

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VHC4051AF,TC74VHC4051AFT,TC74VHC4051AFK TC74VHC4052AF,TC74VHC4052AFT,TC74VHC4052AFK TC74VHC4053AF,TC74VHC4053AFT,TC74VHC4053AFK

TC74VHC4051AF/AFT/AFK

8-Channel Analog Multiplexer/Demultiplexer

TC74VHC4052AF/AFT/AFK

Dual 4-Channel Analog Multiplexer/Demultiplexer

TC74V4053AF/AFT/AFK

Triple 2-Channel Analog Multiplexer/Demultiplexer

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 $\times$ 2 configuration, and the 4053A has a 2-channel $\times$ 3 configuration.

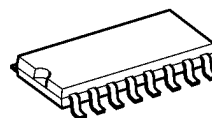
The switches for each channel are turned ON by the control pin digital signals.

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

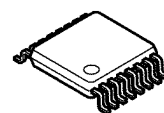
- Low ON-resistance: $R_{on} = 45 \Omega$ (typ.) ($V_{CC} = 3 V$)
 $R_{on} = 24 \Omega$ (typ.) ($V_{CC} = 4.5 V$)
- Low power dissipation: $I_{CC} = 2.0 \mu A$ (max) ($T_a = 25^\circ C$)
- Input level: $V_{IL} = 0.8 V$ (max) ($V_{CC} = 3 V$)
 $V_{IH} = 2.0 V$ (min) ($V_{CC} = 3 V$)
- Power down protection is provided on all control inputs

TC74VHC4051AF, TC74VHC4052AF,
TC74VHC4053AF



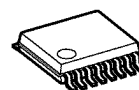
SOP16-P-300-1.27A

TC74VHC4051AFT, TC74VHC4052AFT,
TC74VHC4053AFT



TSSOP16-P-0044-0.65A

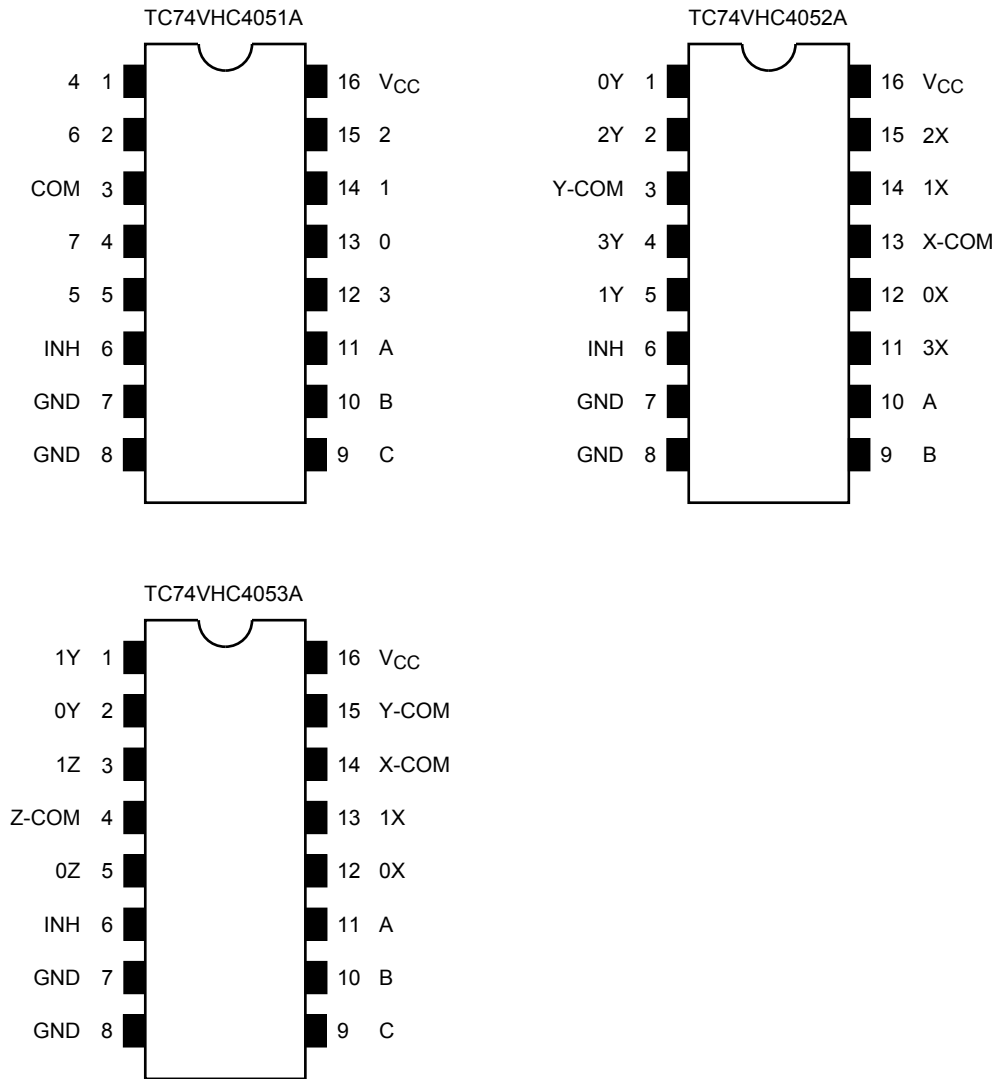
TC74VHC4051AFK, TC74VHC4052AFK,
TC74VHC4053AFK



