

TC74LCX138F, TC74LCX138FN, TC74LCX138FT, TC74LCX138FK

Low-Voltage 3-to-8 Line Decoder with 5-V Tolerant Inputs and Outputs

The TC74LCX138 is a high-performance CMOS 3-to-8 decoder. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low-power dissipation.

The device is designed for low-voltage (3.3 V) V_{CC} applications, but it could be used to interface to 5-V supply environment for inputs.

When the device is enabled, 3 binary select inputs (A, B and C) determine which one of the outputs ($\bar{Y}0 - \bar{Y}7$) will go low.

When enable input G1 is held low or either $\bar{G}2A$ or $\bar{G}2B$ is held high, decoding function is inhibited and all outputs go high.

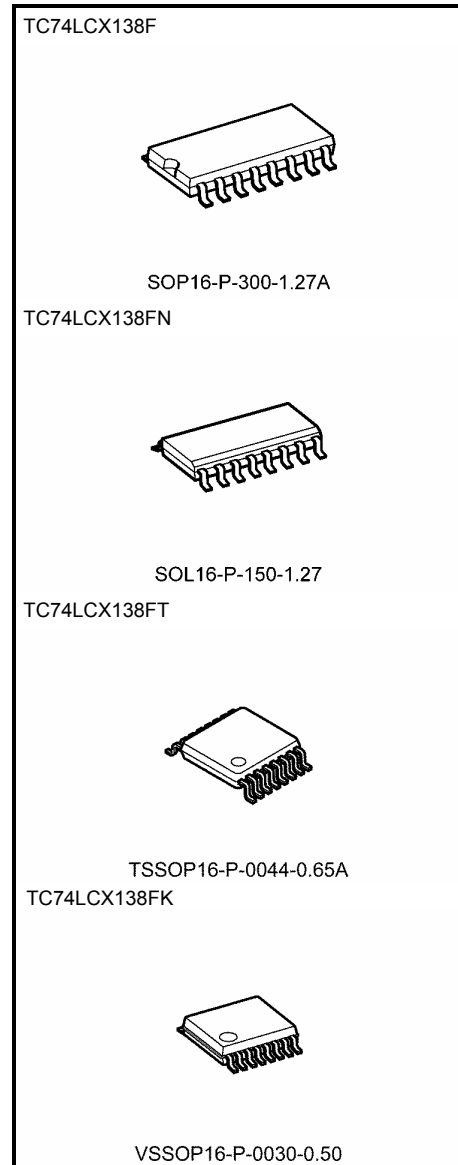
G1, $\bar{G}2A$, and $\bar{G}2B$ inputs are provided to ease cascade connection and for use as an address decoder for memory systems.

All inputs are equipped with protection circuits against static discharge.

Features

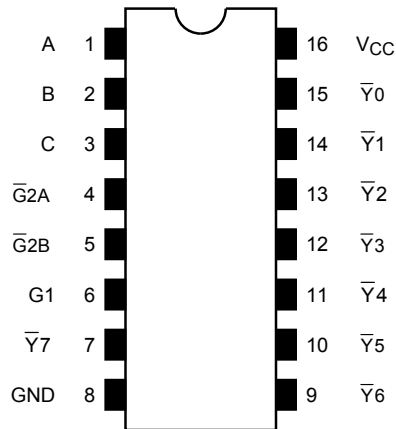
- Low-voltage operation: $V_{CC} = 2.0$ to 3.6 V
- High-speed operation: $t_{pd} = 6.0$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
- Output current: $|I_{OH}|/I_{OL} = 24$ mA (min) ($V_{CC} = 3.0$ V)
- Latch-up performance: -500 mA
- Available in JEDEC SOP, JEITA SOP, TSSOP and VSSOP (US)
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 138 type

Note: xxxFN (JEDEC SOP) is not available in Japan.

