

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74LVX4051F,TC74LVX4051FT,TC74LVX4051FK TC74LVX4052F,TC74LVX4052FT,TC74LVX4052FK TC74LVX4053F,TC74LVX4053FT,TC74LVX4053FK

TC74LVX4051F/FT/FK

8-Channel Analog Multiplexer/Demultiplexer

TC74LVX4052F/FT/FK

Dual 4-Channel Analog Multiplexer/Demultiplexer

TC74LVX4053F/FT/FK

Triple 2-Channel Analog Multiplexer/Demultiplexer

The TC74LVX4051/4052/4053 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 TC74LVX4051/4052/4053 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.

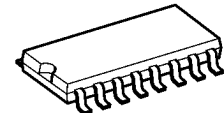
For example, if $V_{CC} = 3\text{ V}$, $GND = 0\text{ V}$, and $V_{EE} = -3\text{ V}$, signals between -3 V and $+3\text{ V}$ can be switched from the logical circuit using a single 3 V power supply.

All control 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 TC74LVX4051/4052/4053 can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

Features

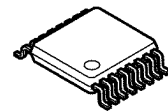
- Low ON resistance: $R_{on} = 22\ \Omega$ (typ.) ($V_{CC} - V_{EE} = 3\text{ V}$)
 $R_{on} = 15\ \Omega$ (typ.) ($V_{CC} - V_{EE} = 6\text{ V}$)
- High speed: $t_{pd} = 3\text{ ns}$ (typ.) ($V_{CC} = 3.0\text{ V}$)
- Low power dissipation: $I_{CC} = 4\ \mu\text{A}$ (max) ($T_a = 25^\circ\text{C}$)
- 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

