TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCX245FT, TC74VCX245FK, TC74VCX245FTG

Low-Voltage Octal Bus Transceiver with 3.6 V Tolerant Inputs and Outputs

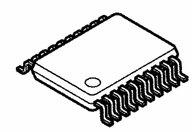
The TC74VCX245 is a high performance CMOS octal bus transceiver which is guaranteed to operate from 1.2-V to 3.6-V. Designed for use in 1.5V, 1.8V, 2.5V or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

The direction of data transmission is determined by the level of the DIR inputs. The $\overline{OE}$ inputs can be used to disable the device so that the busses are effectively isolated.

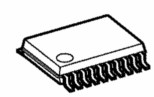
All inputs are equipped with protection circuits against static discharge.

TC74VCX245FT



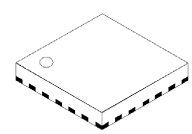
TSSOP20-P-0044-0.65A

TC74VCX245FK



VSSOP20-P-0030-0.50

TC74VCX245FTG



VQON20-0404-0.50

Weight

TSSOP20-P-0044-0.65A	: 0.08 g (typ.)
VSSOP20-P-0030-0.50	: 0.03 g (typ.)
VQON20-P-0404-0.50	: 0.0145g (typ.)

Features (Note 1) (Note 2) (Note 3)

- Low voltage operation: V_{CC} = 1.2~3.6 V
- High speed operation: t_{pd} = 3.5 ns (max) (V_{CC} = 3.0~3.6 V)
  t_{pd} = 4.2 ns (max) (V_{CC} = 2.3~2.7 V)
  t_{pd} = 8.4 ns (max) (V_{CC} = 1.65~1.95 V)
  t_{pd} = 16.8 ns (max) (V_{CC} = 1.4~1.6 V)
  t_{pd} = 42.0 ns (max) (V_{CC} = 1.2 V)
- 3.6 V tolerant inputs and outputs.
- Output current: I_{OH}/I_{OL} = ±24 mA (min) (V_{CC} = 3.0 V)
  I_{OH}/I_{OL} = ±18 mA (min) (V_{CC} = 2.3 V)
  I_{OH}/I_{OL} = ±6 mA (min) (V_{CC} = 1.65 V)
  I_{OH}/I_{OL} = ±2 mA (min) (V_{CC} = 1.4 V)
- Latch-up performance: −300 mA
- ESD performance: Machine model ≥ ±200 V
  Human body model ≥ ±2000 V
- Package: TSSOP
  VSSOP (US)
  VQON
- Bidirectional interface between 2.5 V and 3.3 V signals. (Note 1)
- Power down protection is provided on all inputs and outputs. (Note 2)

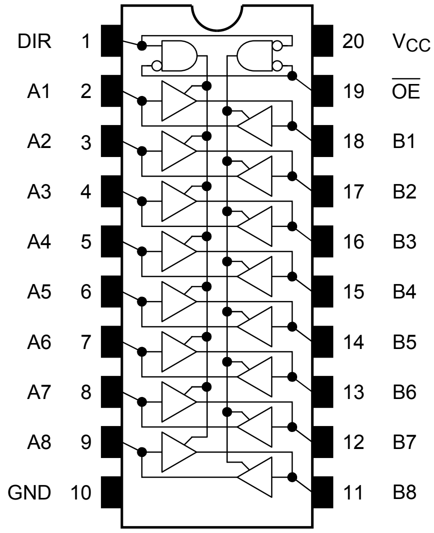
Note 1: Do not apply a signal to any bus terminal when it is in the output mode. Damage may result.

Note 2: All floating (high impedance) bus terminal must have their input level fixed by means of pull up or pull down resistors.

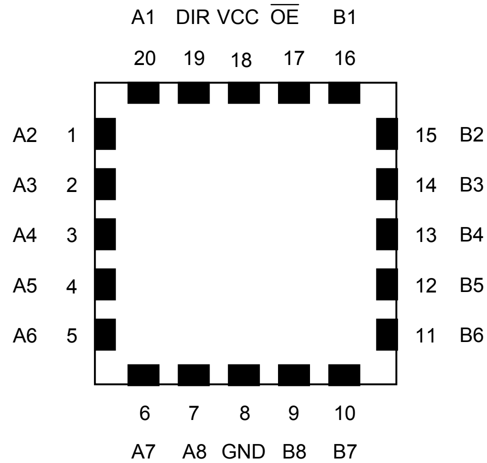
Note 3: When mounting VQON package, the type of recommended flux is RA or RMA.

