TOSHIBA CMOS Digital Integrated Circuit   Silicon Monolithic

TC74LCX138F,TC74LCX138FN,TC74LCX138FT,TC74LCX138FK

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

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

The TC74LCX138F/FN/FT/FK 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 ($\overline{Y}0$ - $\overline{Y}7$) will go low. When enable input G1 is held low or either $\overline{G2A}$ or $\overline{G2B}$ is held high, decoding function is inhibited and all outputs go high.

G1, $\overline{G2A}$, and $\overline{G2B}$ inputs are provided to ease cascade connection and for use as an address decoder for memory systems.
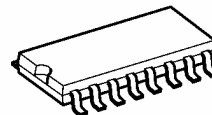
All inputs are equipped with protection circuits against static discharge.

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)
- Ouput current: $|I_{OH}|/I_{OL}$ = 24 mA (min) (V_{CC} = 3.0 V)
- Latch-up performance: ±500 mA
- Available in JEDEC SOP, JEITA SOP and TSSOP
- 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
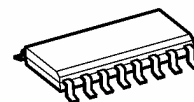
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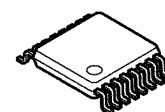

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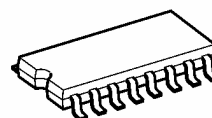
SOP16-P-300-1.27

TC74LCX138FN

SOL16-P-150-1.27

TC74LCX138FT

TSSOP16-P-0044-0.65A

TC74LCX138FK
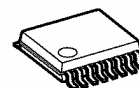
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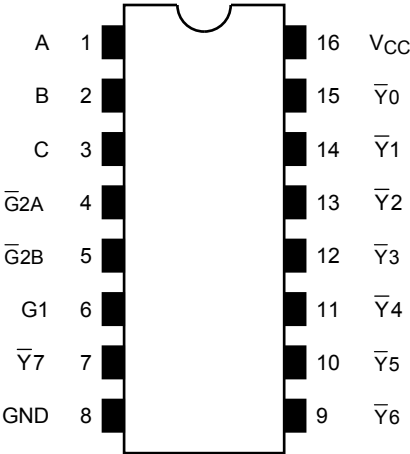
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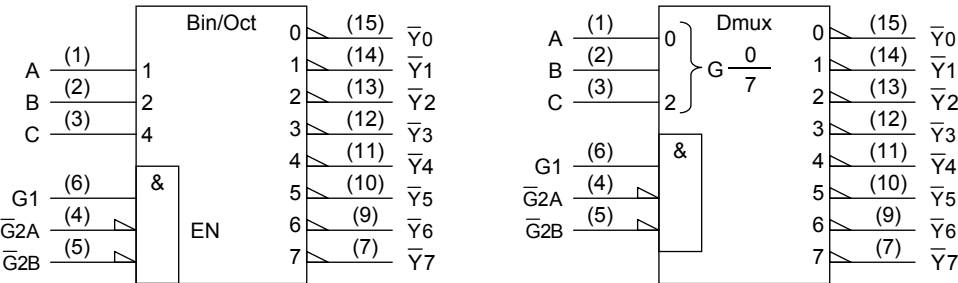|	
SOP16-P-300-1.27A	: 0.18 g (typ.)
SOP16-P-300-1.27	: 0.18 g (typ.)
SOL16-P-150-1.27	: 0.12 g (typ.)
TSSOP16-P-0044-0.65A	: 0.06 g (typ.)
VSSOP16-P-0030-0.50	: 0.02 g (typ.)

Pin Assignment (top view)

A	1		16	V_{CC}
B	2		15	$\overline{Y}0$
C	3		14	$\overline{Y}1$
$\overline{G}2A$	4		13	$\overline{Y}2$
$\overline{G}2B$	5		12	$\overline{Y}3$
G1	6		11	$\overline{Y}4$
$\overline{Y}7$	7		10	$\overline{Y}5$
GND	8		9	$\overline{Y}6$

IEC Logic Symbol

Truth Table

Inputs						Outputs								Selected Output
Enable			Select			$\overline{Y}0$	$\overline{Y}1$	$\overline{Y}2$	$\overline{Y}3$	$\overline{Y}4$	$\overline{Y}5$	$\overline{Y}6$	$\overline{Y}7$	
G1	$\overline{G}2A$	$\overline{G}2B$	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	$\overline{Y}0$
H	L	L	L	L	H	H	L	H	H	H	H	H	H	$\overline{Y}1$
H	L	L	L	H	L	H	H	L	H	H	H	H	H	$\overline{Y}2$
H	L	L	L	H	H	H	H	H	L	H	H	H	H	$\overline{Y}3$
H	L	L	H	L	L	H	H	H	H	L	H	H	H	$\overline{Y}4$
H	L	L	H	L	H	H	H	H	H	H	L	H	H	$\overline{Y}5$
H	L	L	H	H	L	H	H	H	H	H	H	L	H	$\overline{Y}6$
H	L	L	H	H	H	H	H	H	H	H	H	H	L	$\overline{Y}7$