TC74LVX4051F, TC74LVX4052F,
TC74LVX4053F



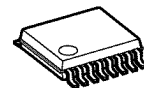
SOP16-P-300-1.27A

TC74LVX4051FT, TC74LVX4052FT,
TC74LVX4053FT



TSSOP16-P-0044-0.65A

TC74LVX4051FK, TC74LVX4052FK,
TC74LVX4053FK

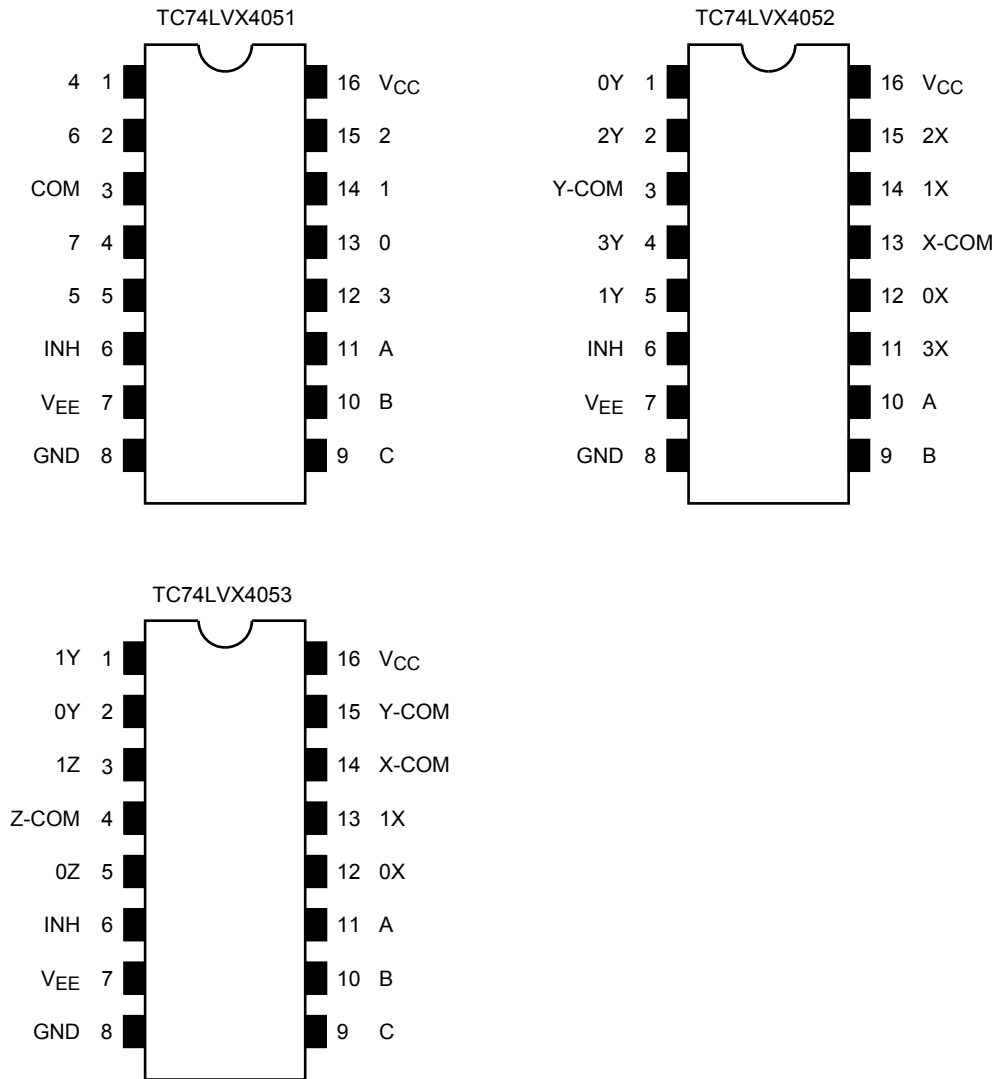


VSSOP16-P-0030-0.50

Weight

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)

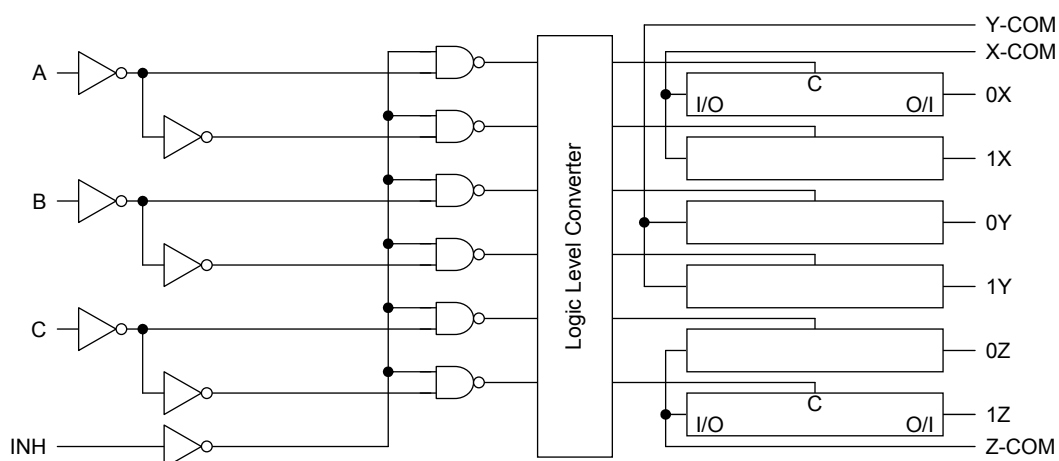


Truth Table

Control Inputs				“ON” Channel		
Inhibit	C*	B	A	TC74LVX4051	TC74LVX4052	TC74LVX4053
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 TC74LVX4052

