

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

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

### TC4051B

Single 8-Channel Multiplexer/Demultiplexer

### TC4052B

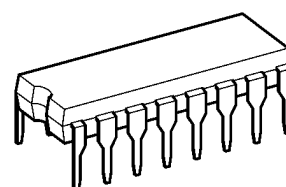
Differential 4-Channel  
Multiplexer/Demultiplexer

### TC4053B

Triple 2-Channel Multiplexer/Demultiplexer

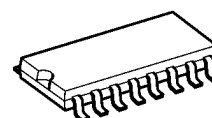
TC4051B, TC4052B and TC4053B are multiplexers with capabilities of selection and mixture of analog signal and digital signal. TC4051B has 8 channels configuration. TC4052B has 4 channel  $\times$  2 configuration and TC4053B has 2 channel  $\times$  3 configuration. The digital signal to the control 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



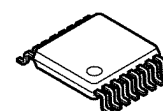
DIP16-P-300-2.54A

TC4051BF, TC4052BF, TC4053BF



SOP16-P-300-1.27A

TC4051BFT, TC4052BFT, TC4053BFT

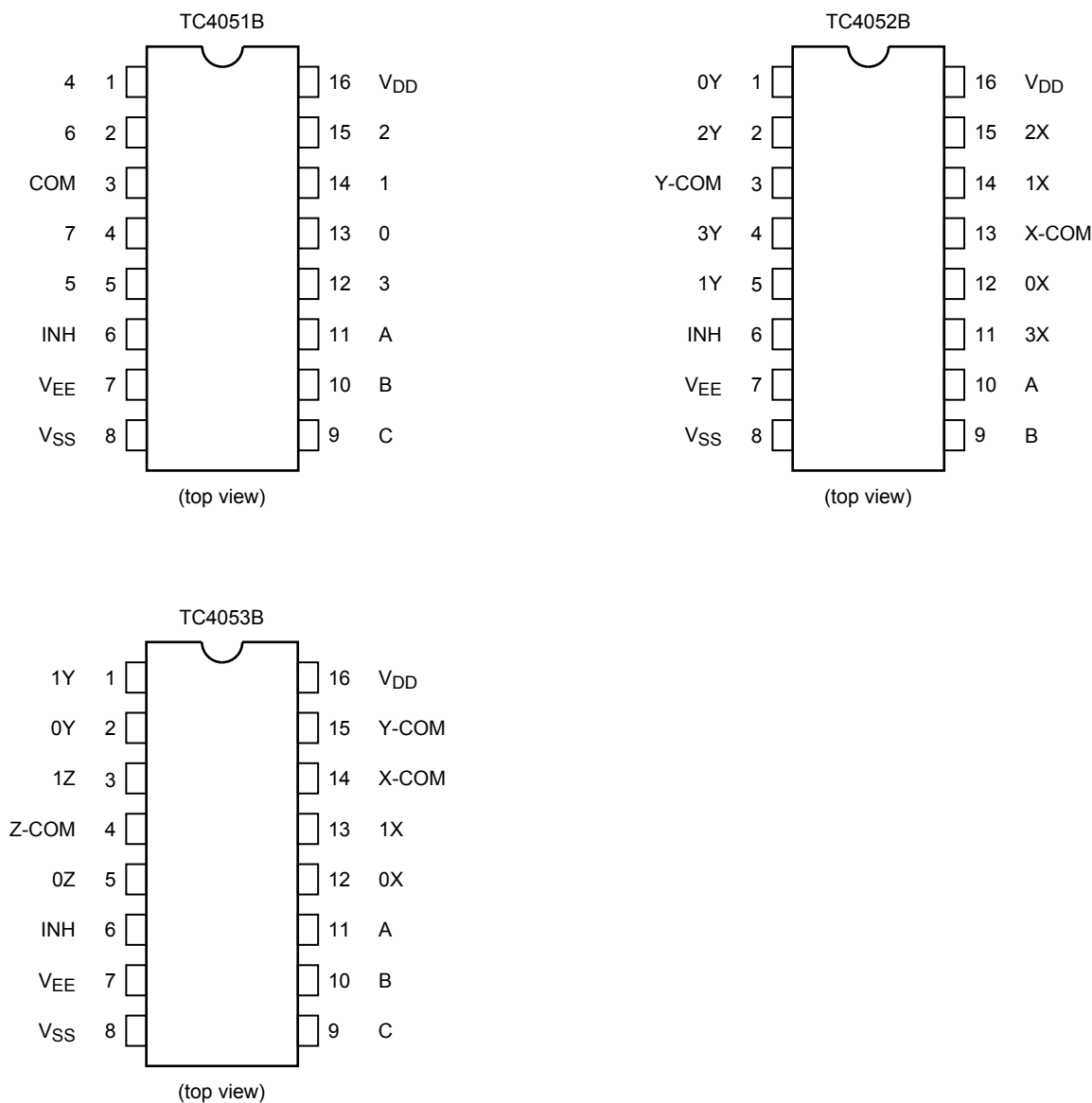


TSSOP16-P-0044-0.65A

#### 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.) |

Pin Assignment



Truth Table

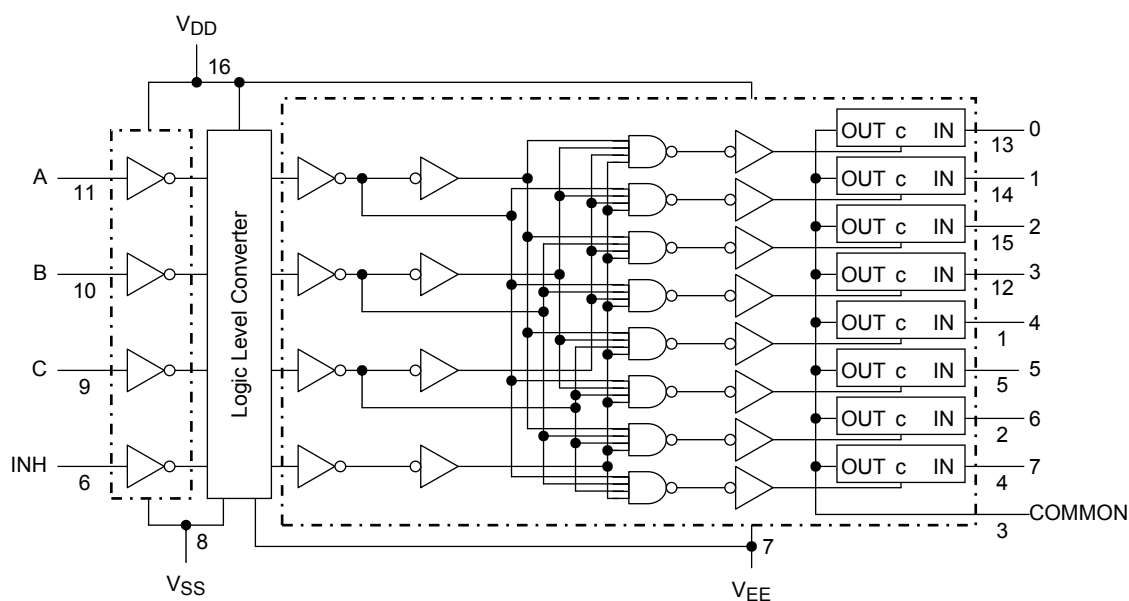
| Control Inputs |    |   |   | “ON” Channel |         |            |
|----------------|----|---|---|--------------|---------|------------|
| Inhibit        | CΔ | B | A | TC4051B      | TC4052B | TC4053B    |
| L              | L  | L | L | 0            | 0X, 0Y  | 0X, 0Y, 0Z |
| L              | L  | 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 | 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