X: Don't care

System Diagram
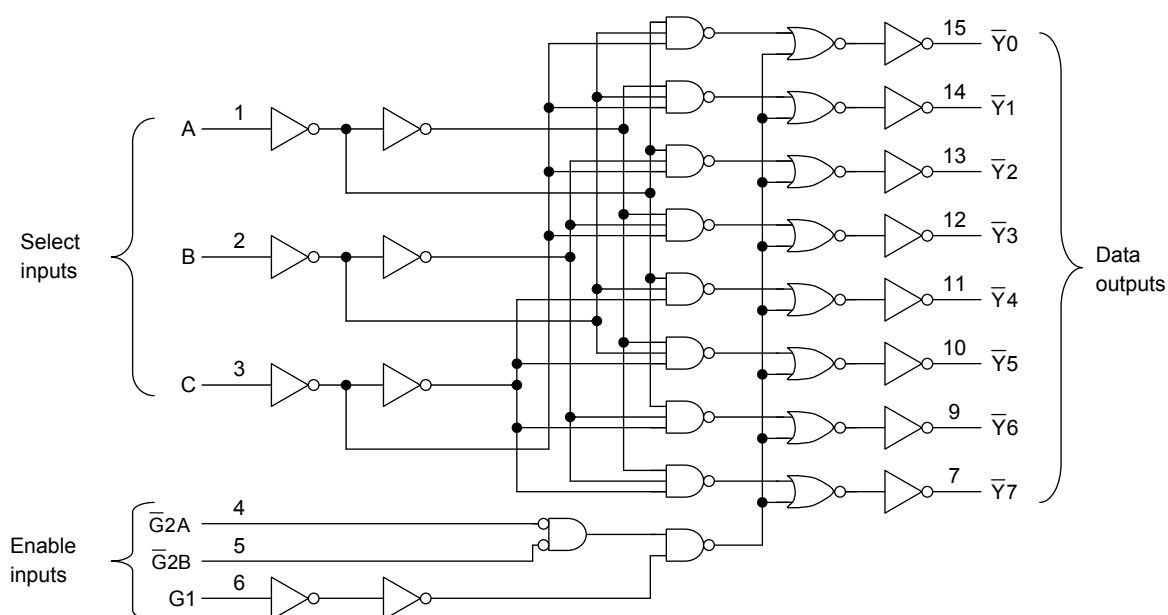
Absolute Maximum Ratings (Note 1)

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	°C

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

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, $V_{OUT} > V_{CC}$

Recommended Operating Conditions (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 recommended operating conditions are required to ensure the normal operation of the device. Unused inputs must be tied to either VCC 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 (Ta = −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 Icc 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- $\overline{Y}$)	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- $\overline{Y}$)	t_{pLH}	Figure 1, Figure 2	2.7	—	8.0	ns
	t_{pHL}		3.3 ± 0.3	1.5	7.0	
Propagation delay time ($\overline{G2}$ - $\overline{Y}$)	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

Output ○————→ Measure

C_L R_L

$C_L = 50$ pF
$R_L = 500\ \Omega$

Figure 1

AC Waveform

t_f 2.5 ns t_r 2.5 ns

2.7 V

90%

Input   1.5 V

10%

GND

V_{OH}

Output   1.5 V

V_{OL}
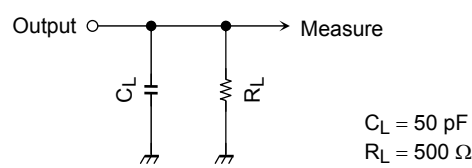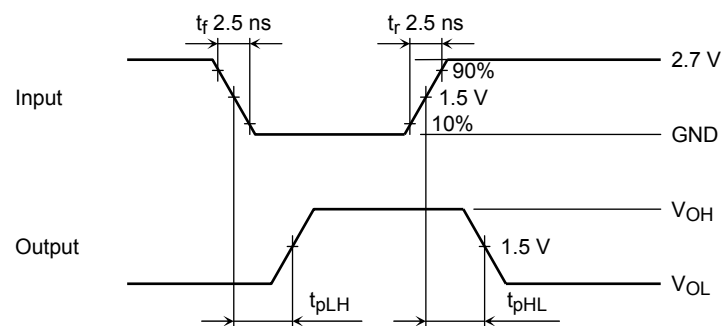
t_{pLH} t_{pHL}

