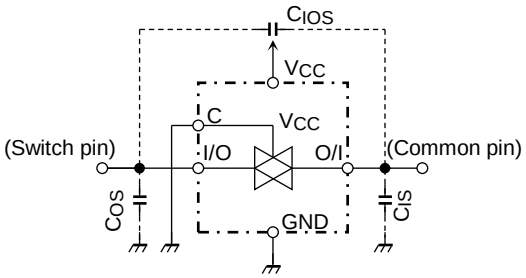


Figure 2 C_{IOS}, C_{IS}, C_{OS}

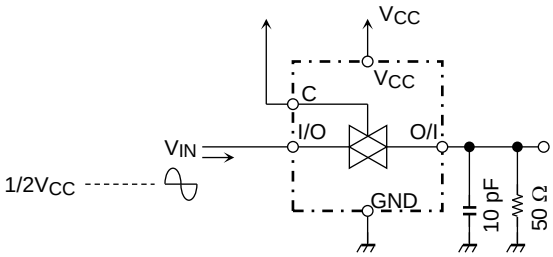


Figure 3 Frequency Response (switch on)

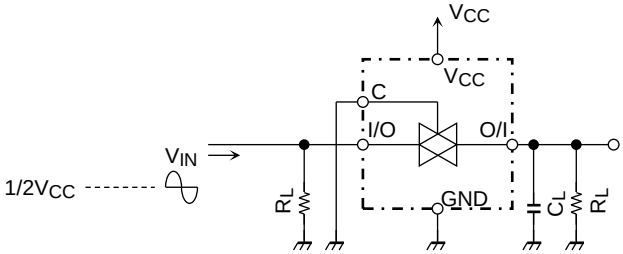


Figure 4 Feedthrough

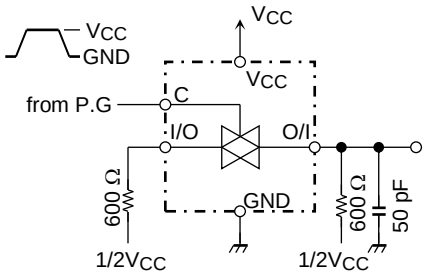


Figure 5 Cross Talk (control input to output signal)

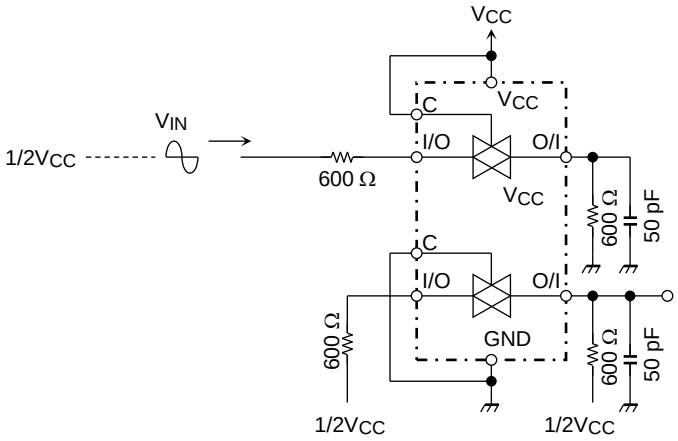
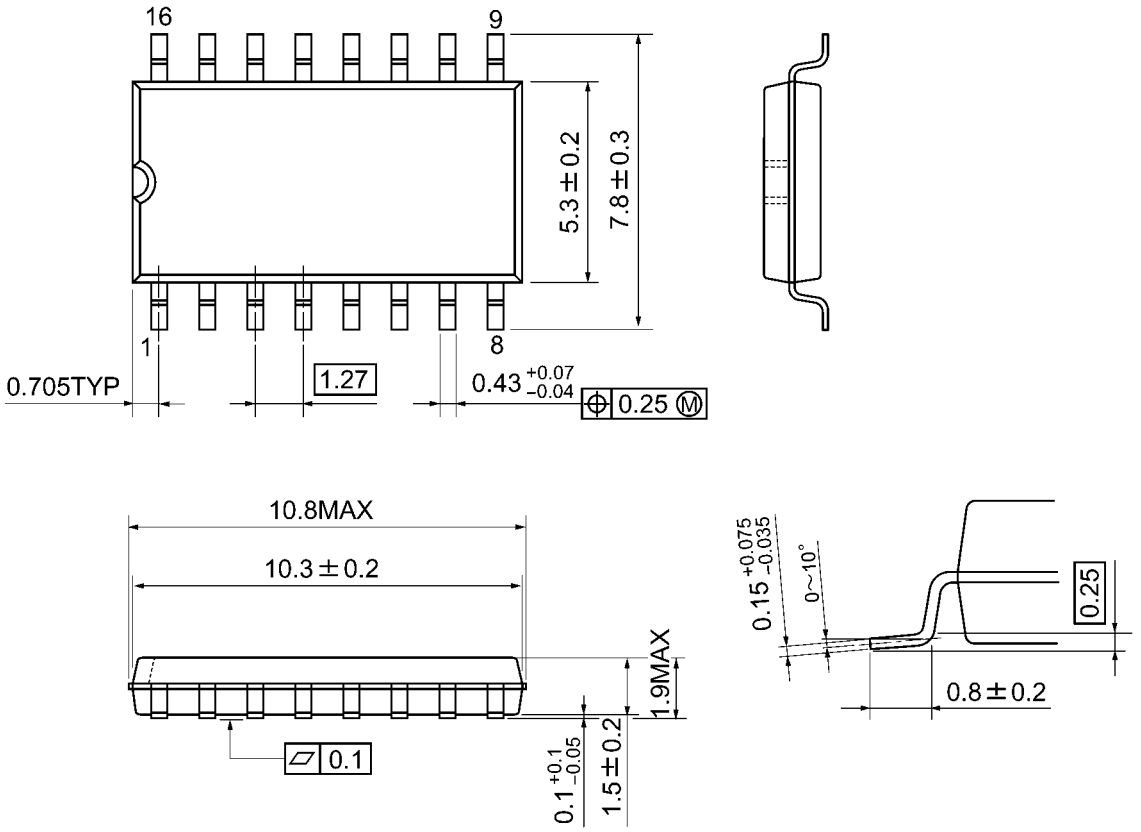