Pin Assignment (top view)

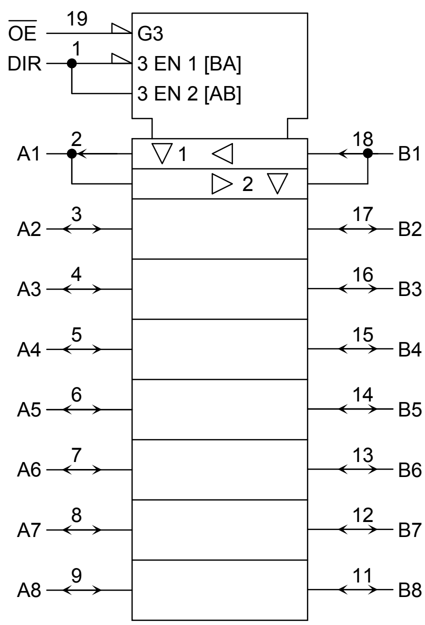
FT(TSSOP20-P-0044-0.65)
FK(VSSOP20-P-0030-0.50)



FTG(VQON20-P-0404-0.50)



IEC Logic Symbol



Truth Table

Inputs		Outputs	Function	
$\overline{OE}$	DIR		A-Bus	B-Bus
L	L	A = B	Output	Input
L	H	B = A	Input	Output
H	X	Z	Z	

X: Don't care

Z: High impedance

Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	−0.5~4.6	V
DC input voltage (DIR, $\overline{OE}$)	V_{IN}	−0.5~4.6	V
DC bus I/O voltage	$V_{I/O}$	−0.5~4.6 (Note 2)	V
		−0.5~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}	−65~150	°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 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).

Note 2: Off-state

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
Supply voltage	V_{CC}	1.2~3.6	V
Input voltage (DIR, $\overline{OE}$)	V_{IN}	−0.3~3.6	V
Bus I/O voltage	$V_{I/O}$	0~3.6 (Note 2)	V
		0~V_{CC} (Note 3)	
Output current	I_{OH}/I_{OL}	±24 (Note 4)	mA
		±18 (Note 5)	
		±6 (Note 6)	
		±2 (Note 7)	
Operating temperature	T_{opr}	−40~85	°C
Input rise and fall time	dt/dv	0~10 (Note 8)	ns/V

Note 1: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs and bus inputs must be tied to either VCC or GND. Please connect both bus inputs and the bus outputs with VCC or GND when the I/O of the bus terminal changes by the function. In this case, please note that the output is not short-circuited.

Note 2: Off-state

Note 3: High or low state

Note 4: V_{CC} = 3.0~3.6 V

Note 5: V_{CC} = 2.3~2.7 V

Note 6: V_{CC} = 1.65~1.95 V

Note 7: V_{CC} = 1.4~1.6 V

Note 8: V_{IN} = 0.8~2.0 V, V_{CC} = 3.0 V

Electrical Characteristics

DC Characteristics (Ta = −40~85°C, 2.7 V < V_{CC} ≦ 3.6 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		2.7~3.6	2.0	—	V
	Low level	V_{IL}	—		2.7~3.6	—	0.8	
Output voltage	High level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100$ μA	2.7~3.6	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	—	
	Low level	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100$ μA	2.7~3.6	—	0.2	
				$I_{OL} = 12$ mA	2.7	—	0.4	
				$I_{OL} = 18$ mA	3.0	—	0.4	
				$I_{OL} = 24$ mA	3.0	—	0.55	
Input leakage current		I_{IN}	$V_{IN} = 0$~3.6 V		2.7~3.6	—	±5.0	μA
3-state output off-state current		I_{OZ}	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$~3.6 V		2.7~3.6	—	±10.0	μA
Power off leakage current		I_{OFF}	V_{IN}, $V_{OUT} = 0$~3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	$V_{IN} = V_{CC}$ or GND		2.7~3.6	—	20.0	μA
			V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6 V		2.7~3.6	—	±20.0	
Increase in I_{CC} per input		ΔI_{CC}	$V_{IH} = V_{CC} - 0.6$ V		2.7~3.6	—	750	