Figure 2 t_{pLH}, t_{pHL}

Package Dimensions

SOP16-P-300-1.27A

Unit: mm
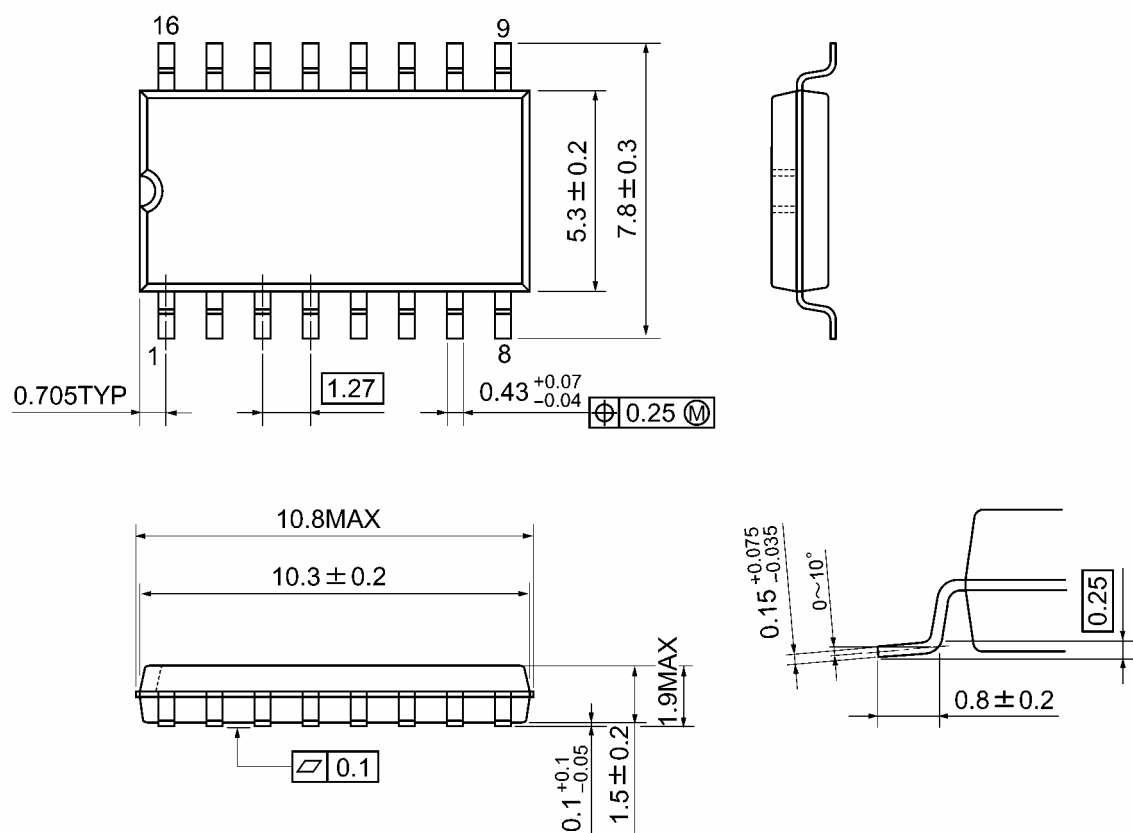
Weight: 0.18 g (typ.)
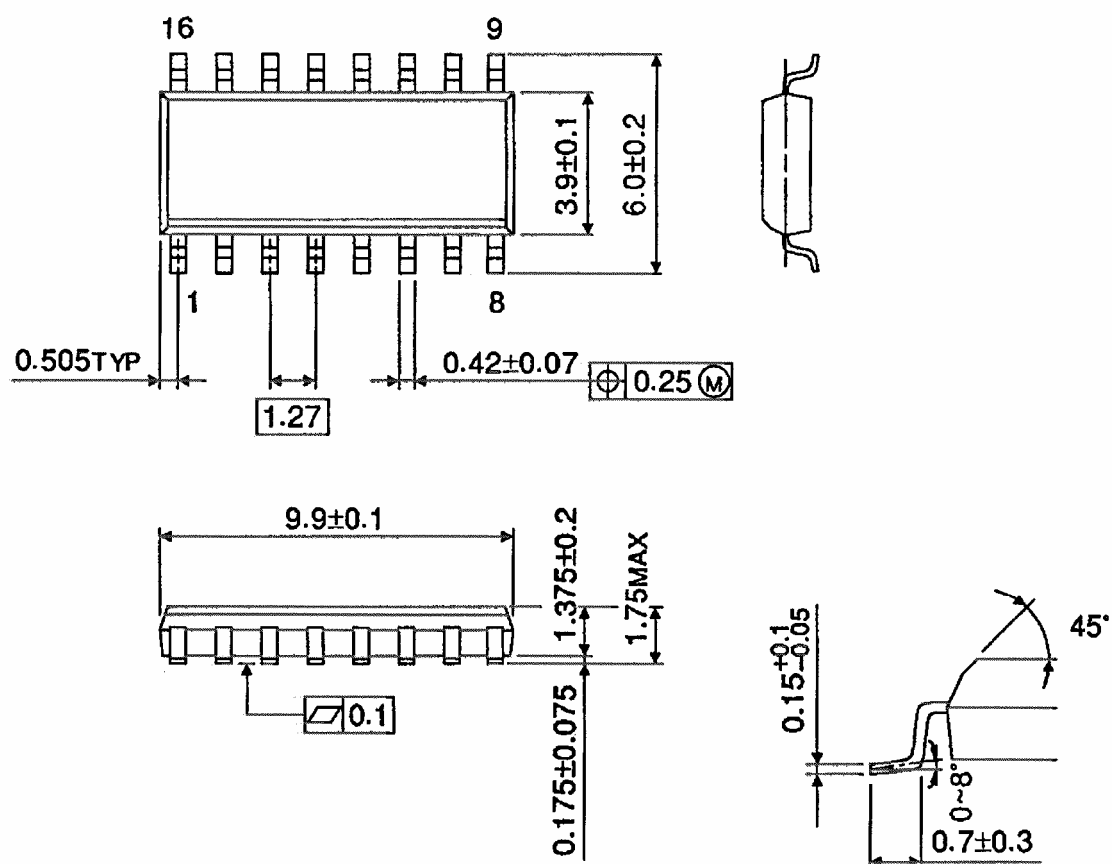
Package Dimensions