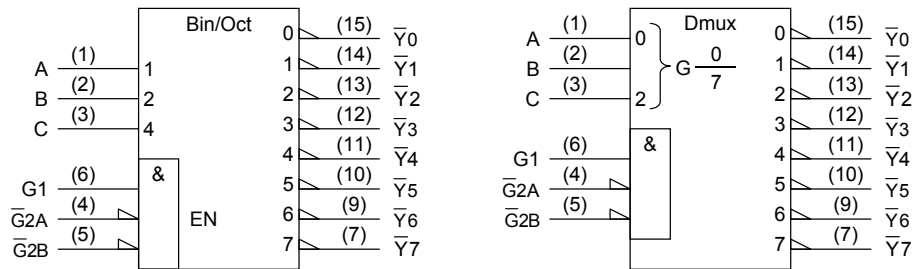


| | |
|----------------------|-----------------|
| Weight | |
| SOP16-P-300-1.27A | : 0.18 g (typ.) |
| SOL16-P-150-1.27 | : 0.12 g (typ.) |
| TSSOP16-P-0044-0.65A | : 0.06 g (typ.) |
| VSSOP16-P-0030-0.50 | : 0.02 g (typ.) |

Pin Assignment (top view)



IEC Logic Symbol

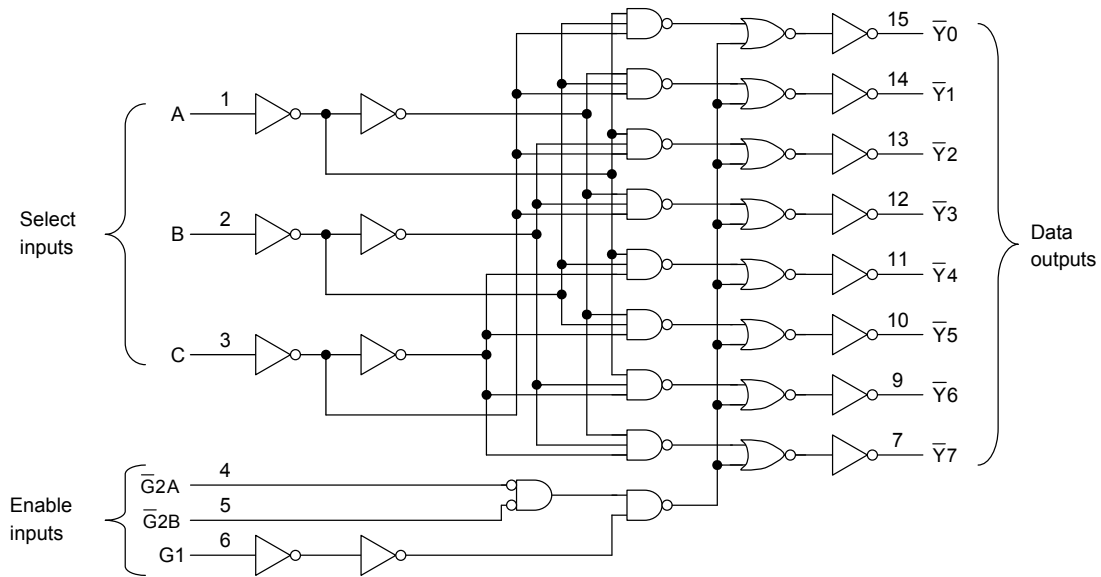


Truth Table

| Inputs | | | | | | Outputs | | | | | | | | Selected Output |
|--------|-------------|-------------|--------|---|---|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Enable | | | Select | | | $\bar{Y}0$ | $\bar{Y}1$ | $\bar{Y}2$ | $\bar{Y}3$ | $\bar{Y}4$ | $\bar{Y}5$ | $\bar{Y}6$ | $\bar{Y}7$ | |
| G1 | $\bar{G}2A$ | $\bar{G}2B$ | C | B | A | | | | | | | | | |
| L | X | X | X | X | X | H | H | H | H | H | H | H | H | None |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H | None |
| X | X | H | X | X | X | H | H | H | H | H | H | H | H | None |
| H | L | L | L | L | L | L | H | H | H | H | H | H | H | $\bar{Y}0$ |
| H | L | L | L | L | H | H | L | H | H | H | H | H | H | $\bar{Y}1$ |
| H | L | L | L | H | L | H | H | L | H | H | H | H | H | $\bar{Y}2$ |
| H | L | L | L | H | H | H | H | H | L | H | H | H | H | $\bar{Y}3$ |
| H | L | L | H | L | L | H | H | H | H | L | H | H | H | $\bar{Y}4$ |
| H | L | L | H | L | H | H | H | H | H | H | L | H | H | $\bar{Y}5$ |
| H | L | L | H | H | L | H | H | H | H | H | H | L | H | $\bar{Y}6$ |
| H | L | L | H | H | H | H | H | H | H | H | H | H | L | $\bar{Y}7$ |

