TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

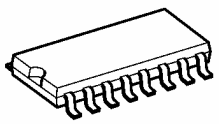
TC74LVX4051F,TC74LVX4052F,TC74LVX4053F TC74LVX4051FT,TC74LVX4052FT,TC74LVX4053FT

TC74LVX4051F/FT 8-Channel Analog Multiplexer/Demultiplexer

TC74LVX4052F/FT Dual 4-Channel Analog Multiplexer/Demultiplexer

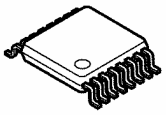
TC74LVX4053F/FT Triple 2-Channel Analog Multiplexer/Demultiplexer

TC74LVX4051F, TC74LVX4052F, TC74LVX4053F



SOP16-P-300-1.27A

TC74LVX4051FT, TC74LVX4052FT, TC74LVX4053FT



TSSOP16-P-0044-0.65A

Weight
SOP16-P-300-1.27A: 0.18 g (typ.)
TSSOP16-P-0044-0.65A: 0.06 g (typ.)

The TC74LVX4051/4052/4053F/FT 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 TC74LVX4051/4052/4053F/FT 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.

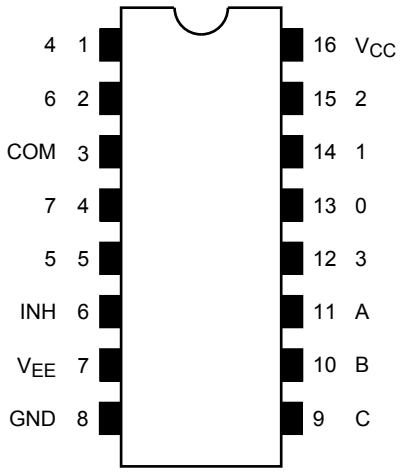
All input pins are equipped with a newly developed input protection circuit that avoids the need for a diode on the plus side (forward side from the input to the V_{CC}). As a result, for example, 5 V signals can be permitted on the inputs even when the power supply voltage to the circuits is off. As a result of this input power protection, the TC74LVX4051/4052/4053F/FT can be used in a variety of applications, including in the system which has two power supplies, and in battery backup circuits.

Features

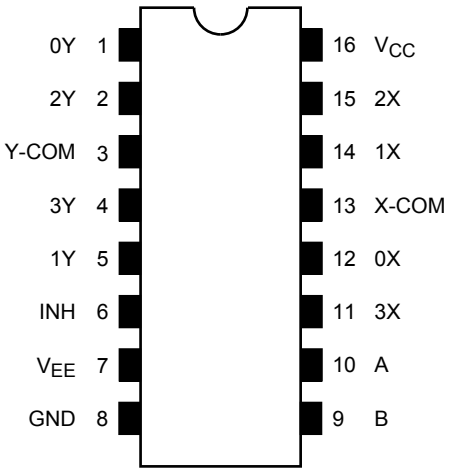
- Low ON resistance: R_{on} = 22 Ω (typ.) (V_{CC} − V_{EE} = 3 V)
  R_{on} = 15 Ω (typ.) (V_{CC} − V_{EE} = 6 V)
- High speed: t_{pd} = 3 ns (typ.) (V_{CC} = 3.0 V)
- Low power dissipation: I_{CC} = 4 μA (max) (Ta = 25°C)
- Input level: V_{IL} = 0.8 V (max) (V_{CC} = 3 V)
  V_{IH} = 2.0 V (min) (V_{CC}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

Pin Assignment (top view)