VSSOP16-P-0030-0.50

SOP16-P-300-1.27A	: 0.18 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)
VSSOP16-P-0030-0.50	: 0.02 g (typ.)

Pin Assignment (top view)



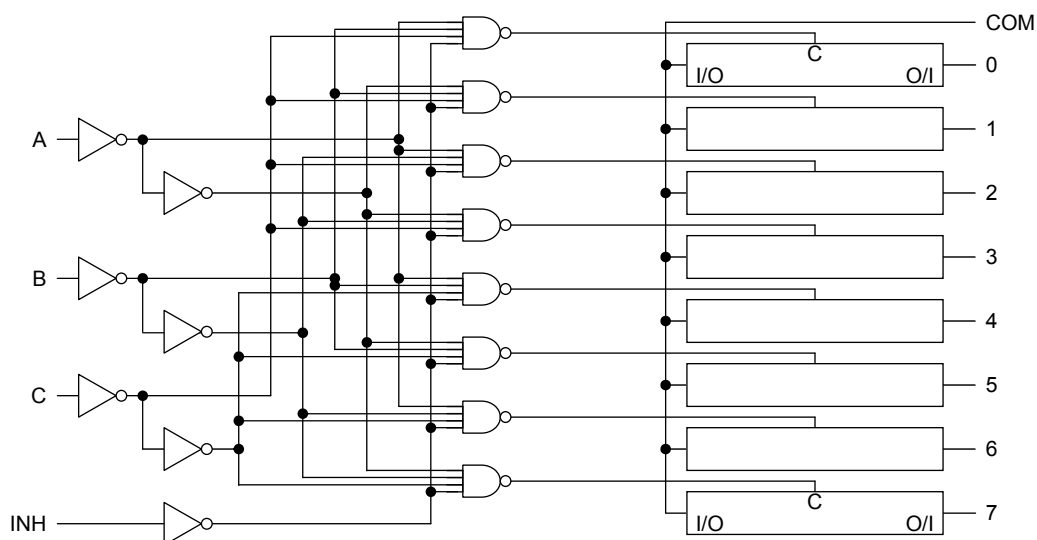
Truth Table

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

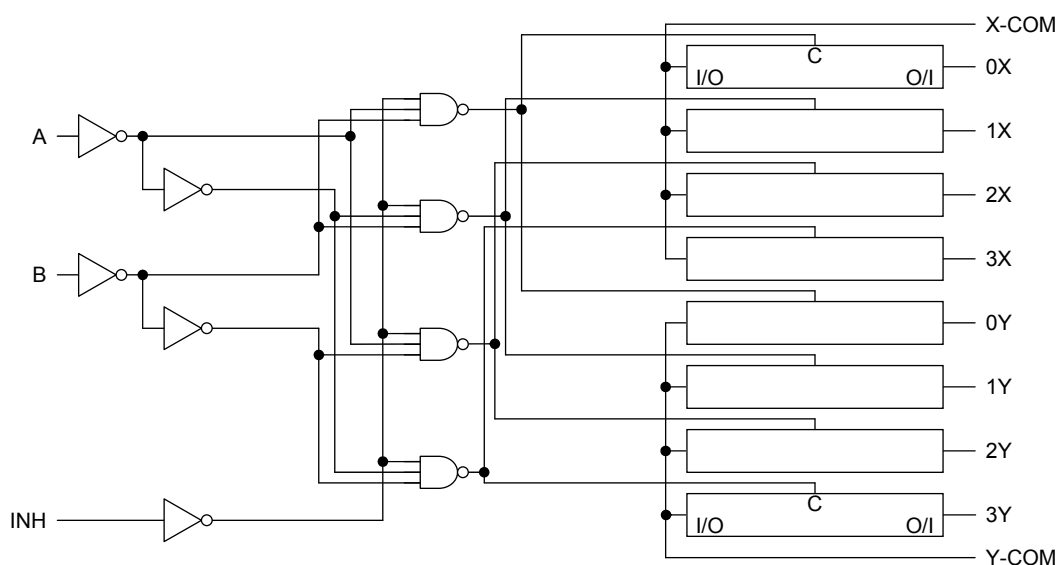
X: Don't care, *: Except VHC4052A

System Diagram

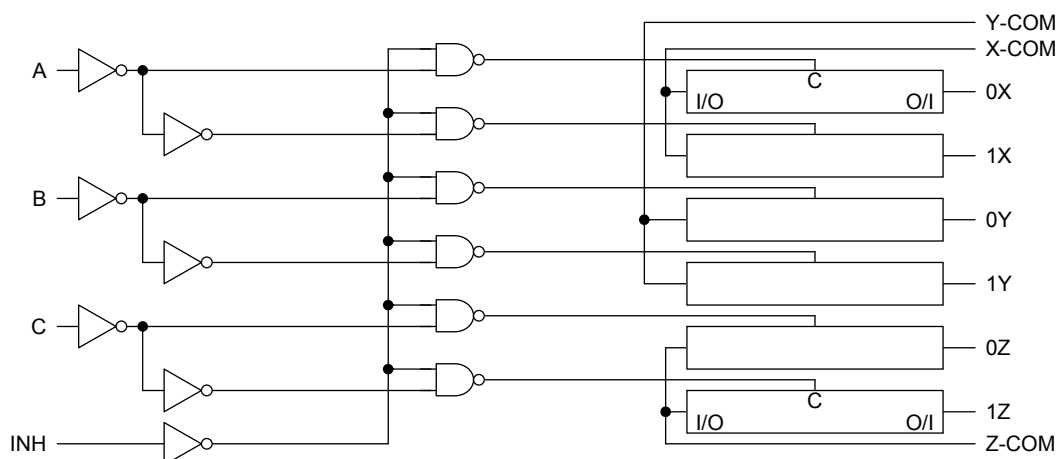
TC74VHC4051A



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 ($V_{CC} = 2.5 \pm 0.2$ V)	ns/V
		0 to 100 ($V_{CC} = 3.3 \pm 0.3$ V)	
		0 to 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 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			Ta = −40 to 85°C		Unit
					Min	Typ.	Max	Min	Max	
Phase difference between input and output	φ/I/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.