DC Characteristics (Ta = −40~85°C, 2.3 V ≦ V_{CC} ≦ 2.7 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		2.3~2.7	1.6	—	V
	Low level	V_{IL}	—		2.3~2.7	—	0.7	
Output voltage	High level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100$ μA	2.3~2.7	V_{CC} − 0.2	—	V
				$I_{OH} = -6$ mA	2.3	2.0	—	
				$I_{OH} = -12$ mA	2.3	1.8	—	
				$I_{OH} = -18$ mA	2.3	1.7	—	
	Low level	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100$ μA	2.3~2.7	—	0.2	
				$I_{OL} = 12$ mA	2.3	—	0.4	
				$I_{OL} = 18$ mA	2.3	—	0.6	
Input leakage current		I_{IN}	$V_{IN} = 0$~3.6 V		2.3~2.7	—	±5.0	μA
3-state output off-state current		I_{OZ}	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$~3.6 V		2.3~2.7	—	±10.0	μA
Power off leakage current		I_{OFF}	V_{IN}, $V_{OUT} = 0$~3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	$V_{IN} = V_{CC}$ or GND		2.3~2.7	—	20.0	μA
			V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6 V		2.3~2.7	—	±20.0	

DC Characteristics (Ta = −40~85°C, 1.65 V ≦ V_{CC} < 2.3 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		1.65~2.3	0.65 × V_{CC}	—	V
	Low level	V_{IL}	—		1.65~2.3	—	0.2 × V_{CC}	
Output voltage	High level	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −100 μA	1.65~2.3	V_{CC} − 0.2	—	V
				I_{OH} = − 6 mA	1.65	1.25	—	
	Low level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.65~2.3	—	0.2	
				I_{OL} = 6 mA	1.65	—	0.3	
Input leakage current		I_{IN}	V_{IN} = 0~3.6 V		1.65~2.3	—	±5.0	μA
3-state output off-state current		I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0~3.6 V		1.65~2.3	—	±10.0	μA
Power off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		1.65~2.3	—	20.0	μA
			V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6 V		1.65~2.3	—	±20.0	

DC Characteristics (Ta = −40~85°C, 1.4 V ≦ V_{CC} < 1.65 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		1.4~1.65	0.65 × V_{CC}	—	V
	Low level	V_{IL}	—		1.4~1.65	—	0.05 × V_{CC}	
Output voltage	High level	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −100 μA	1.4~1.65	V_{CC} − 0.2	—	V
				I_{OH} = −2 mA	1.4	1.05	—	
	Low level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.4~1.65	—	0.05	
				I_{OL} = 2 mA	1.4	—	0.35	
Input leakage current		I_{IN}	V_{IN} = 0~3.6 V		1.4~1.65	—	±5.0	μA
3-state output off-state current		I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0~3.6 V		1.4~1.65	—	±10.0	μA
Power off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		1.4~1.65	—	20.0	μA
			V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6 V		1.4~1.65	—	±20.0	

DC Characteristics (Ta = –40~85°C, 1.2 V ≦ V_{CC} < 1.4 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		1.2~1.4	0.8 × V_{CC}	—	V
	Low level	V_{IL}	—		1.2~1.4	—	0.05 × V_{CC}	
Output voltage	High level	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = –100 μA	1.2	V_{CC} – 0.1	—	V
	Low level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.2	—	0.05	
Input leakage current		I_{IN}	V_{IN} = 0~3.6 V		1.2	—	±5.0	μA
3-state output off-state current		I_{OZ}	V_{IN} = V_{IH} or V_{IL} V_{OUT} = 0~3.6 V		1.2	—	±10.0	μA
Power off leakage current		I_{OFF}	V_{IN}, V_{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		1.2	—	20.0	μA
			V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6 V		1.2	—	±20.0	