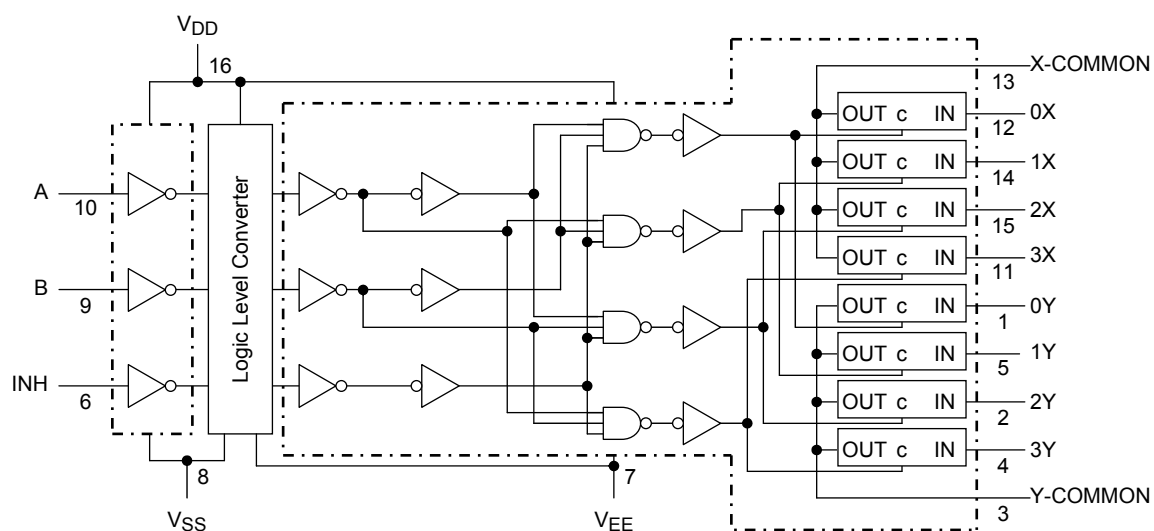
Δ: Except TC4052B

## Logic Diagram

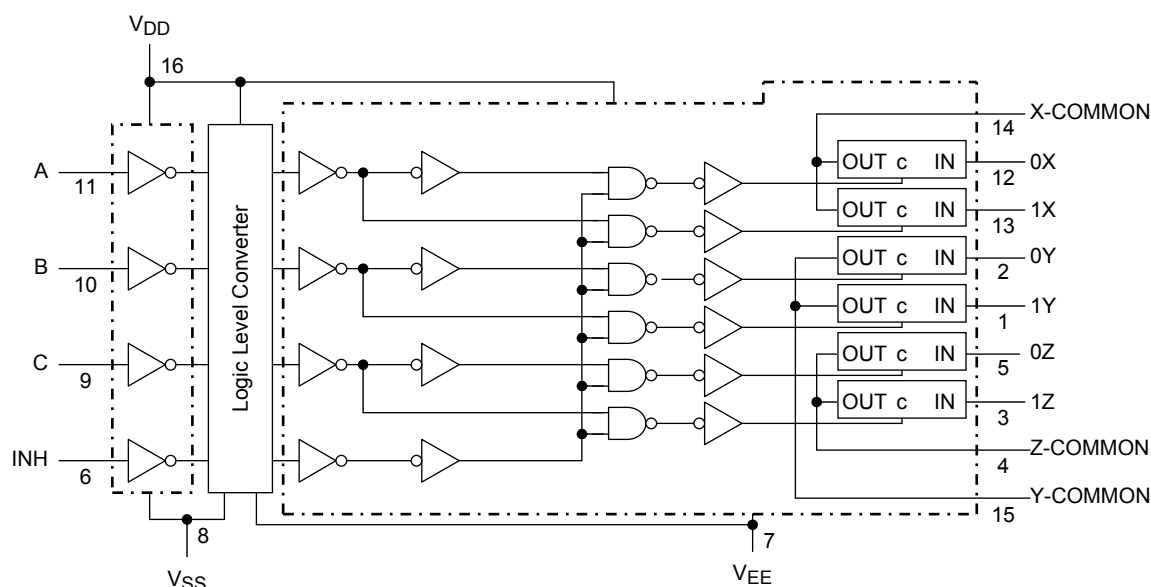
### TC4051B



### TC4052B



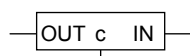
## TC4053B



## Truth Table

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

Note: See electrical characteristics



## Absolute Maximum Ratings (Note)

| Characteristics                           | Symbol          | 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                               | °C   |
| Storage temperature range                 | $T_{stg}$       | -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           | 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                                     | Symbol         | Test Condition                                                       |                                                                                                                |                 | -40°C |     | 25°C      |      |            | 85°C      |     | Unit     |
|-----------------------------------------------------|----------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------|-------|-----|-----------|------|------------|-----------|-----|----------|
|                                                     |                | $V_{SS}$<br>(V)                                                      | $V_{EE}$<br>(V)                                                                                                | $V_{DD}$<br>(V) | Min   | Max | Min       | Typ. | Max        | Min       | Max |          |
| Control input high voltage                          | $V_{IH}$       | $V_{IS} = V_{DD}$<br>thru 1 k $\Omega$                               | $V_{EE} = V_{SS}$<br>$R_L = 1$ k $\Omega$<br>to $V_{SS}$<br><br>$I_{IS} < 2$ $\mu$ A<br>on all OFF<br>channels | 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                           | $V_{IL}$       |                                                                      |                                                                                                                | 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                                 | $R_{ON}$       | $0 \leq V_{IS} \leq V_{DD}$<br>$R_L = 10$ k $\Omega$                 | 0                                                                                                              | 0               | 5     | —   | 850       | —    | 240        | 950       | —   | $\Omega$ |
|                                                     |                |                                                                      | 0                                                                                                              | 0               | 10    | —   | 210       | —    | 110        | 250       | —   |          |
|                                                     |                |                                                                      | 0                                                                                                              | 0               | 15    | —   | 140       | —    | 80         | 160       | —   |          |
| $\Delta$ 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<br>$V_{IN} = 0$ V, $V_{OUT} = 18$ V |                                                                                                                |                 | 18    | —   | $\pm 100$ | —    | $\pm 0.01$ | $\pm 100$ | —   | nA       |
|                                                     |                |                                                                      |                                                                                                                |                 | 18    | —   | $\pm 100$ | —    | $\pm 0.01$ | $\pm 100$ | —   |          |