SOP16-P-300-1.27   Unit : mm
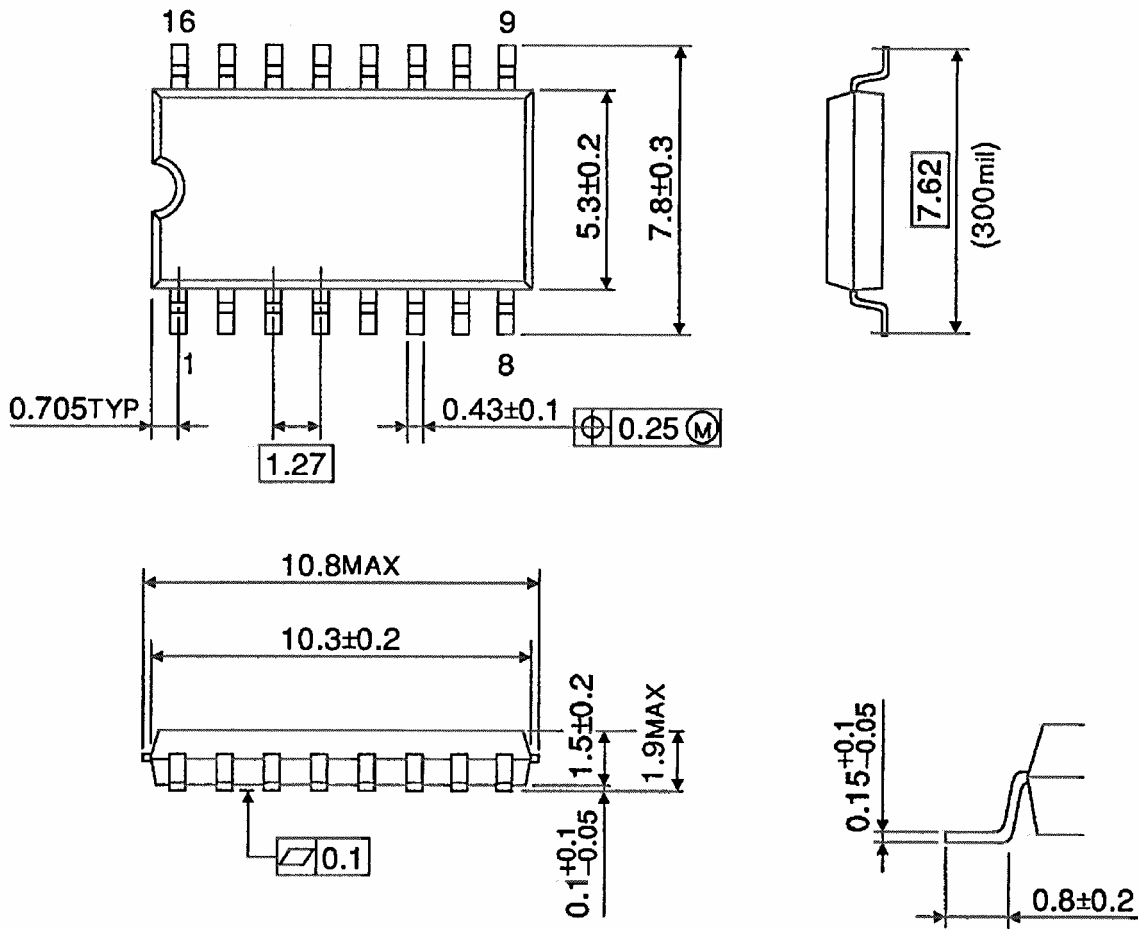
Weight: 0.18 g (typ.)