AC Characteristics (Ta = –40~85°C, Input: t_r = t_f = 2.0 ns, C_L = 30 pF, R_L = 500 Ω) (Note 1)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	Figure 1, Figure 2	C_L = 15 pF, R_L = 2 kΩ	1.2	1.5	42.0	ns
				1.5 ± 0.1	1.0	16.8	
			C_L = 30 pF, R_L = 500 Ω	1.8 ± 0.15	1.5	8.4	
				2.5 ± 0.2	0.8	4.2	
				3.3 ± 0.3	0.6	3.5	
3-state output enable time	t_{pZL} t_{pZH}	Figure 1, Figure 3	C_L = 15 pF, R_L = 2 kΩ	1.2	1.5	49.0	ns
				1.5 ± 0.1	1.0	19.6	
			C_L = 30 pF, R_L = 500 Ω	1.8 ± 0.15	1.5	9.8	
				2.5 ± 0.2	0.8	5.6	
				3.3 ± 0.3	0.6	4.5	
3-state output disable time	t_{pLZ} t_{pHZ}	Figure 1, Figure 3	C_L = 15 pF, R_L = 2 kΩ	1.2	1.5	36.0	ns
				1.5 ± 0.1	1.0	14.4	
			C_L = 30 pF, R_L = 500 Ω	1.8 ± 0.15	1.5	7.2	
				2.5 ± 0.2	0.8	4.0	
				3.3 ± 0.3	0.6	3.6	
Output to output skew	t_{osLH} t_{osHL}	(Note 2)	C_L = 15 pF, R_L = 2 kΩ	1.2	—	1.5	ns
				1.5 ± 0.1	—	1.5	
			C_L = 30 pF, R_L = 500 Ω	1.8 ± 0.15	—	0.5	
				2.5 ± 0.2	—	0.5	
				3.3 ± 0.3	—	0.5	

Note 1: For C_L = 50 pF, add approximately 300 ps to the AC maximum specification.

Note 2: This parameter is guaranteed by design.
($t_{osLH} = |t_{pLHm} - t_{pLHn}|$, $t_{osHL} = |t_{pHLm} - t_{pHLn}|$)

Dynamic Switching Characteristics (Ta = 25°C, Input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V (Note)	1.8	0.25	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V (Note)	2.5	0.6	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V (Note)	3.3	0.8	
Quiet output minimum dynamic V_{OL}	V_{OLV}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V (Note)	1.8	−0.25	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V (Note)	2.5	−0.6	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V (Note)	3.3	−0.8	
Quiet output minimum dynamic V_{OH}	V_{OHV}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V (Note)	1.8	1.5	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V (Note)	2.5	1.9	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V (Note)	3.3	2.2	

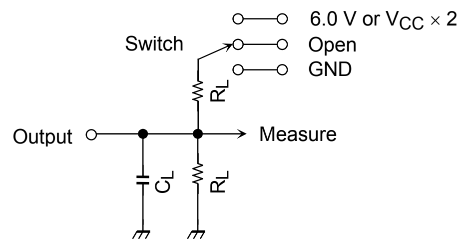
Note: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	—	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	$C_{I/O}$	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C_{PD}	$f_{IN} = 10$ MHz (Note)	1.8, 2.5, 3.3	20	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:
$I_{CC\,(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8$ (per bit)

AC Test Circuit



Parameter	Switch
t_{pLH}, t_{pHL}	Open
t_{pLZ}, t_{pZL}	6.0 V @V_{CC} = 3.3 ± 0.3 V @V_{CC} = 2.5 ± 0.2 V V_{CC} × 2 @V_{CC} = 1.8 ± 0.15 V @V_{CC} = 1.5 ± 0.1 V @V_{CC} = 1.2 V
t_{pHZ}, t_{pZH}	GND

Symbol	V_{CC}	
	3.3 ± 0.3 V 2.5 ± 0.2 V 1.8 ± 0.15 V	1.5 ± 0.1 V 1.2 V
R_L	500Ω	2kΩ
C_L	30pF	15pF