X: Don't care

System Diagram



Absolute Maximum Ratings (Note 1)

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|------------------|---------------------------------|-------------|
| Power supply voltage | V_{CC} | -0.5 to 7.0 | V |
| DC input voltage | V_{IN} | -0.5 to 7.0 | V |
| DC output voltage | V_{OUT} | -0.5 to 7.0 (Note 2) | V |
| | | -0.5 to $V_{CC} + 0.5$ (Note 3) | |
| Input diode current | I_{IK} | -50 | mA |
| Output diode current | I_{OK} | ± 50 (Note 4) | mA |
| DC output current | I_{OUT} | ± 50 | mA |
| Power dissipation | P_D | 180 | mW |
| DC V_{CC} /ground current | I_{CC}/I_{GND} | ± 100 | mA |
| Storage temperature | T_{stg} | -65 to 150 | $^{\circ}C$ |

Note 1: 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 range (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).

Note 2: $V_{CC} = 0$ V

Note 3: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 4: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Operating Ranges (Note 1)

| Characteristics | Symbol | Rating | Unit |
|--------------------------|-----------------|------------------------|------|
| Power supply voltage | V_{CC} | 2.0 to 3.6 | V |
| | | 1.5 to 3.6 (Note 2) | |
| Input voltage | V_{IN} | 0 to 5.5 | V |
| Output voltage | V_{OUT} | 0 to 5.5 (Note 3) | V |
| | | 0 to V_{CC} (Note 4) | |
| Output current | I_{OH}/I_{OL} | ± 24 (Note 5) | mA |
| | | ± 12 (Note 6) | |
| Operating temperature | T_{opr} | -40 to 85 | °C |
| Input rise and fall time | dt/dv | 0 to 10 (Note 7) | ns/V |

Note 1: 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.

Note 2: Data retention only

Note 3: $V_{CC} = 0$ V

Note 4: High or low state

Note 5: $V_{CC} = 3.0$ to 3.6 V

Note 6: $V_{CC} = 2.7$ to 3.0 V

Note 7: $V_{IN} = 0.8$ to 2.0 V, $V_{CC} = 3.0$ V

Electrical Characteristics

DC Characteristics ($T_a = -40$ to 85°C)

| Characteristics | | Symbol | Test Condition | V_{CC} (V) | Min | Max | Unit |
|--------------------------------|---------|-----------------|-------------------------------|-----------------------|------------|----------------|---------|
| Input voltage | H-level | V_{IH} | — | 2.7 to 3.6 | 2.0 | — | V |
| | L-level | V_{IL} | — | 2.7 to 3.6 | — | 0.8 | |
| Output voltage | H-level | V_{OH} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OH} = -100 \mu A$ | 2.7 to 3.6 | $V_{CC} - 0.2$ | V |
| | | | | $I_{OH} = -12$ mA | 2.7 | 2.2 | |
| | | | | $I_{OH} = -18$ mA | 3.0 | 2.4 | |
| | | | | $I_{OH} = -24$ mA | 3.0 | 2.2 | |
| | L-level | V_{OL} | $V_{IN} = V_{IH}$ or V_{IL} | $I_{OL} = 100 \mu A$ | 2.7 to 3.6 | — | 0.2 |
| | | | | $I_{OL} = 12$ mA | 2.7 | — | 0.4 |
| | | | | $I_{OL} = 16$ mA | 3.0 | — | 0.4 |
| | | | | $I_{OL} = 24$ mA | 3.0 | — | 0.55 |
| Input leakage current | | I_{IN} | $V_{IN} = 0$ to 5.5 V | 2.7 to 3.6 | — | ± 5.0 | μA |
| Power-off leakage current | | I_{OFF} | $V_{IN}/V_{OUT} = 5.5$ V | 0 | — | 10.0 | μA |
| Quiescent supply current | | I_{CC} | $V_{IN} = V_{CC}$ or GND | 2.7 to 3.6 | — | 10.0 | μA |
| | | | $V_{IN} = 3.6$ to 5.5 V | 2.7 to 3.6 | — | ± 10.0 | |
| Increase in I_{CC} per input | | ΔI_{CC} | $V_{IH} = V_{CC} - 0.6$ V | 2.7 to 3.6 | — | 500 | |

