

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC4051BP, TC4051BF, TC4051BFT TC4052BP, TC4052BF, TC4052BFT TC4053BP, TC4053BF, TC4053BFT

TC4051B

Single 8-Channel Multiplexer/Demultiplexer

TC4052B

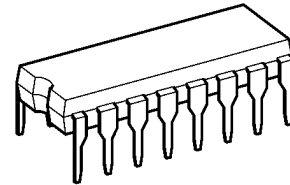
Differential 4-Channel  
Multiplexer/Demultiplexer

TC4053B

Triple 2-Channel Multiplexer/Demultiplexer

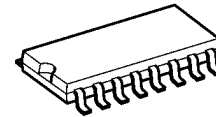
TC4051B, TC4052B and TC4053B are multiplexers with capabilities of selection and mixture of analog signal and digital signal. TC4051B has 8 channels configuration. TC4052B has 4 channel  $\times$  2 configuration and TC4053B has 2 channel  $\times$  3 configuration. The digital signal to the control terminal turns "ON" the corresponding switch of each channel, with large amplitude ( $V_{DD} - V_{EE}$ ) can be switched by the control signal with small logical amplitude ( $V_{DD} - V_{SS}$ ). For example, in the case of  $V_{DD} = 5\text{ V}$ ,  $V_{SS} = 0\text{ V}$  and  $V_{EE} = -5\text{ V}$ , signals between  $-5\text{ V}$  and  $+5\text{ V}$  can be switched from the logical circuit with single power supply of 5 volts. As the ON-resistance of each switch is low, these can be connected to the circuits with low input impedance.

TC4051BP, TC4052BP, TC4053BP



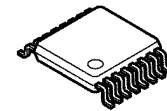
DIP16-P-300-2.54A

TC4051BF, TC4052BF, TC4053BF



SOP16-P-300-1.27A

TC4051BFT, TC4052BFT, TC4053BFT



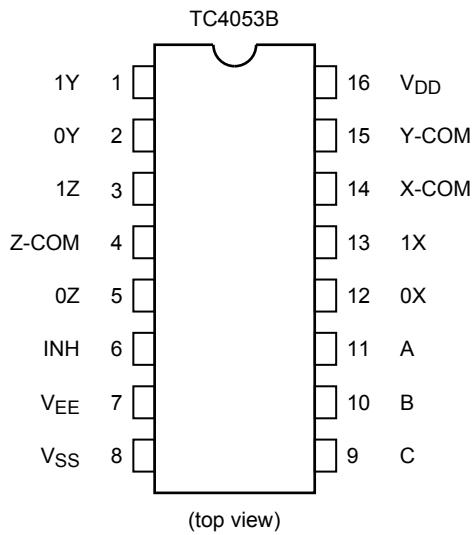
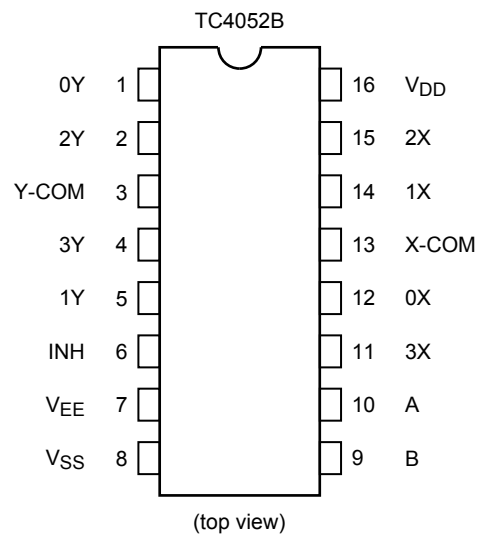
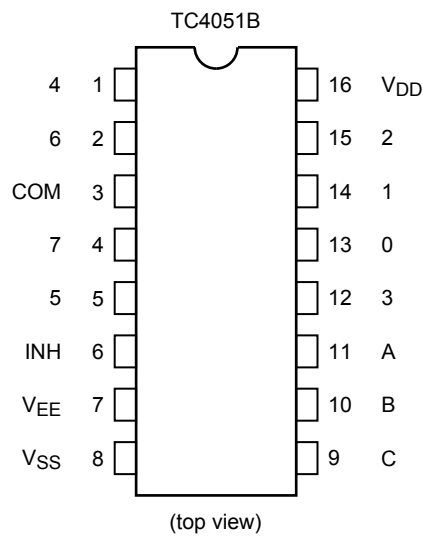
TSSOP16-P-0044-0.65A