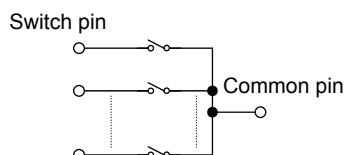
Average operating current can be obtained by the equation:

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

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

Characteristics	Test Condition		Typ.	Unit	
					V _{CC} (V)
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		
		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

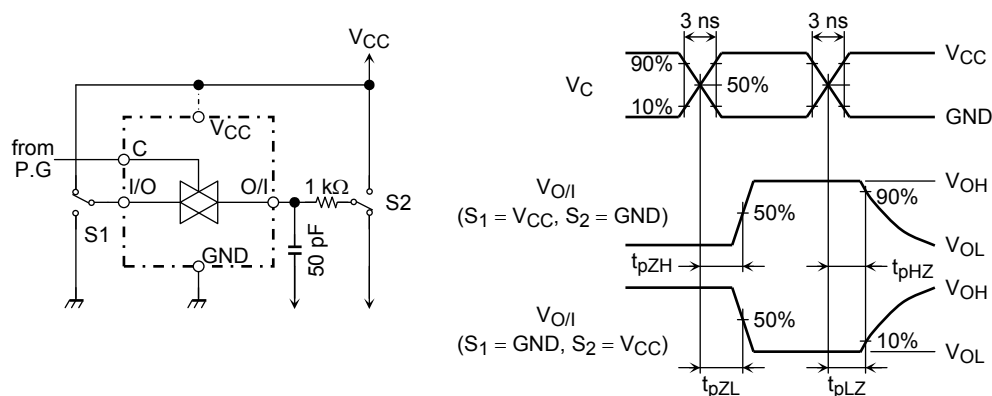


Figure 1 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

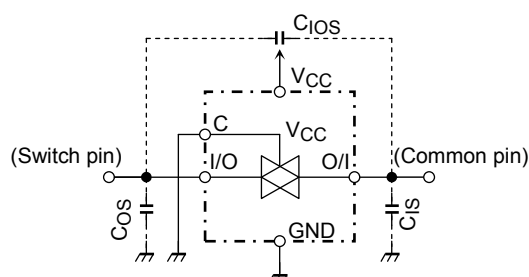


Figure 2 C_{10S} , C_{1S} , C_{0S}

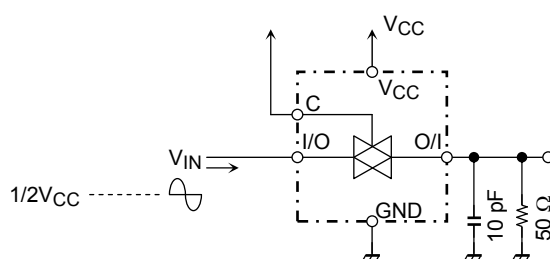


Figure 3 Frequency Response (switch on)

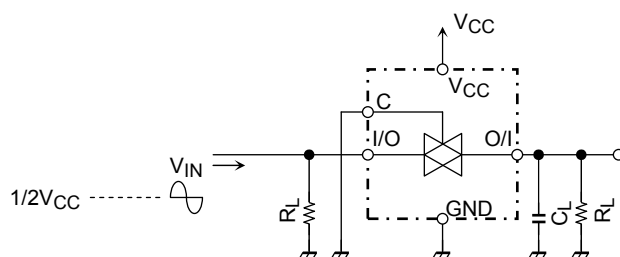


Figure 4 Feedthrough

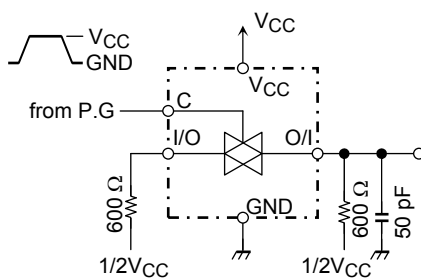


Figure 5 Cross Talk (control input to output signal)