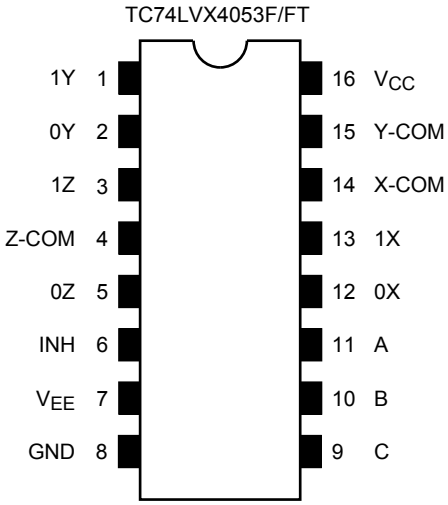
TC74LVX4051F/FT



TC74LVX4052F/FT



TC74LVX4053F/FT



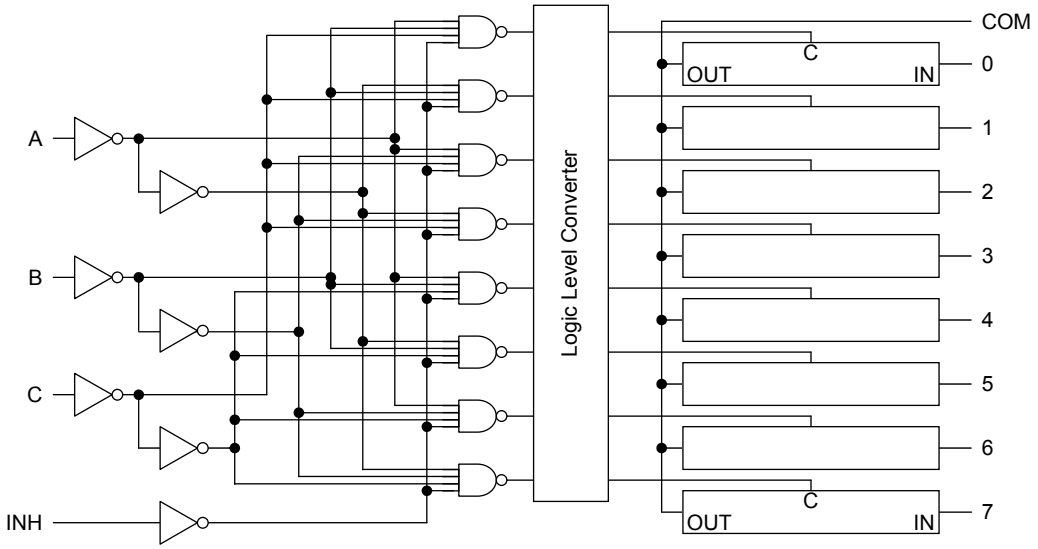
Truth Table

Control Inputs				"ON" Channel		
Inhibit	C*	B	A	LVX4051F/FT	LVX4052F/FT	LVX4053F/FT
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