Weight

DIP16-P-300-2.54A	: 1.00 g (typ.)
SOP16-P-300-1.27A	: 0.18 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)

Start of commercial production  
1978-04

## Pin Assignment



## Truth Table

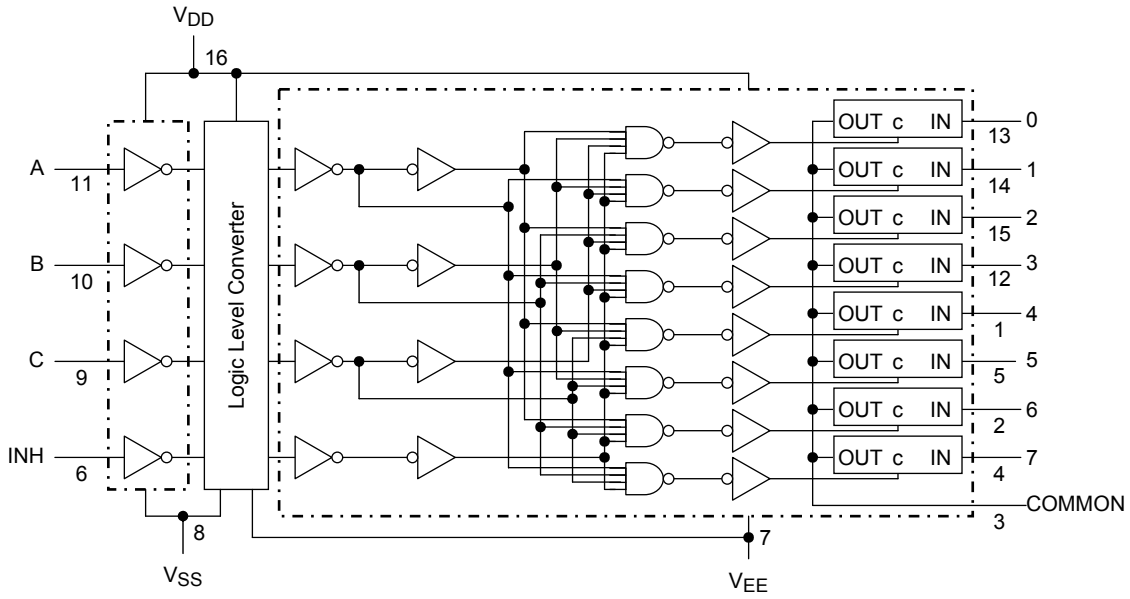
Control Inputs				"ON" Channel		
Inhibit	C	Δ	B A	TC4051B	TC4052B	TC4053B
L	L	L	L	0	0X, 0Y	0X, 0Y, 0Z
L	L	L	H	1	1X, 1Y	1X, 0Y, 0Z
L	L	H	L	2	2X, 2Y	0X, 1Y, 0Z
L	L	H	H	3	3X, 3Y	1X, 1Y, 0Z
L	H		L	4	—	0X, 0Y, 1Z
L	H		L H	5	— 1X,	0Y, 1Z
L	H		H L	6	— 0X,	1Y, 1Z
L	H		H H	7	— 1X,	1Y, 1Z
H	X	X	X	None	None	None