TC74LVX4051



Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	-0.5 to 7.0	V
	V_{CC} to V_{EE}	-0.5 to 7.0	
Control input voltage	V_{IN}	-0.5 to 7.0	V
Switch I/O voltage	$V_{I/O}$	$V_{EE} - 0.5$ to $V_{CC} + 0.5$	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 to 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 to 6	V
	V_{EE}	-4 to 0	
	V_{CC} to V_{EE}	2 to 6	
Input voltage	V_{IN}	0 to 6.0	V
Switch I/O voltage	$V_{I/O}$	V_{EE} to V_{CC}	V
Operating temperature	T_{opr}	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 100 ($V_{CC} = 3.3 \pm 0.3$ V)	ns/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 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 _{EE} (V)	V _{CC} (V)	Min	Typ.	Max	
Input voltage	High-level	V _{IH}	—			2.0	1.5	—	—	V
						3.0	2.0	—	—	
						4.5	3.15	—	—	
						6.0	4.2	—	—	
	Low-level	V _{IL}	—			2.0	—	—	0.5	
						3.0	—	—	0.8	
						4.5	—	—	1.35	
						6.0	—	—	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			Ta = 25°C			Ta = -40 to 85°C		Unit
			V _{EE} (V)	V _{CC} (V)	Min	Typ.	Max	Min	Max	
Phase difference between input and output	φ _{I/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		
		4053					7	15		
SWITCH terminal capacitance	C _{OS}	4051	Figure 2 (Note 2)	-3.0	3.0	—	6	13	13	pF
		4052					6	13		
		4053					6	13		
Feedthrough capacitance	C _{IOS}	4051	Figure 2 (Note 2)	-3.0	3.0	—	3	6	6	pF
		4052					3	6		
		4053					3	6		
Power dissipation capacitance	C _{PD}	4051	Figure 2 (Note 3)	GND	6.0	—	14	—	—	pF
		4052					24			
		4053					18			

Note 1: R_L = 1 kΩ

Note 2: C_{in}, C_{IS}, C_{OS} and C_{IOS} are guaranteed by the design.

Note 3: C_{PD} is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.

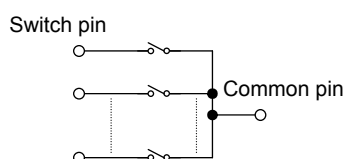
Average operating current can be obtained by the equation:

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

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

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	

Note: These characteristics are determined by design of devices.



AC Test Circuit

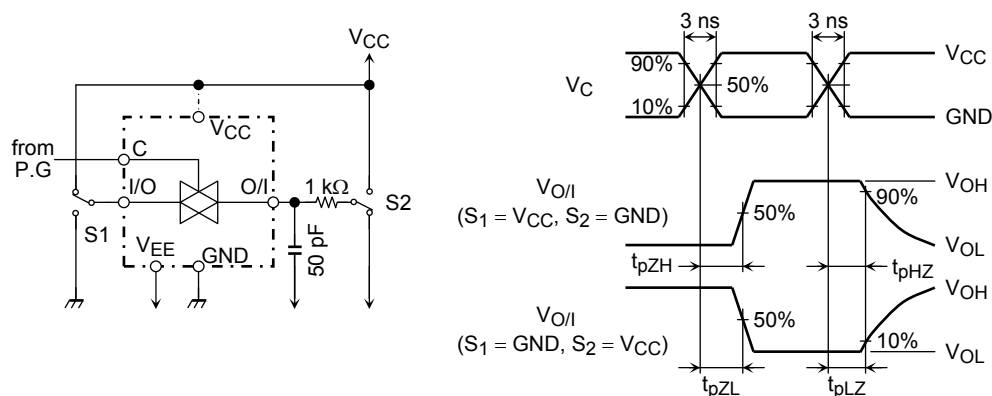


Figure 1 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

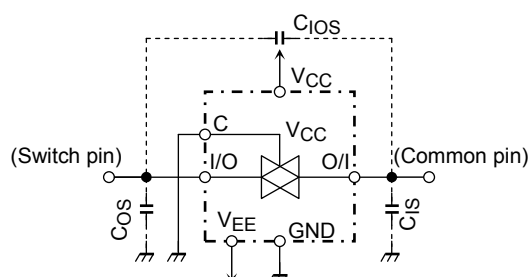


Figure 2 C_{10S} , C_{1S} , C_{0S}

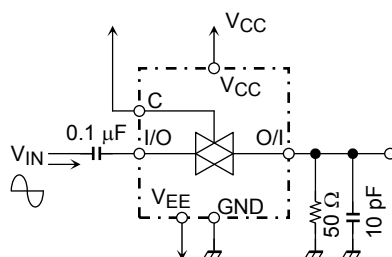


Figure 3 Frequency Response (switch on)