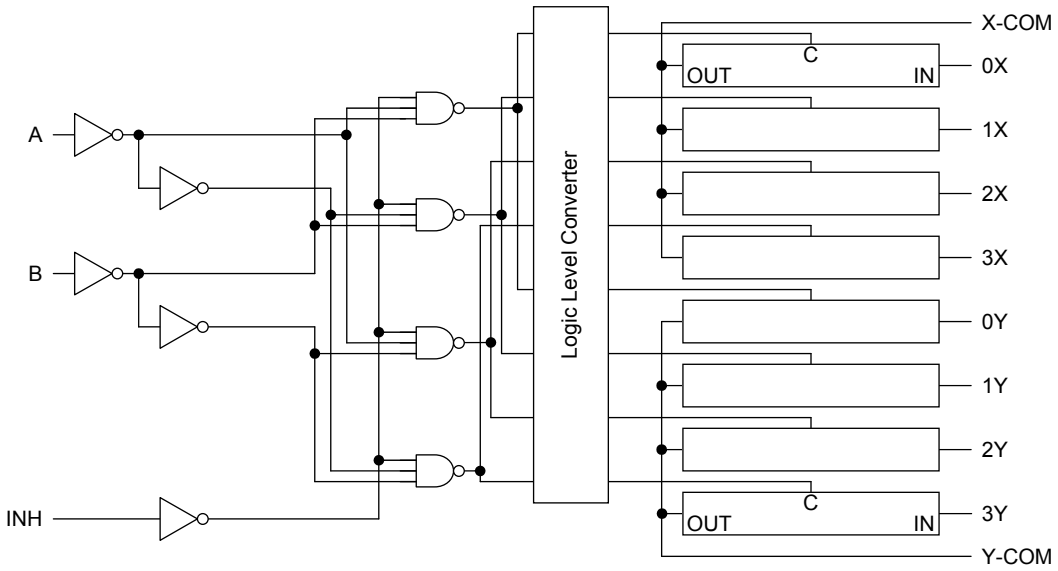
X: Don't care, *: Except LVX4052F/FT

System Diagram

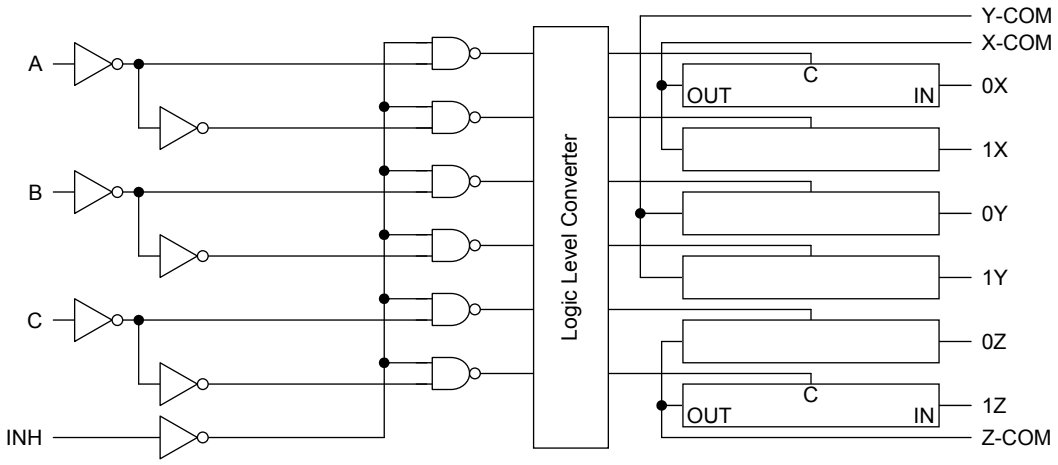
TC74LVX4051F/FT



TC74LVX4052F/FT



TC74LVX4053F/FT



Absolute Maximum Ratings (Note)

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

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}~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)	

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either VCC or GND.

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				

Note 1: R_L = 1 kΩ

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

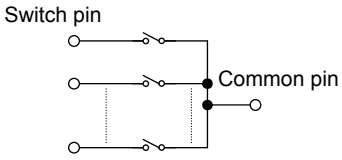
Note 3: C_{PD} is defined as the value of the internal equivalent capacitance of IC which is calculated from the operating current consumption without load.
Average operating current can be obtained by the equation:

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

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

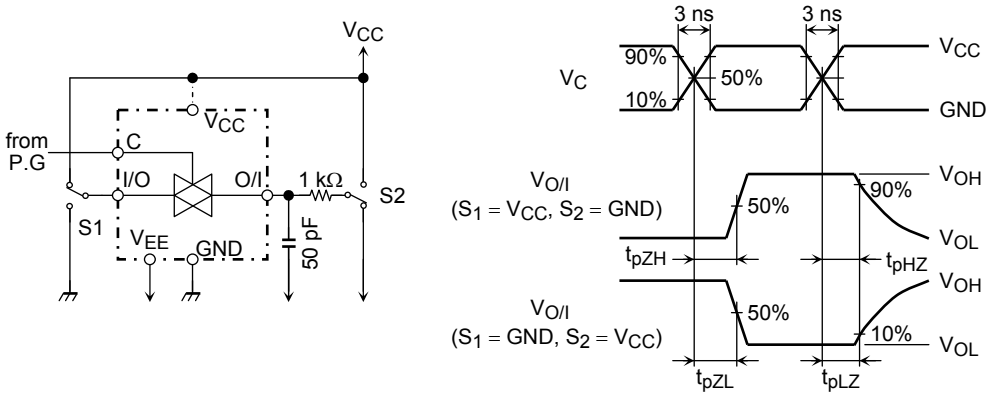


Figure 1 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

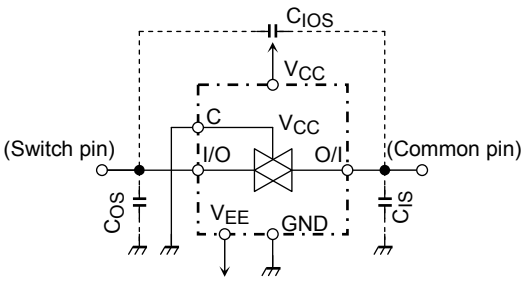


Figure 2 C_{IOS}, C_{IS}, C_{OS}

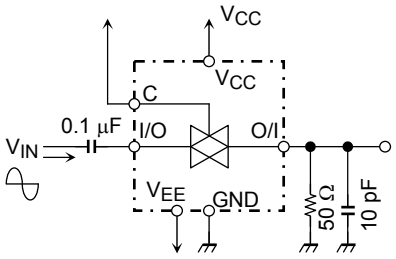


Figure 3 Frequency Response (switch on)