X: Don't care

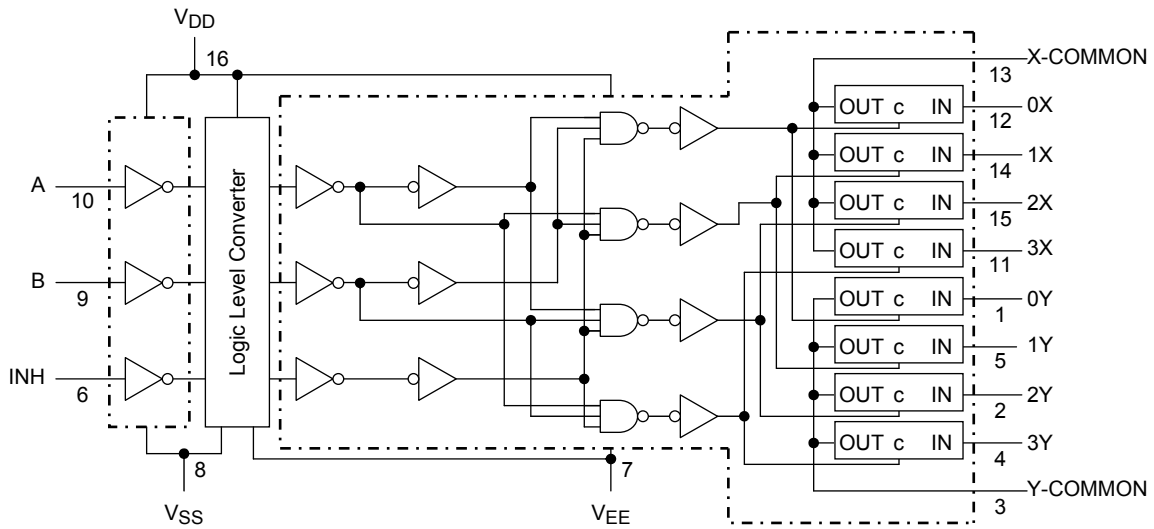
Δ: Except TC4052B

## Logic Diagram

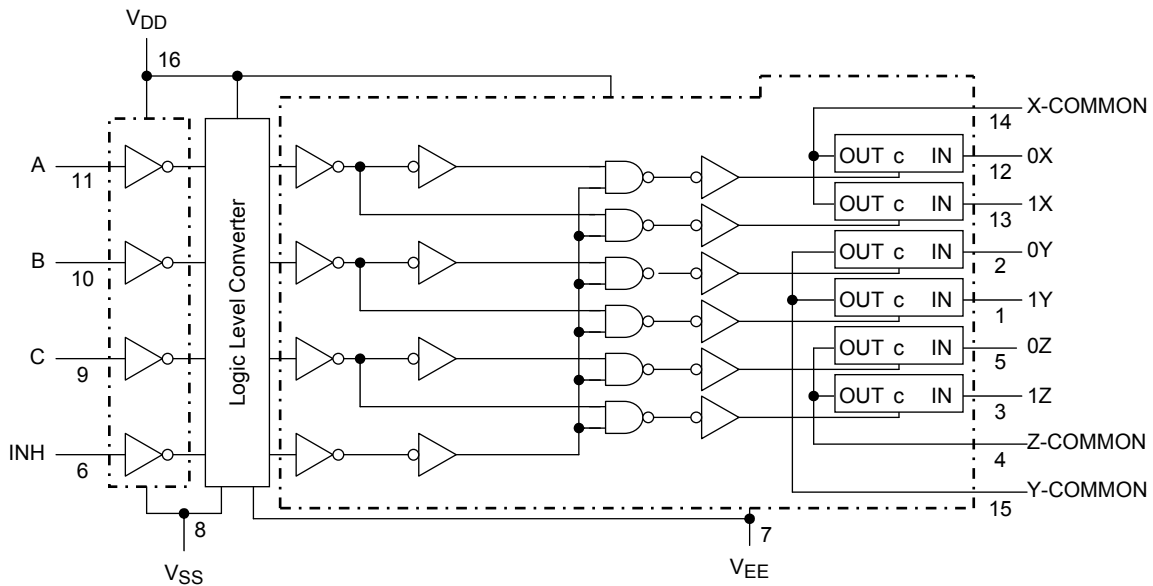
### TC4051B



### TC4052B



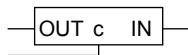
**TC4053B**



**Truth Table**

Control C	Impedance between IN-O UT (Note)
H	$0.5 \text{ to } 5 \times 10^2 \Omega$
L	$>10^9 \Omega$

Note: See electrical characteristics



**Absolute Maximum Ratings (Note)**

Characteristics S	ymbol	Rating	Unit
DC supply voltage	$V_{DD}-V_{SS}$	-0.5 to 20	V
DC supply voltage	$V_{DD}-V_{EE}$	-0.5 to 20	V
Control input voltage	$V_{CIN}$	$V_{SS} - 0.5 \text{ to } V_{DD} + 0.5$	V
Switch I/O voltage	$V_I/V_O$	$V_{EE} - 0.5 \text{ to } V_{DD} + 0.5$	V
Control input current	$I_{CIN}$	$\pm 10$	mA
Potential difference across I/O during ON	$V_I-V_O$	-0.5 to 0.5	V
Power dissipation	$P_D$	300 (DIP)/180 (SOIC)	mW
Operating temperature range	$T_{opr}$	-40 to 85	$^{\circ}C$
Storage temperature range	$T_{stg}$	-65 to 150	$^{\circ}C$