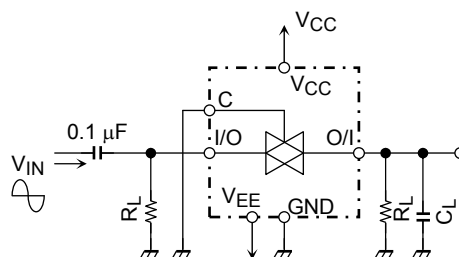


Figure 4 Feedthrough

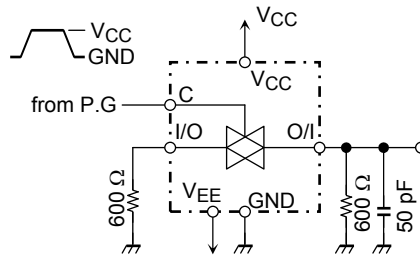


Figure 5 Cross Talk (control input to output signal)

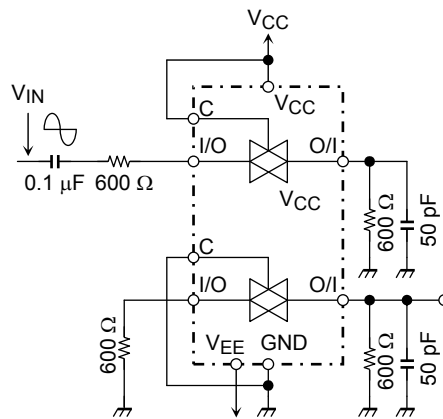
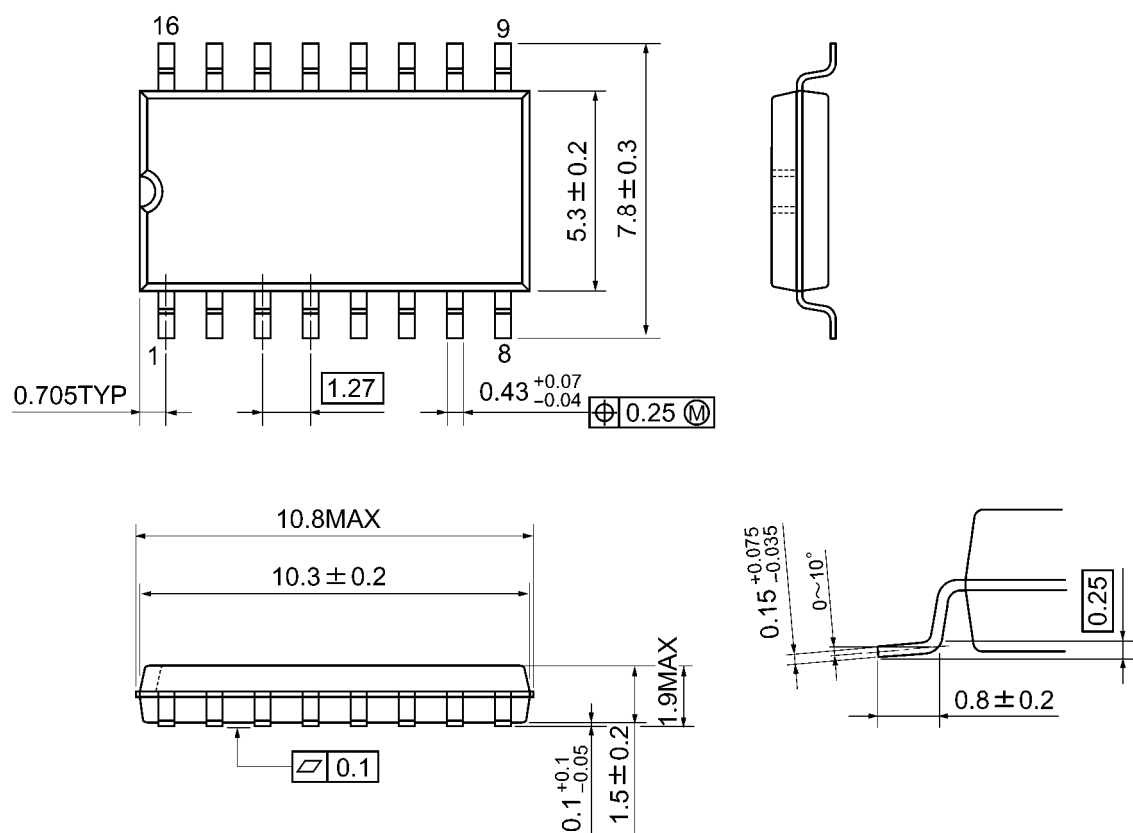