| Quiescent supply current                            | $I_{DD}$       | $V_{IN} = V_{SS}$ , $V_{DD}$ (Note)                                  |                                                                                                                |                 | 5     | —   | 5.0       | —    | 0.005      | 5.0       | —   | $\mu$ A  |
|                                                     |                |                                                                      |                                                                                                                |                 | 10    | —   | 10        | —    | 0.010      | 10        | —   |          |
|                                                     |                |                                                                      |                                                                                                                |                 | 15    | —   | 20        | —    | 0.015      | 20        | —   |          |
| Input current                                       | $I_{IN}$       | $V_{IH} = 18$ V<br>$V_{IL} = 0$ V                                    |                                                                                                                |                 | 18    | —   | 0.1       | —    | $10^{-5}$  | 0.1       | —   | $\mu$ A  |
|                                                     |                |                                                                      |                                                                                                                |                 | 18    | —   | -0.1      | —    | $-10^{-5}$ | -0.1      | —   |          |
| 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                          | Symbol          | Test Condition                                           | VSS<br>(V) | VEE<br>(V) | VDD<br>(V) | Min | Typ. | Max | Unit |
|------------------------------------------|-----------------|----------------------------------------------------------|------------|------------|------------|-----|------|-----|------|
|                                          |                 |                                                          |            |            |            |     |      |     |      |
| Phase difference between input to output | $\phi_{I-O}$    | —                                                        | 0          | 0          | 5          | —   | 15   | 45  | ns   |
|                                          |                 |                                                          | 0          | 0          | 10         | —   | 8    | 20  |      |
|                                          |                 |                                                          | 0          | 0          | 15         | —   | 6    | 15  |      |
| Propagation delay time (A, B, C, -OUT)   | $t_{pZL}$       | $R_L = 1\text{ k}\Omega$                                 | 0          | 0          | 5          | —   | 170  | 550 | ns   |
|                                          | $t_{pZH}$       |                                                          | 0          | 0          | 10         | —   | 90   | 240 |      |
|                                          | $t_{pLZ}$       |                                                          | 0          | 0          | 15         | —   | 70   | 160 |      |
|                                          | $t_{pLH}$       |                                                          | 0          | -5         | 5          | —   | 100  | 240 |      |