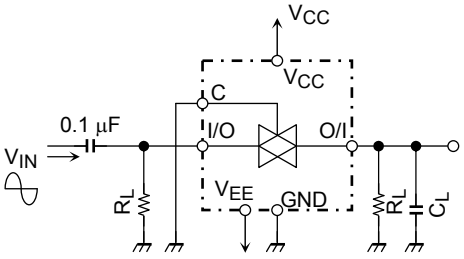


Figure 4 Feedthrough

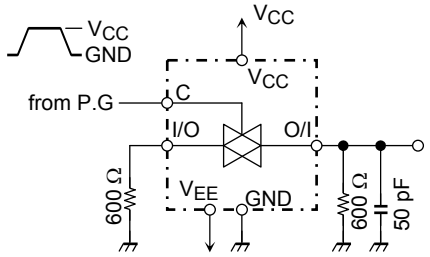


Figure 5 Cross Talk (control input to output signal)

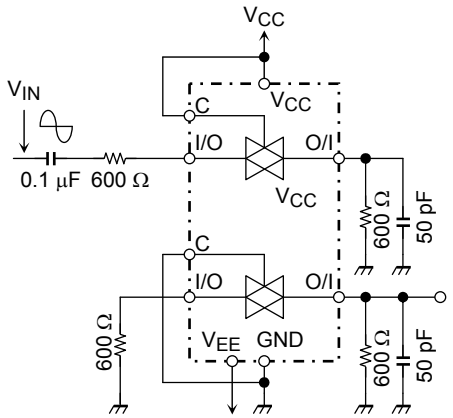
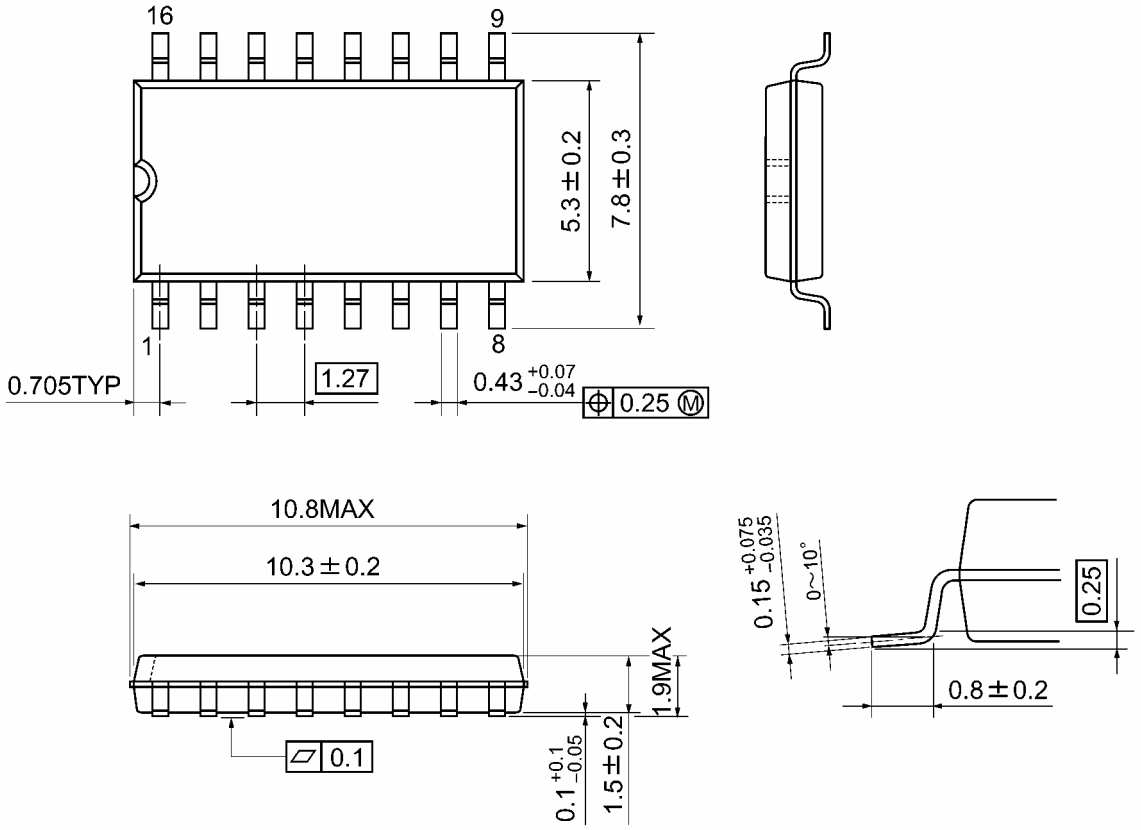