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	Test Condition	Min	Typ.	Max	Unit
DC supply voltage	$V_{DD}-V_{SS}$	—	3	—	18	V
	$V_{DD}-V_{EE}$	— 3		— 18		
Control input voltage	$V_{IN}$	—	$V_{SS}$	—	$V_{DD}$	V
Input/output voltage	$V_{IN}/V_{OUT}$	—	$V_{EE}$	—	$V_{DD}$	V

Note: The operating ranges must be maintained to ensure the normal operation of the device.  
Unused Control inputs must be tied to either  $V_{DD}$  or  $V_{SS}$ .

## Static Electrical Characteristics

Characteristics S	ymbol	Test Condition	-40°C 25°C						85°C		Unit		
			$V_{SS}$ (V)	$V_{EE}$ (V)	$V_{DD}$ (V)	Min	Max	Min	Typ.	Max		Min	Max
Control input high voltage	$V_{IH}$	$V_{IS} = V_{DD}$ thru 1 k $\Omega$	$V_{EE} = V_{SS}$ $R_L = 1$ k $\Omega$ to $V_{SS}$	5	3.5	—	3.5	2.75	—	3.5	—	V	
				10	7.0	—	7.0	5.50	—	7.0	—		
				15	11.0	—	11.0	8.25	—	11.0	—		
Control input low voltage	$V_{IL}$		$I_{IS} < 2$ $\mu$ A on all OFF channels	5	—	1.5	—	2.25	1.5	—	1.5	V	
				10	—	3.0	—	4.5	3.0	—	3.0		
				15	—	4.0	—	6.75	4.0	—	4.0		
On-state resistance	$R_{ON}$	$0 \leq V_{IS} \leq V_{DD}$ $R_L = 10$ k $\Omega$	0	0	5	—	850	—	240	950	—	1200	$\Omega$
			0	0	10	—	210	—	110	250	—	300	
			0	0	15	—	140	—	80	160	—	200	
$\Delta$ On-state resistance between any 2 switches	$R_{ON\Delta}$	—	0	0	5	—	—	—	10	—	—	—	$\Omega$
			0	0	10	—	—	—	6	—	—	—	
			0	0	15	—	—	—	4	—	—	—	
Input/output leakage current	$I_{OFF}$	$V_{IN} = 18$ V, $V_{OUT} = 0$ V	18	—	$\pm 100$	—	$\pm 0.01$	$\pm 100$	—	$\pm 1000$	nA		
		$V_{IN} = 0$ V, $V_{OUT} = 18$ V	18	—	$\pm 100$	—	$\pm 0.01$	$\pm 100$	—	$\pm 1000$			
Quiescent supply current	$I_{DD}$	$V_{IN} = V_{SS}$ , $V_{DD}$ (Note)	5	—	5.0	—	0.005	5.0	—	150	$\mu$ A		
			10	—	10	—	0.010	10	—	300			
			15	—	20	—	0.015	20	—	600			
Input current	$I_{IN}$	$V_{IH} = 18$ V	18	—	0.1	—	$10^{-5}$	0.1	—	1.0	$\mu$ A		
		$V_{IL} = 0$ V	18	—	-0.1	—	$-10^{-5}$	-0.1	—	-1.0			
Input capacitance	$C_{IN}$	—	—	—	—	—	— 5	—	7.5	—	—	pF	
Switch input capacitance	$C_{IN}$	—	—	—	—	—	— 10	—	—	—	—	pF	
Output capacitance	$C_{OUT}$	TC4051B	10	—	—	—	58	—	—	—	—	pF	
		TC4052B	10	—	—	—	30	—	—	—	—		
		TC4053B	10	—	—	—	17	—	—	—	—		
Feedthrough capacitance	$C_{IN}$ - $C_{OUT}$	TC4051B	10	—	—	—	0.2	—	—	—	—	pF	
		TC4052B	10	—	—	—	0.2	—	—	—	—		
		TC4053B	10	—	—	—	0.2	—	—	—	—		

Note: All valid input combinations.