Figure 6 Cross Talk (between any two switches)

Package Dimensions

SOP16-P-300-1.27A

Unit: mm

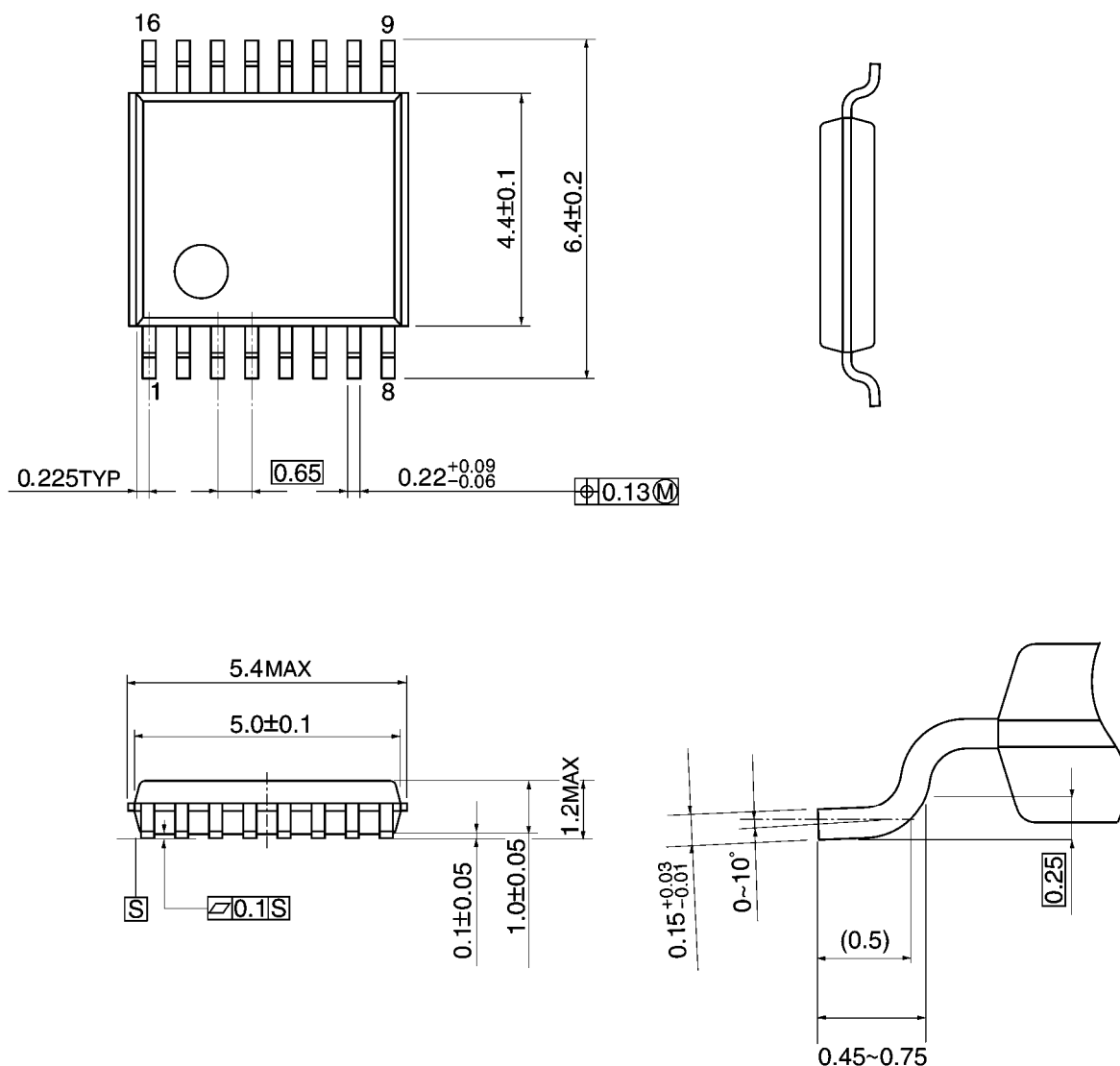


Weight: 0.18 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