AC Characteristics (Ta = -40 to 85°C)

| Characteristics | Symbol | Test Condition | V _{CC} (V) | Min | Max | Unit |
|--|-------------------|--------------------|---------------------|-----|-----|------|
| | | | | | | |
| Propagation delay time (A, B, C- \bar{Y}) | t _{pLH} | Figure 1, Figure 2 | 2.7 | — | 7.0 | ns |
| | t _{pHL} | | 3.3 ± 0.3 | 1.5 | 6.0 | |
| Propagation delay time (G1- \bar{Y}) | t _{pLH} | Figure 1, Figure 2 | 2.7 | — | 8.0 | ns |
| | t _{pHL} | | 3.3 ± 0.3 | 1.5 | 7.0 | |
| Propagation delay time ($\bar{G}2$ - \bar{Y}) | t _{pLH} | Figure 1, Figure 2 | 2.7 | — | 7.0 | ns |
| | t _{pHL} | | 3.3 ± 0.3 | 1.5 | 6.0 | |
| Output to output skew | t _{osLH} | (Note) | 2.7 | — | — | ns |
| | t _{osHL} | | 3.3 ± 0.3 | — | 1.0 | |

Note: Parameter guaranteed by design.
 (t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)

Dynamic Switching Characteristics (Ta = 25°C, input: t_r = t_f = 2.5 ns, C_L = 50 pF, R_L = 500 Ω)

| Characteristics | Symbol | Test Condition | V _{CC} (V) | Typ. | Unit |
|--|------------------|--|---------------------|------|------|
| | | | | | |
| Quiet output maximum dynamic V _{OL} | V _{OLP} | V _{IH} = 3.3 V, V _{IL} = 0 V | 3.3 | 0.8 | V |
| Quiet output minimum dynamic V _{OL} | V _{OLV} | V _{IH} = 3.3 V, V _{IL} = 0 V | 3.3 | 0.8 | V |

Capacitive Characteristics (Ta = 25°C)

| Characteristics | Symbol | Test Condition | V _{CC} (V) | Typ. | Unit |
|-------------------------------|------------------|---------------------------------|---------------------|------|------|
| | | | | | |
| Input capacitance | C _{IN} | — | 3.3 | 7 | pF |
| Output capacitance | C _{OUT} | — | 0 | 8 | pF |
| Power dissipation capacitance | C _{PD} | f _{IN} = 10 MHz (Note) | 3.3 | 25 | pF |