Figure 6 Cross Talk (between any two switches)

Package Dimensions

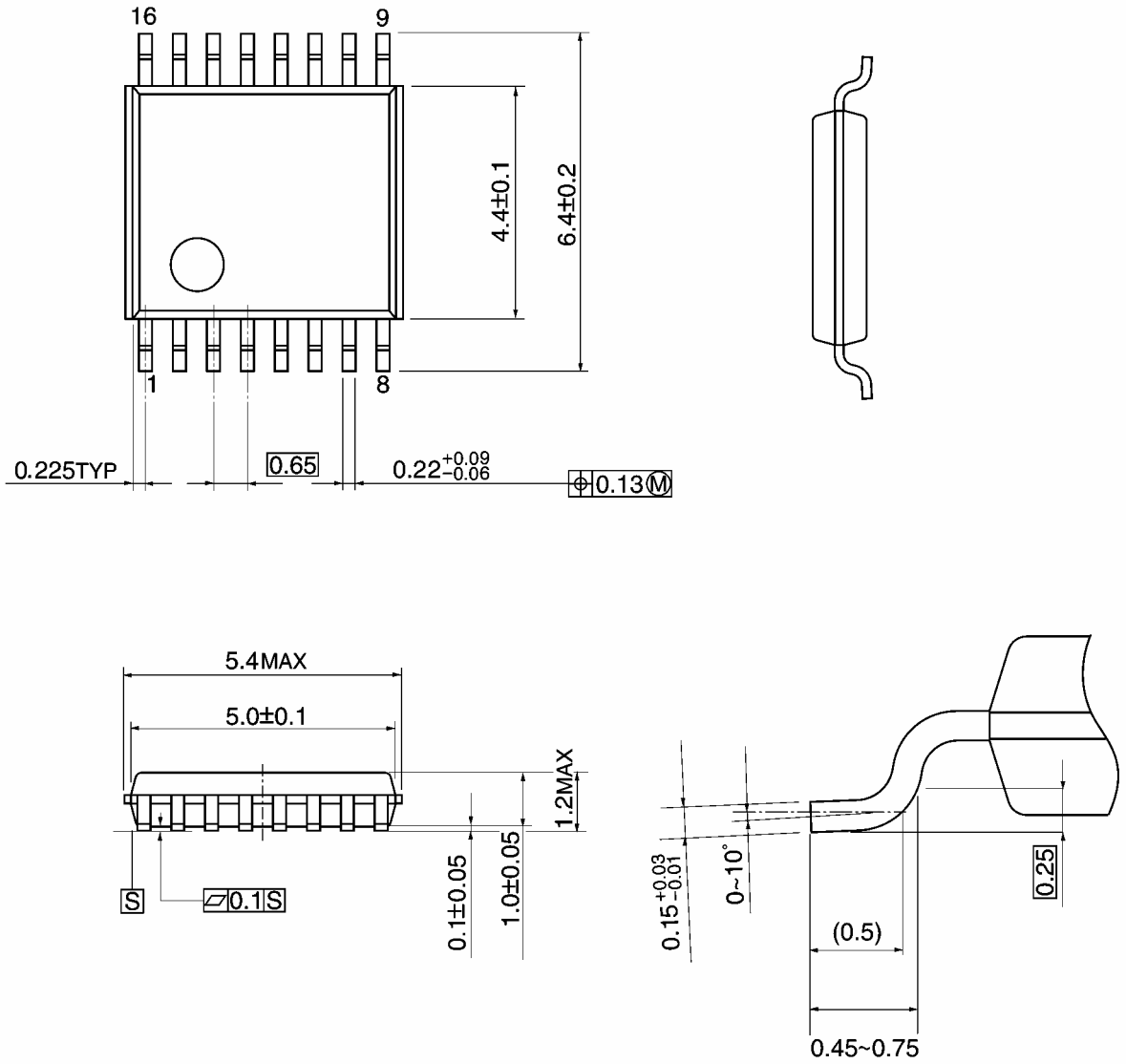
SOP16-P-300-1.27A Unit: mm



Weight: 0.18 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A Unit: mm



Weight: 0.06 g (typ.)

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20070701-EN GENERAL

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