|                                          | $t_{pHZ}$       |                                                          | 0          | -7.5       | 7.5        | —   | 80   | 160 |      |
| Propagation delay time (INH-OUT)         | $t_{pZL}$       | $R_L = 1\text{ k}\Omega$                                 | 0          | 0          | 5          | —   | 120  | 380 | ns   |
|                                          | $t_{pZH}$       |                                                          | 0          | 0          | 10         | —   | 60   | 200 |      |
|                                          | $t_{pLZ}$       |                                                          | 0          | 0          | 15         | —   | 50   | 160 |      |
|                                          | $t_{pLH}$       |                                                          | 0          | -5         | 5          | —   | 80   | 200 |      |
|                                          | $t_{pHZ}$       |                                                          | 0          | -7.5       | 7.5        | —   | 60   | 160 |      |
| Propagation delay time (INH-OUT)         | $t_{pLZ}$       | $R_L = 1\text{ k}\Omega$                                 | 0          | 0          | 5          | —   | 170  | 450 | ns   |
|                                          | $t_{pLH}$       |                                                          | 0          | 0          | 10         | —   | 90   | 210 |      |
|                                          | $t_{pLZ}$       |                                                          | 0          | 0          | 15         | —   | 70   | 160 |      |
|                                          | $t_{pLH}$       |                                                          | 0          | -5         | 5          | —   | 100  | 210 |      |
|                                          | $t_{pHZ}$       |                                                          | 0          | -7.5       | 7.5        | —   | 80   | 160 |      |
| -3dB cutoff frequency                    | $f_{max}$ (I-O) | $R_L = 1\text{ k}\Omega$ (Note 1)                        | -5         | -5         | 5          | —   | 20   | —   | MHz  |
| TC4051B                                  |                 |                                                          | -5         | -5         | 5          | —   | 30   | —   |      |
| TC4052B                                  |                 |                                                          | -5         | -5         | 5          | —   | 40   | —   |      |
| TC4053B                                  |                 |                                                          | -5         | -5         | 5          | —   | 40   | —   |      |
| Total harmonic distortion                | —               | $R_L = 10\text{ k}\Omega$<br>$f = 1\text{ kHz}$ (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)           | —               | $R_L = 1\text{ k}\Omega$ (Note 3)                        | -5         | -5         | 5          | —   | 500  | —   | kHz  |
| Crosstalk                                | —               | $R_L = 1\text{ k}\Omega$ (Note 4)                        | -5         | -5         | 5          | —   | 1.5  | —   | MHz  |
| Crosstalk (control-OUT)                  | —               | $R_{IN} = 1\text{ k}\Omega$                              | 0          | 0          | 5          | —   | 200  | —   | mV   |
|                                          |                 | $R_{OUT} = 10\text{ k}\Omega$                            | 0          | 0          | 10         | —   | 400  | —   |      |
|                                          |                 | $C_L = 15\text{ pF}$                                     | 0          | 0          | 15         | —   | 600  | —   |      |