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

16   9

4.4±0.1

6.4±0.2

1   8

0.225TYP

0.65

$0.22^{+0.09}_{-0.06}$

⊕ 0.13 Ⓜ

5.4MAX

5.0±0.1

1.2MAX

0.1±0.05

1.0±0.05

S

⟋ 0.1 S

$0.15^{+0.03}_{-0.01}$

0~10°

(0.5)

0.25

0.45~0.75
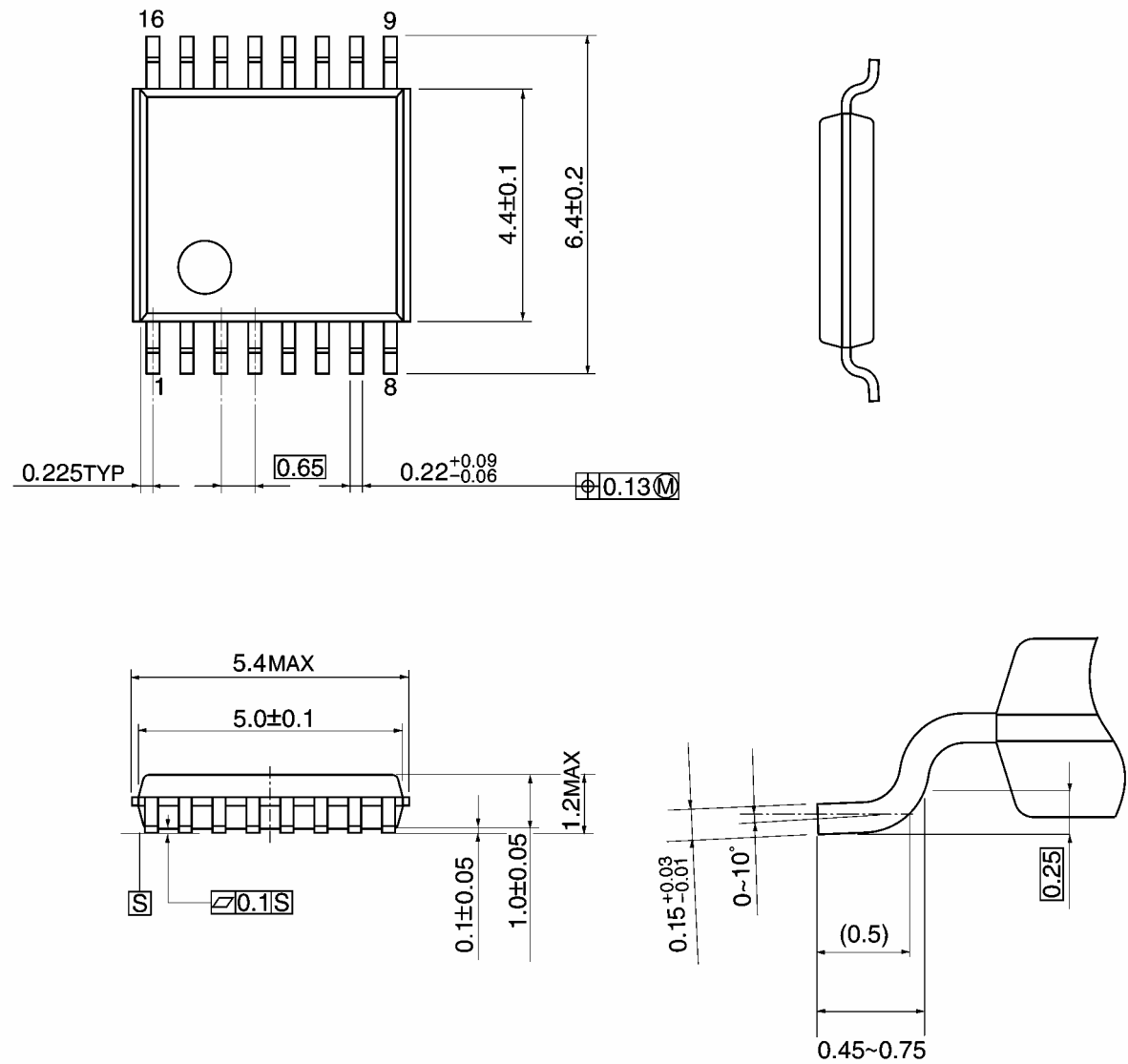
Weight: 0.06 g (typ.)