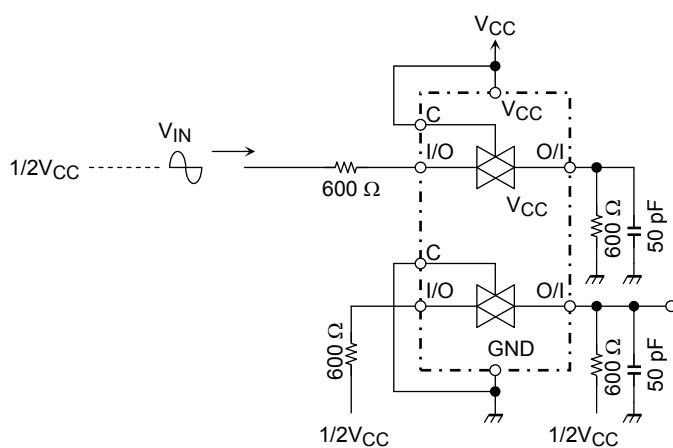
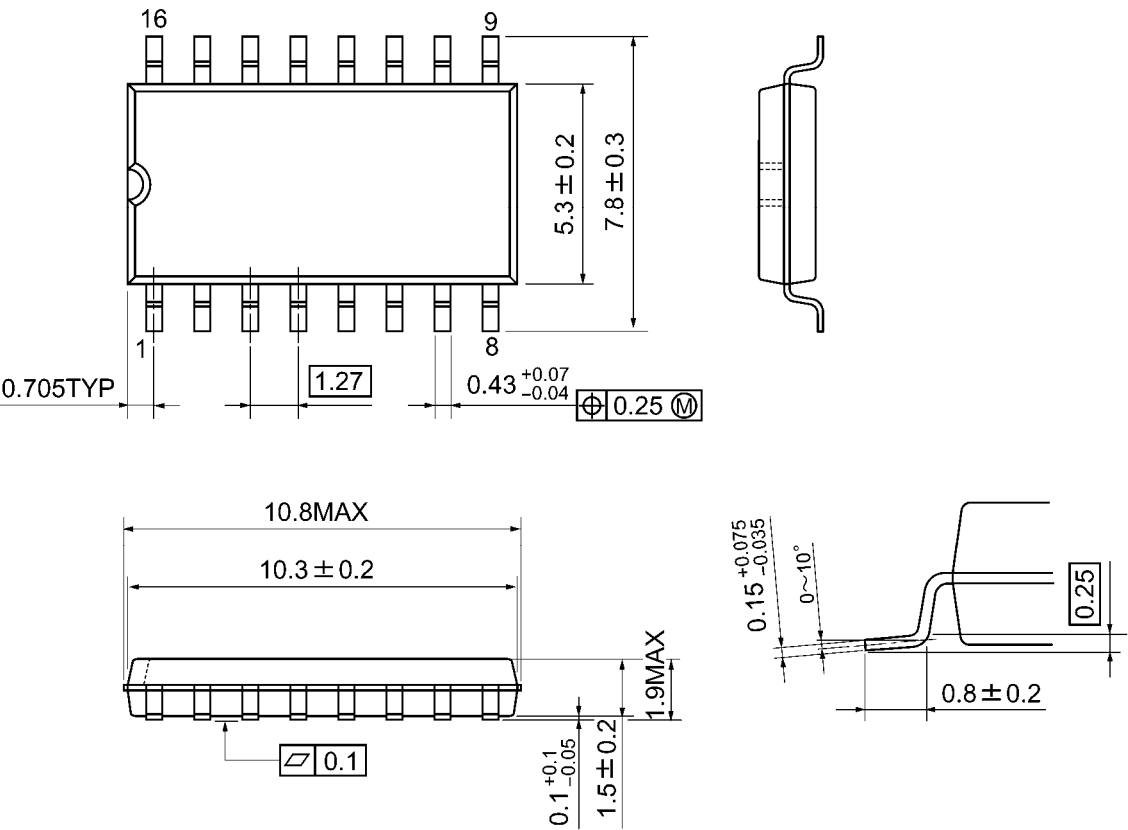