## Dynamic Electrical Characteristics (Ta = 25°C, CL = 50 pF)

Characteristics S	symbol	Test Condition	Test Condition			Min T	yp.	Max	Unit
			VSS (V)	VEE (V)	VDD (V)				
Phase difference between input to output	φI-O	—	0	0	5	—	15	45	ns
			0	0	10	—	8	20	
			0	0	15	—	6	15	
Propagation delay time (A, B, C, -OUT)	t <sub>pZL</sub> t <sub>pZH</sub> t <sub>pLZ</sub> t <sub>pHZ</sub>	R <sub>L</sub> = 1 kΩ	0	0	5	—	170	550	ns
			0	0	10	—	90	240	
			0	0	15	—	70	160	
			0	-5	5	—	100	240	
			0	-7.5	7.5	—	80	160	
Propagation delay time (INH-OUT)	t <sub>pZL</sub> t <sub>pZH</sub>	R <sub>L</sub> = 1 kΩ	0	0	5	—	120	380	ns
			0	0	10	—	60	200	
			0	0	15	—	50	160	
			0	-5	5	—	80	200	
			0	-7.5	7.5	—	60	160	
Propagation delay time (INH-OUT)	t <sub>pLZ</sub> t <sub>pHZ</sub>	R <sub>L</sub> = 1 kΩ	0	0	5	—	170	450	ns
			0	0	10	—	90	210	
			0	0	15	—	70	160	
			0	-5	5	—	100	210	
			0	-7.5	7.5	—	80	160	
-3dB cutoff frequency TC4051B TC4052B TC4053B	f <sub>max</sub> (I-O)	R <sub>L</sub> = 1 kΩ (Note 1)	-5	-5	5	—	20	—	MHz
			-5	-5	5	—	30	—	
			-5	-5	5	—	40	—	
Total harmonic distortion	—	R <sub>L</sub> = 10 kΩ f = 1 kHz (Note 2)	-2.5	-2.5	2.5	—	0.15	—	%
			-5	-5	5	—	0.03	—	
			-7.5	-7.5	7.5	—	0.02	—	
-50dB feedthrough (switch off)	—	R <sub>L</sub> = 1 kΩ (Note 3)	-5	-5	5	—	500	—	kHz
Crosstalk	—	R <sub>L</sub> = 1 kΩ (Note 4)	-5	-5	5	—	1.5	—	MHz
Crosstalk (control-OUT)	—	R <sub>IN</sub> = 1 kΩ	0	0	5	—	200	—	mV
		R <sub>OUT</sub> = 10 kΩ	0	0	10	—	400	—	
		C <sub>L</sub> = 15 pF	0	0	15	—	600	—	

Note 1: Sine wave of  $\pm 2.5 V_{p-p}$  shall be used for  $V_{is}$  and the frequency of  $20 \log 10 \frac{V_{OS}}{V_{is}} = -3dB$  shall be  $f_{max}$ .

Note 2:  $V_{is}$  shall be sine wave of  $\pm \left( \frac{V_{DD} - V_{EE}}{4} \right) p-p$ .