Figure 6 Cross Talk (between any two switches)

Package Dimensions

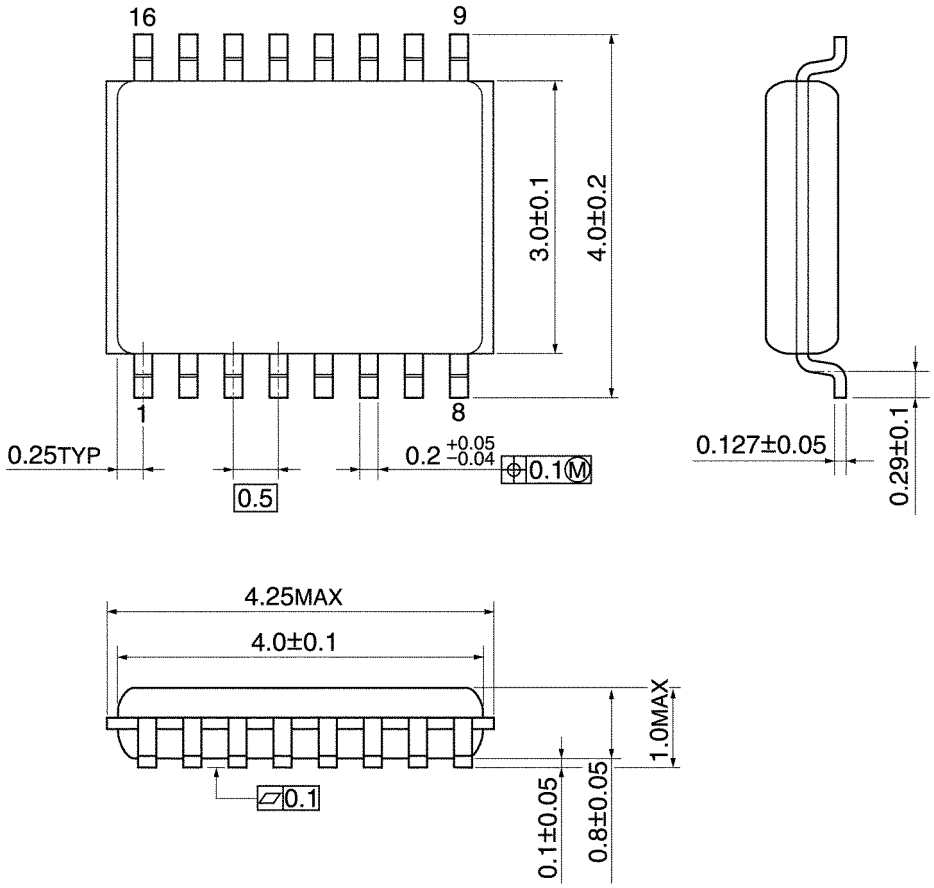
SOP16-P-300-1.27A Unit: mm



Weight: 0.18 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50 Unit: mm



Weight: 0.02 g (typ.)

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