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

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

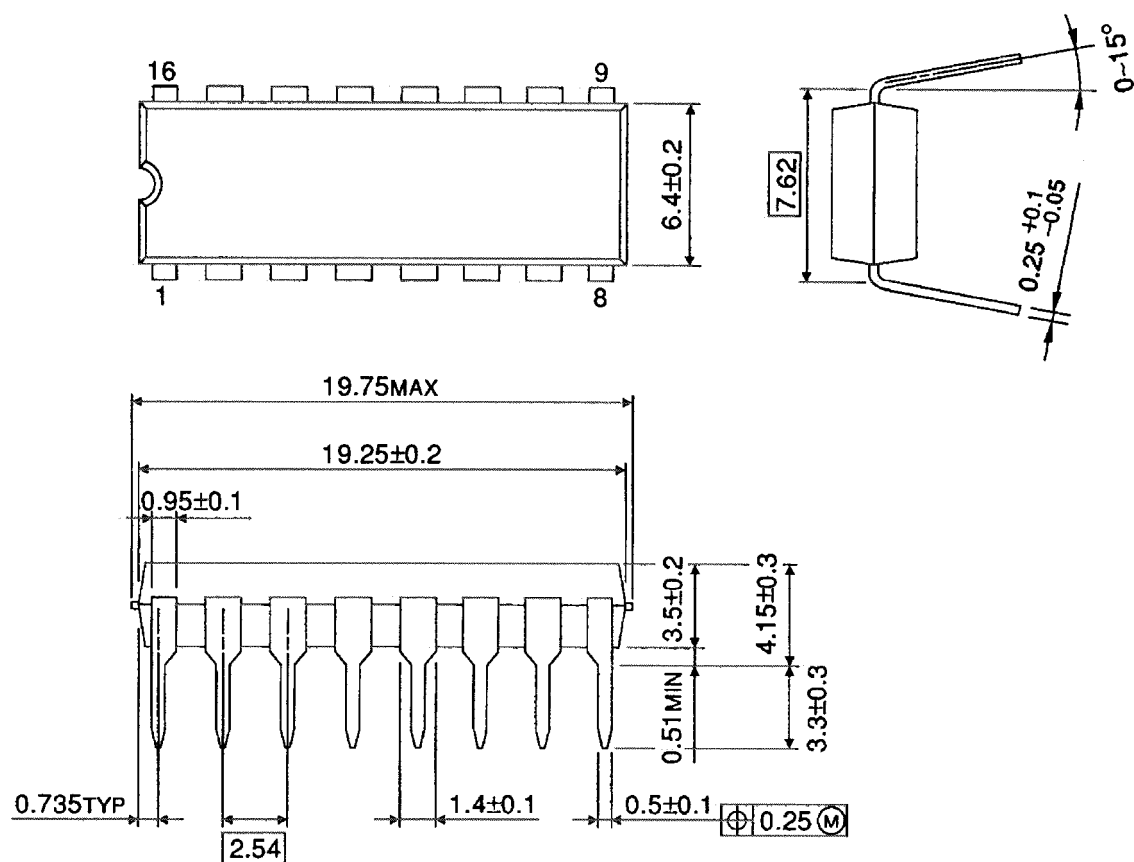
Note 3: Sine wave of  $\pm 2.5\text{ V}_{p-p}$  shall be used for  $V_{is}$  and the frequency of  $20\log 10 \frac{V_{OS}}{V_{is}} = -50\text{dB}$  shall be feed-through.