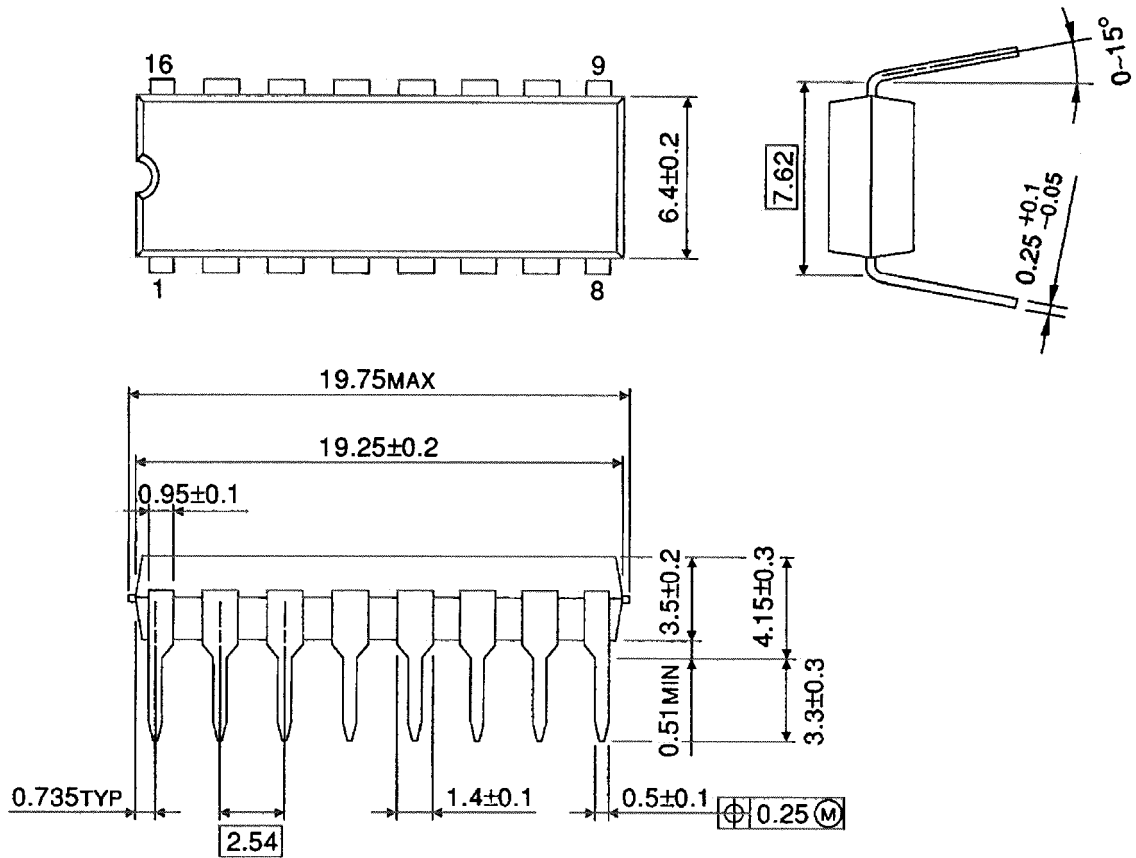
Note 3: Sine wave of  $\pm 2.5 V_{p-p}$  shall be used for  $V_{is}$  and the frequency of  $20 \log 10 \frac{V_{OS}}{V_{is}} = -50dB$  shall be feed-through.

Note 4: Sine wave of  $\pm 2.5 V_{p-p}$  shall be used for  $V_{is}$  and the frequency of  $20 \log 10 \frac{V_{OS}}{V_{is}} = -50dB$  shall be crosstalk.