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

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

AC Test Circuit

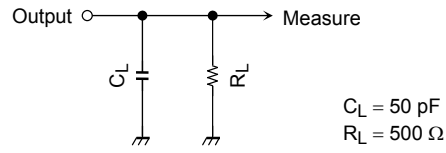


Figure 1

AC Waveform

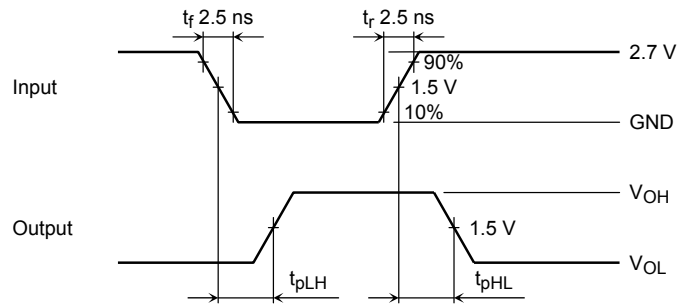
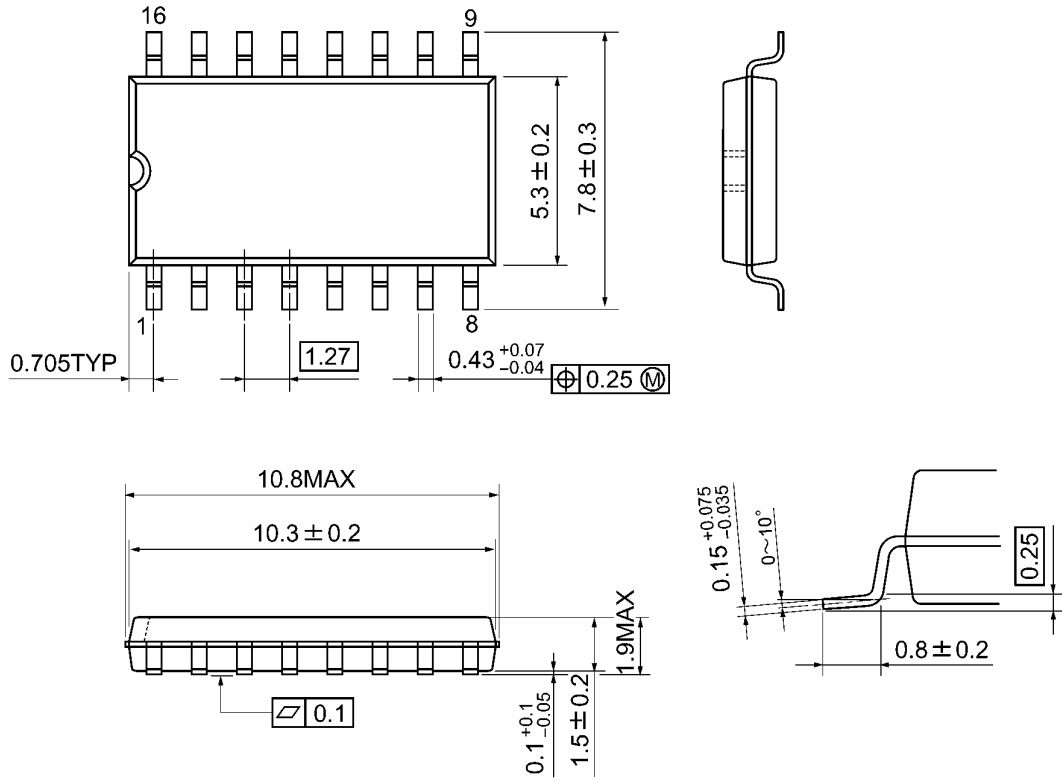