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

## Package Dimensions

DIP16-P-300-2.54A

Unit : mm

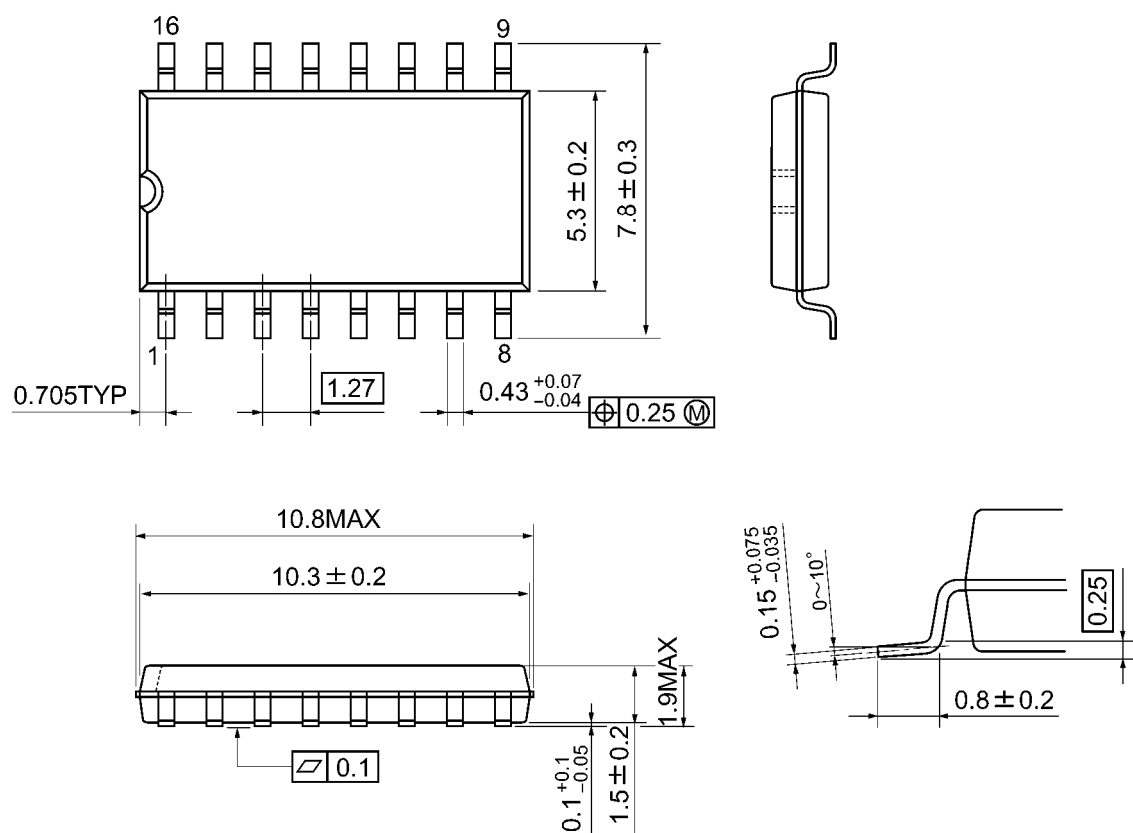


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm

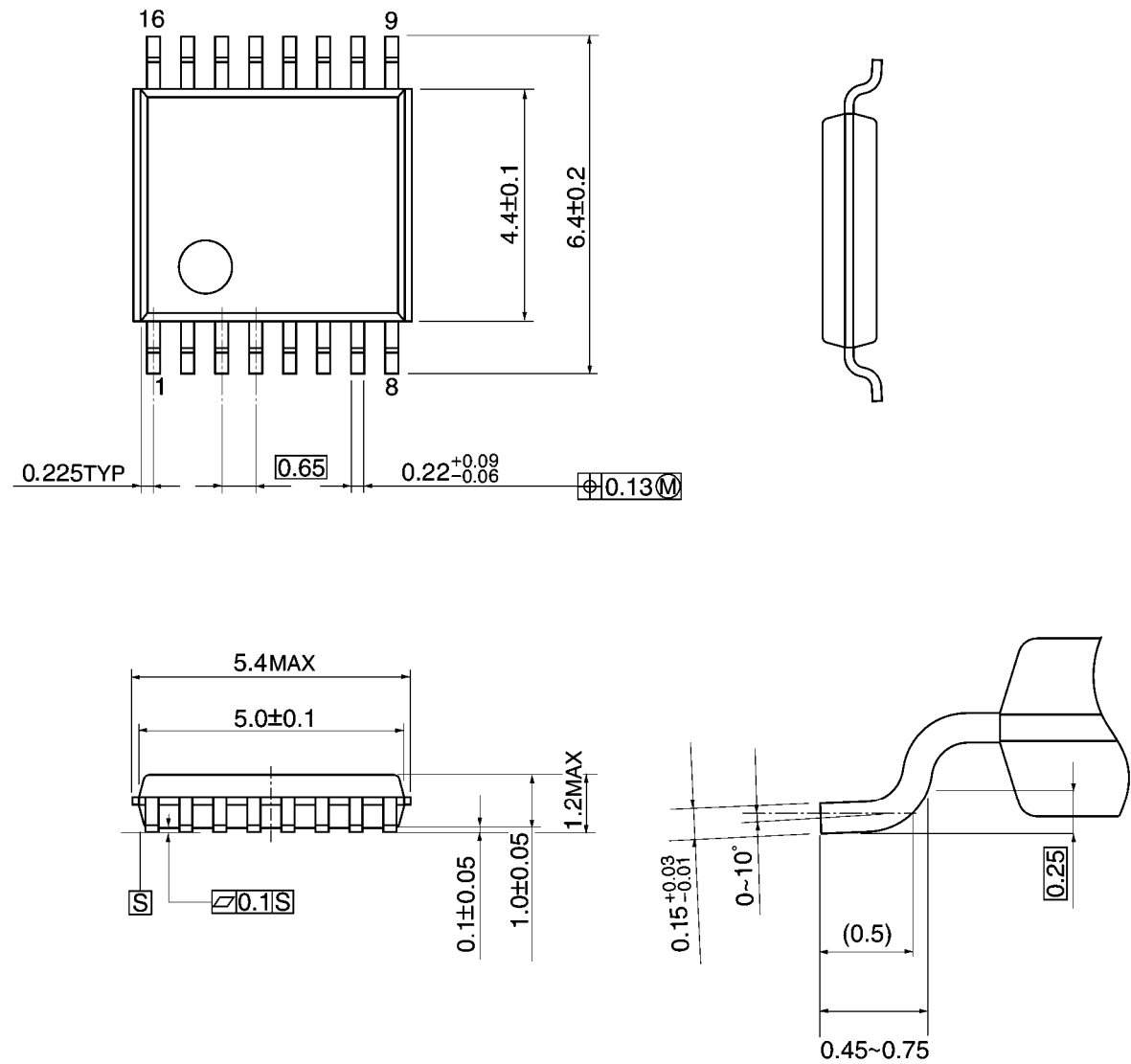


Weight: 0.18 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm



Weight: 0.06 g (typ.)

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