Figure 1

AC Waveform

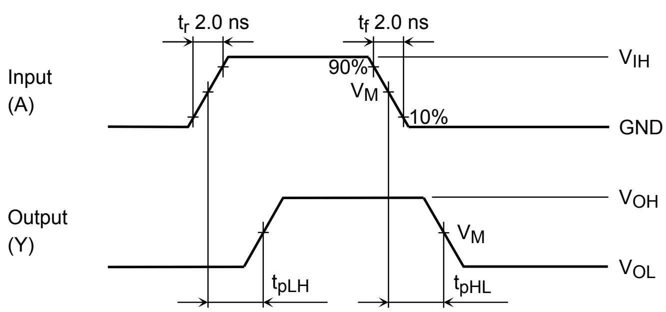


Figure 2 t_{pLH}, t_{pHL}

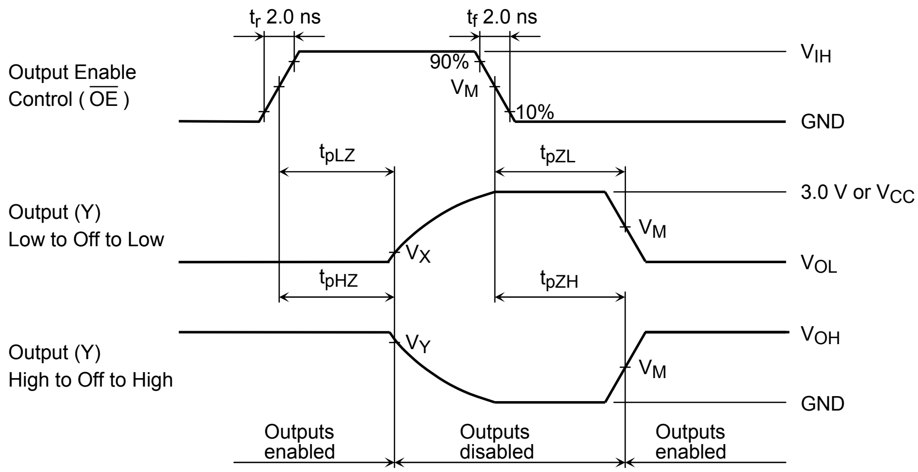
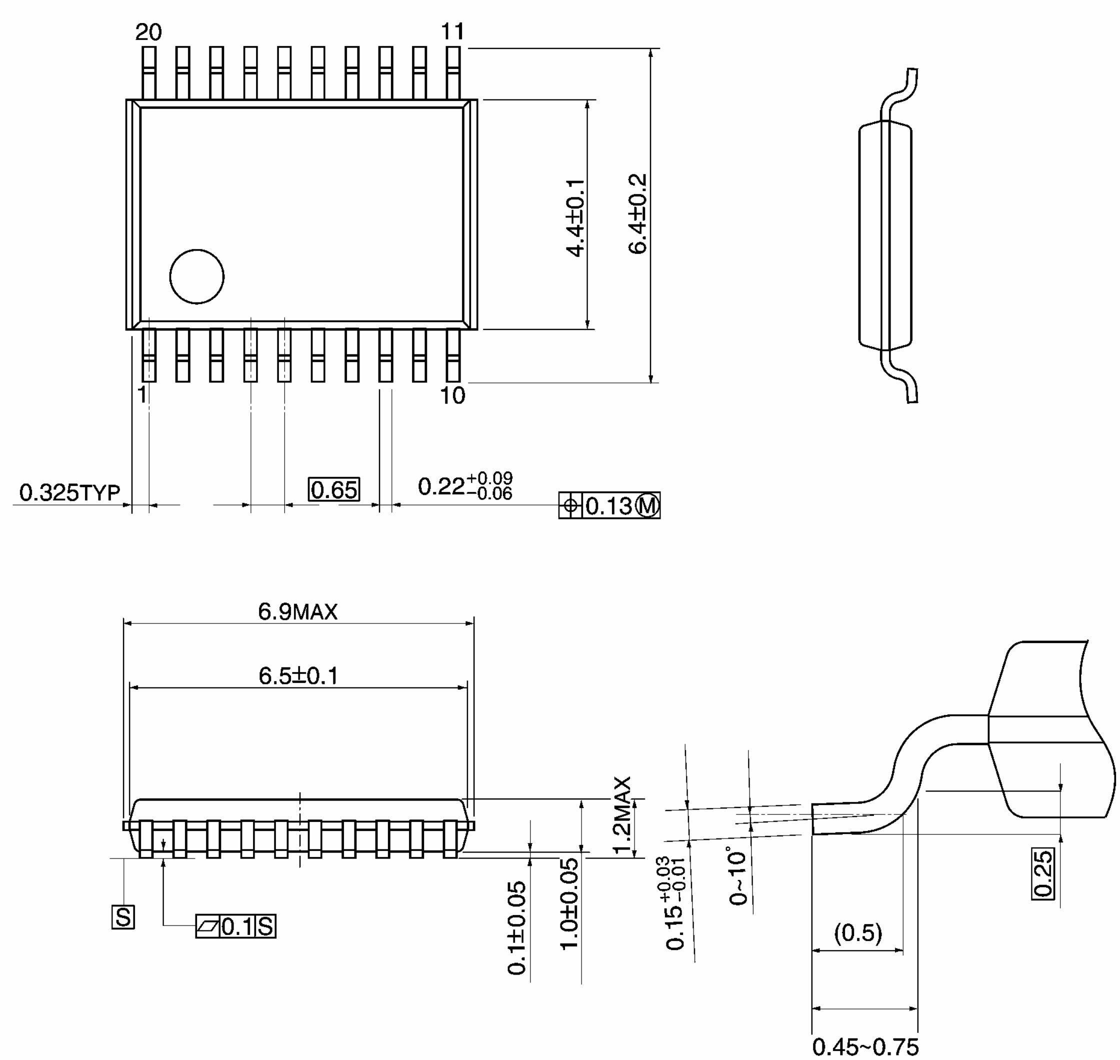


Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

Symbol	V_{CC}				
	3.3 ± 0.3 V	2.5 ± 0.2 V	1.8 ± 0.15 V	1.5 ± 0.1 V	1.2 V
V_{IH}	2.7 V	V_{CC}	V_{CC}	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$	$V_{CC}/2$
V_X	V_{OL} + 0.3 V	V_{OL} + 0.15 V	V_{OL} + 0.15 V	V_{OL} + 0.1 V	V_{OL} + 0.1 V
V_Y	V_{OH} − 0.3 V	V_{OH} − 0.15 V	V_{OH} − 0.15 V	V_{OH} − 0.1 V	V_{OH} − 0.1 V

Package Dimensions

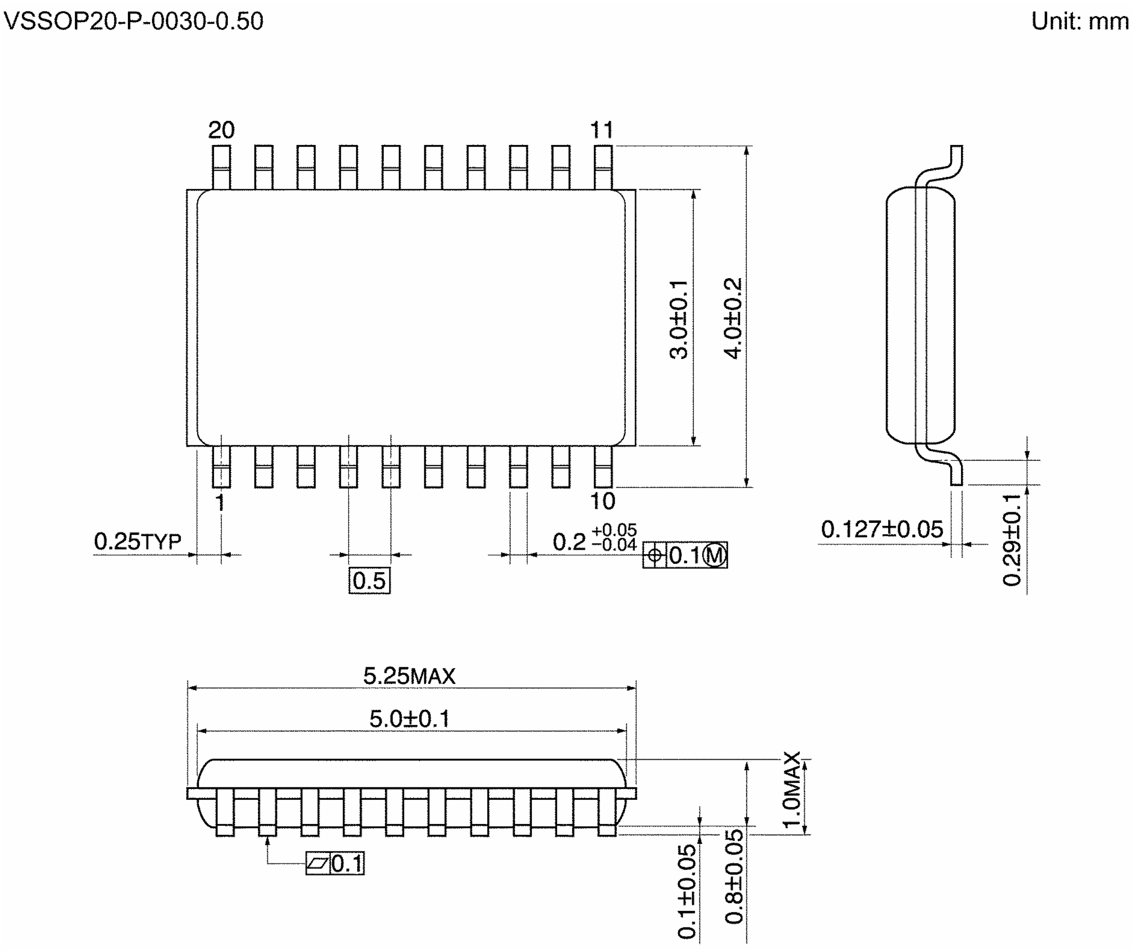
TSSOP20-P-0044-0.65A Unit: mm



Weight: 0.08 g (typ.)

Package Dimensions

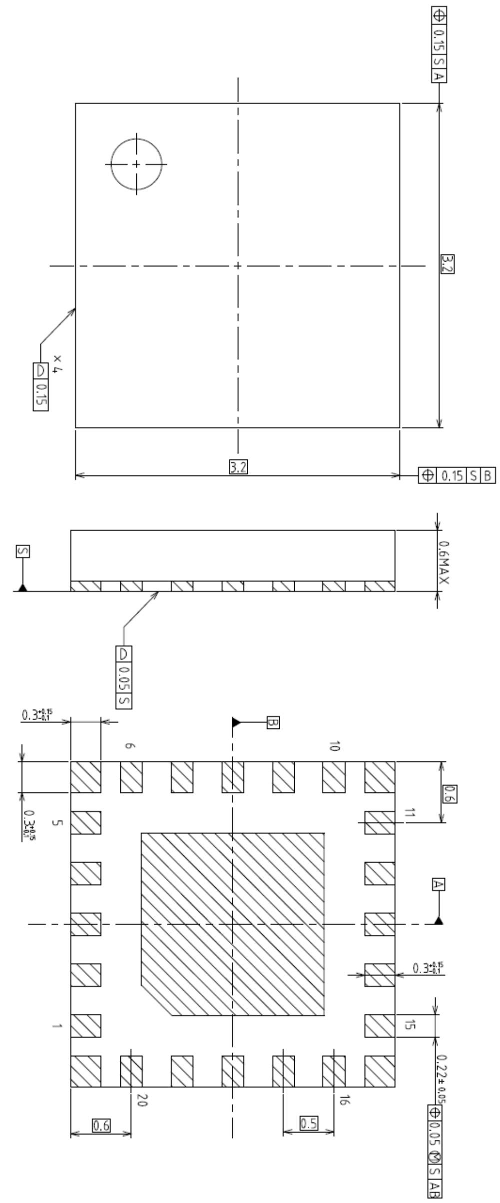
VSSOP20-P-0030-0.50 Unit: mm



Weight: 0.03 g (typ.)

Package Dimensions

VQON20-P-0404-0.50 Unit: mm



Weight: 0.0145 g (typ.)

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20070701-EN

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