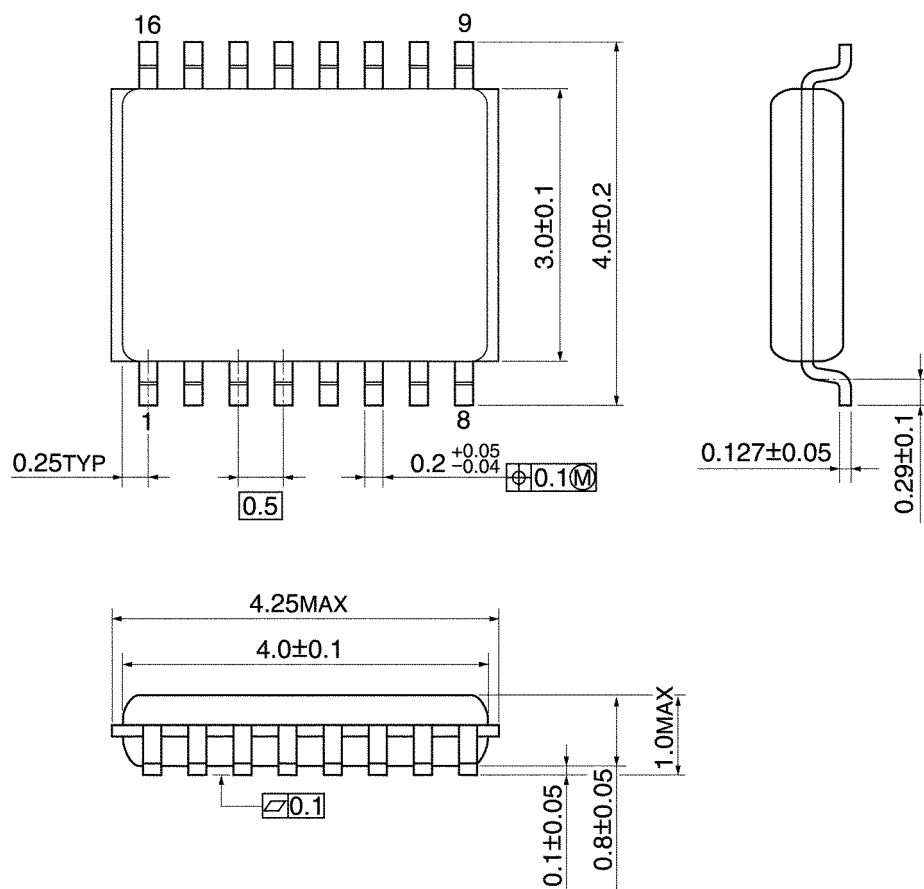


Weight: 0.06 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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