Package Dimensions

VSSOP16-P-0030-0.50   Unit: mm
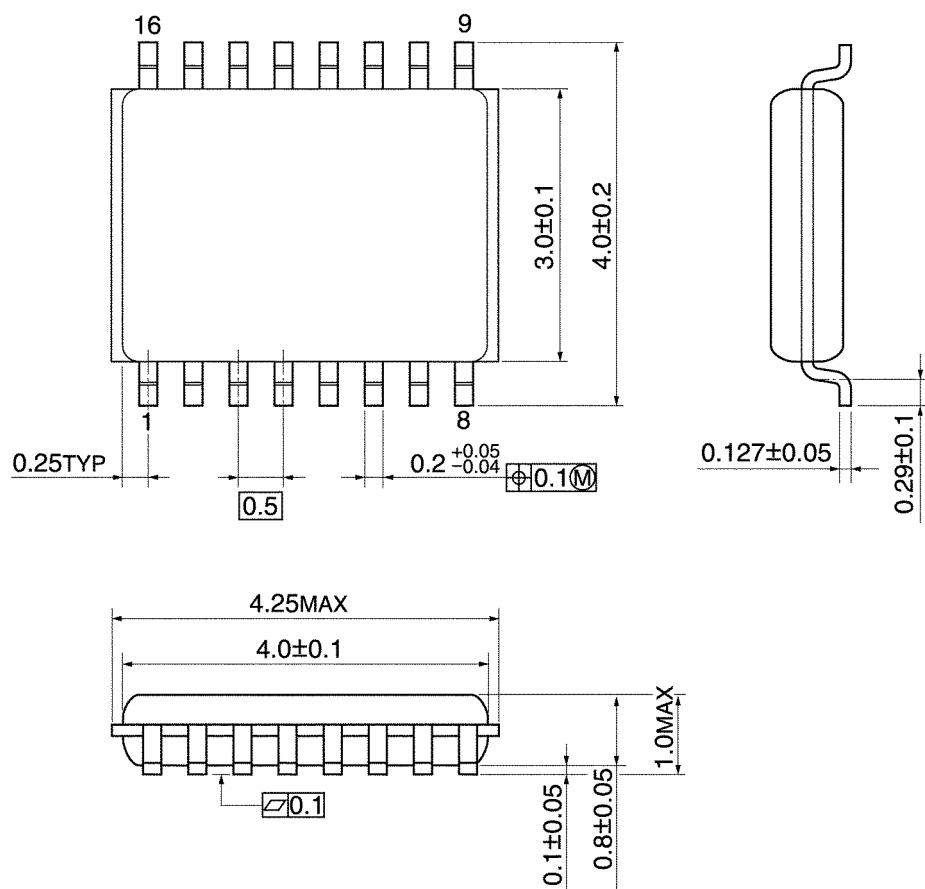
Weight: 0.02 g (typ.)

Note: Lead (Pb)-Free Packages

SOP16-P-300-1.27A   SOL16-P-150-1.27   TSSOP16-P-0044-0.65A   VSSOP16-P-0030-0.50

RESTRICTIONS ON PRODUCT USE