## Package Dimensions

DIP16-P-300-2.54A

Unit : mm

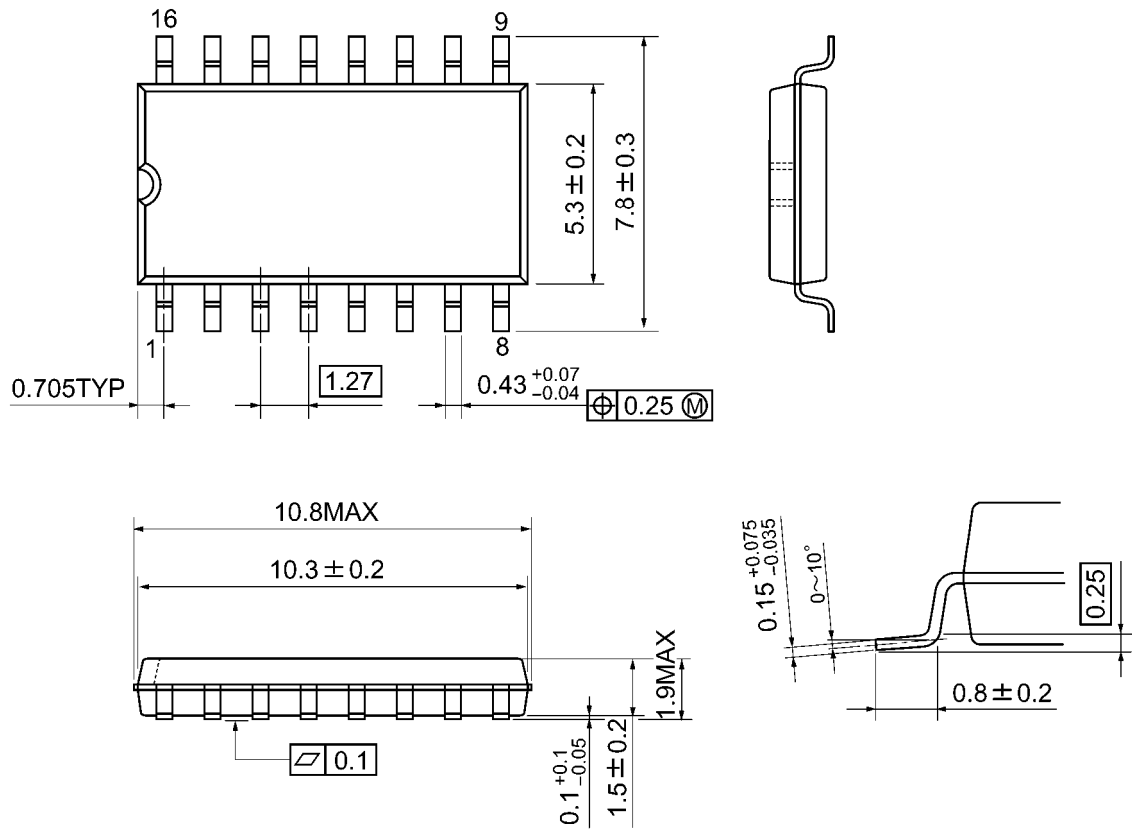


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm



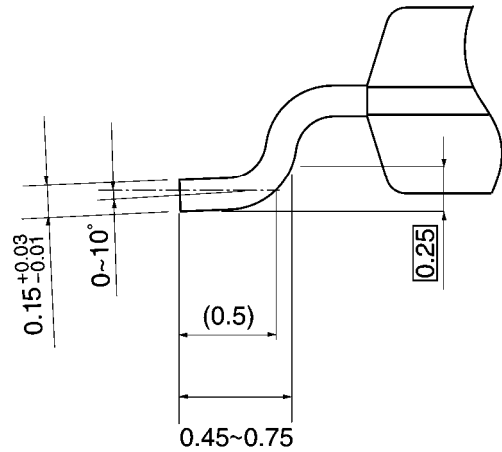
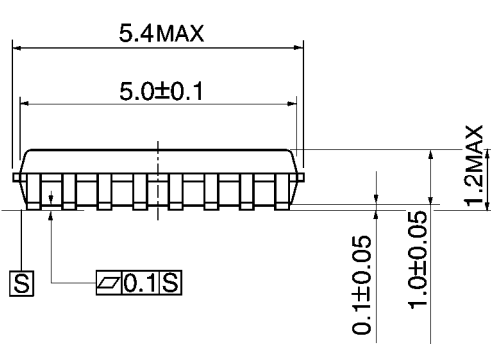
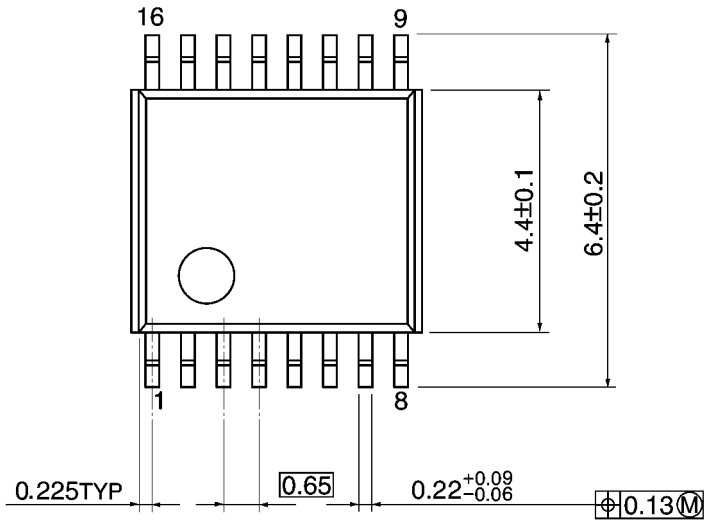
Weight: 0.18 g (typ.)



**Package Dimensions**

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

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