Figure 6 Cross Talk (between any two switches)

Package Dimensions

SOP16-P-300-1.27A

Unit: mm

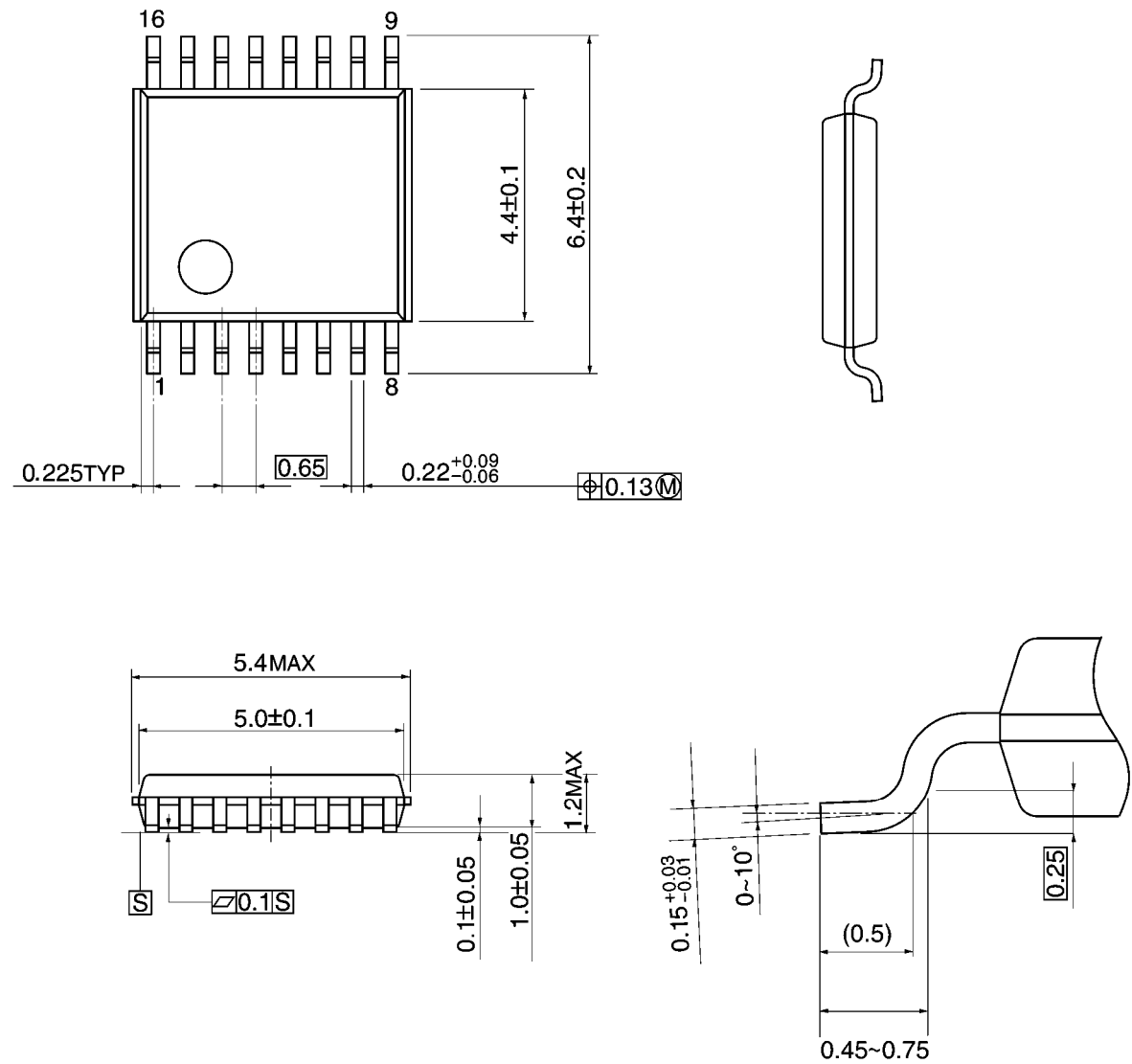


Weight: 0.18 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

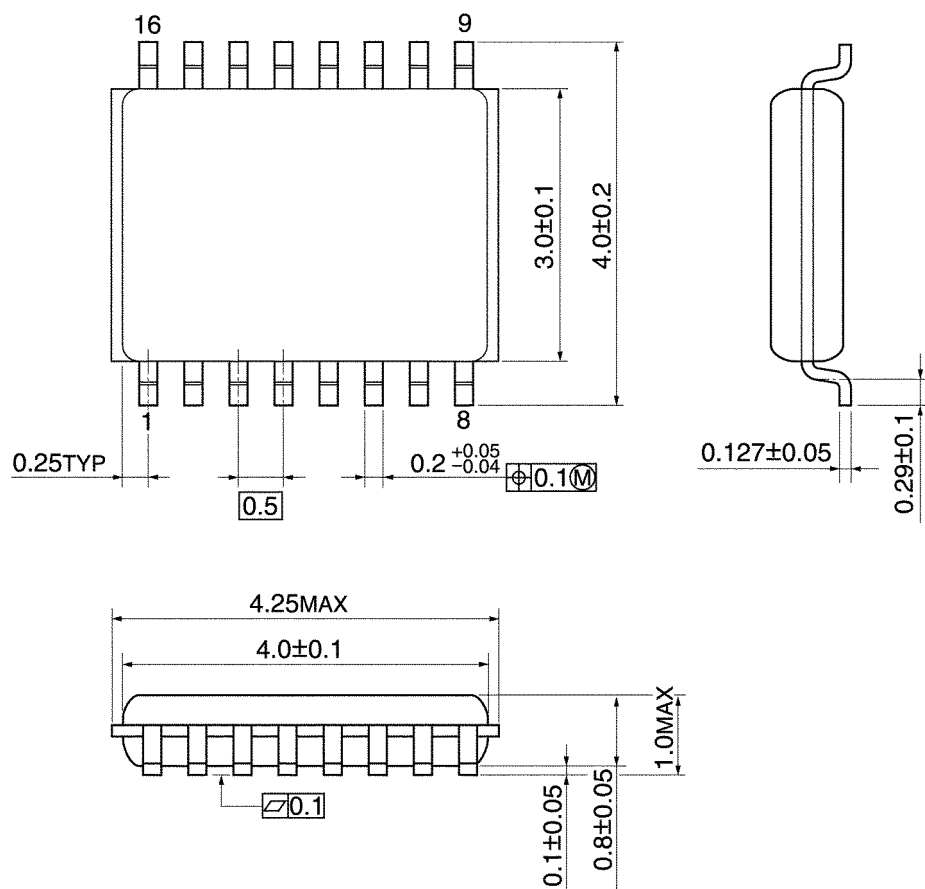


Weight: 0.06 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

RESTRICTIONS ON PRODUCT USE

- Toshiba Corporation, and its subsidiaries and affiliates (collectively "TOSHIBA"), reserve the right to make changes to the information in this document, and related hardware, software and systems (collectively "Product") without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- Product is intended for use in general electronics applications (e.g., computers, personal equipment, office equipment, measuring equipment, industrial robots and home electronics appliances) or for specific applications as expressly stated in this document. Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact ("Unintended Use"). Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for Unintended Use unless specifically permitted in this document.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. TOSHIBA assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.