Figure 2 t_{pLH} , t_{pHL}

Package Dimensions

SOP16-P-300-1.27A

Unit: mm

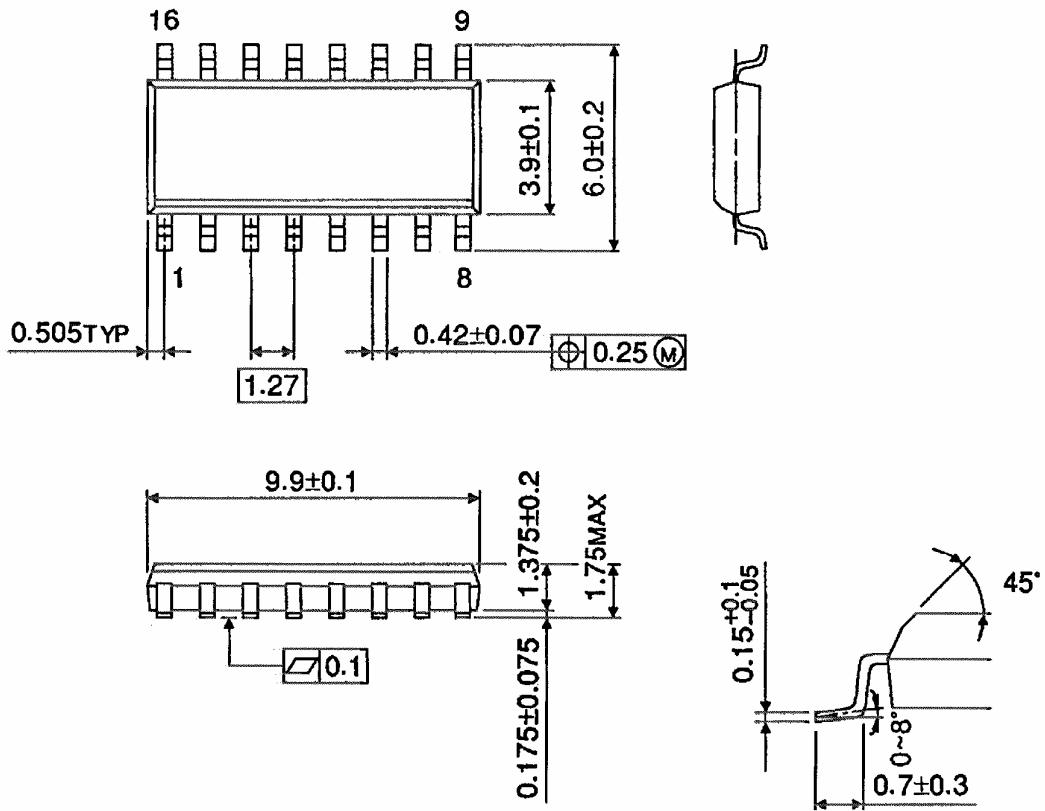


Weight: 0.18 g (typ.)

Package Dimensions (Note)

SOL16-P-150-1.27

Unit : mm



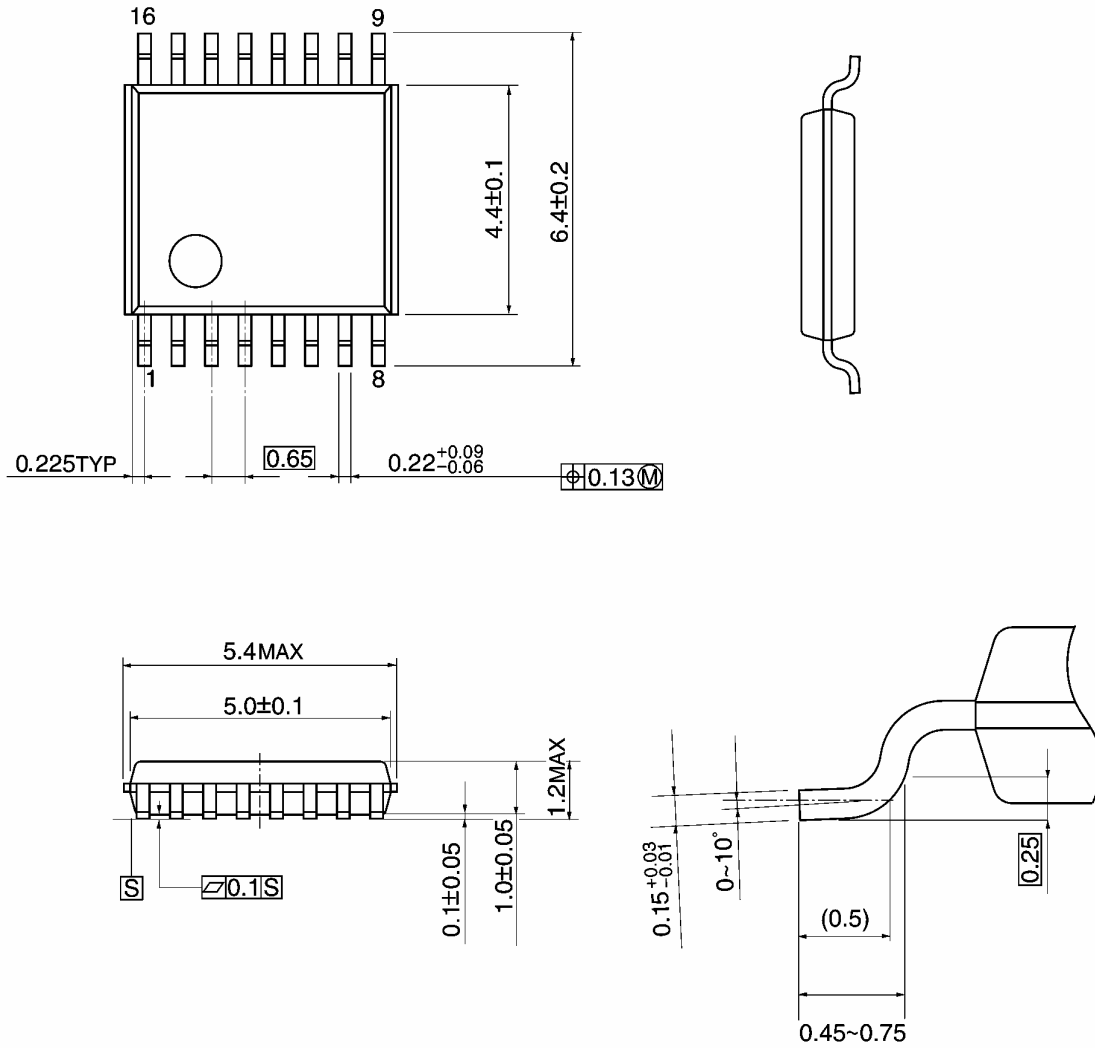
Note: This package is not available in Japan.

Weight: 0.12 g (typ.)

Package Dimensions

TSSOP16-P-0044-0.65A

Unit: mm

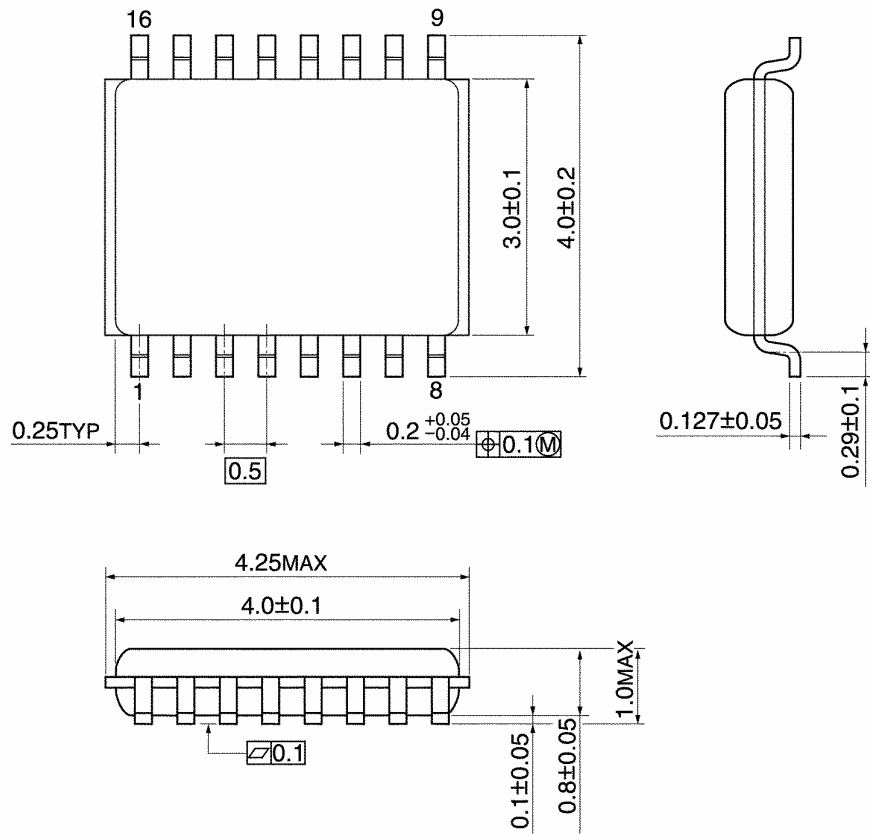


Weight: 0.06 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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20070701-EN GENERAL

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