

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.

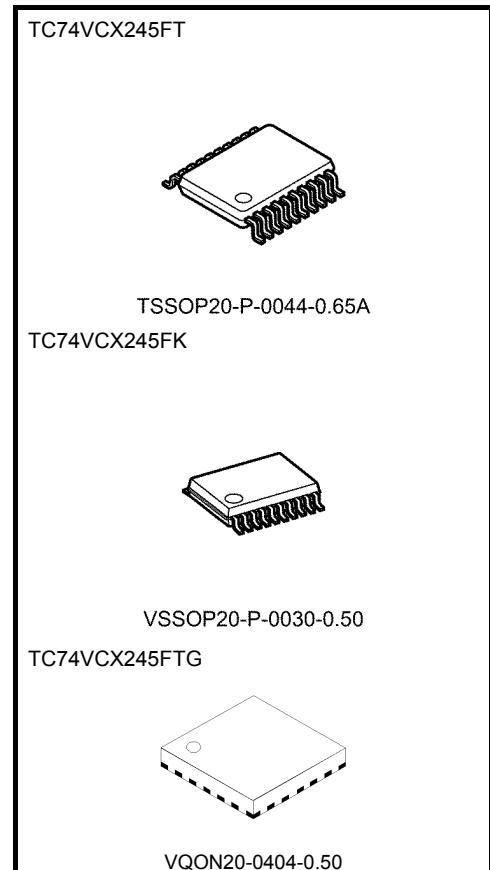
Features (Note 1) (Note 2) (Note 3)

- Low voltage operation: $V_{CC} = 1.2$ to 3.6 V
- High speed operation: $t_{pd} = 3.5$ ns (max) ($V_{CC} = 3.0$ to 3.6 V)
 $t_{pd} = 4.2$ ns (max) ($V_{CC} = 2.3$ to 2.7 V)
 $t_{pd} = 8.4$ ns (max) ($V_{CC} = 1.65$ to 1.95 V)
 $t_{pd} = 16.8$ ns (max) ($V_{CC} = 1.4$ to 1.6 V)
 $t_{pd} = 42.0$ ns (max) ($V_{CC} = 1.2$ V)
- 3.6 V tolerant inputs and outputs.
- Output current: $I_{OH}/I_{OL} = \pm 24$ mA (min) ($V_{CC} = 3.0$ V)
 $I_{OH}/I_{OL} = \pm 18$ mA (min) ($V_{CC} = 2.3$ V)
 $I_{OH}/I_{OL} = \pm 6$ mA (min) ($V_{CC} = 1.65$ V)
 $I_{OH}/I_{OL} = \pm 2$ mA (min) ($V_{CC} = 1.4$ V)
- Latch-up performance: -300 mA
- ESD performance: Machine model $\geq \pm 200$ V
Human body model $\geq \pm 2000$ 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.

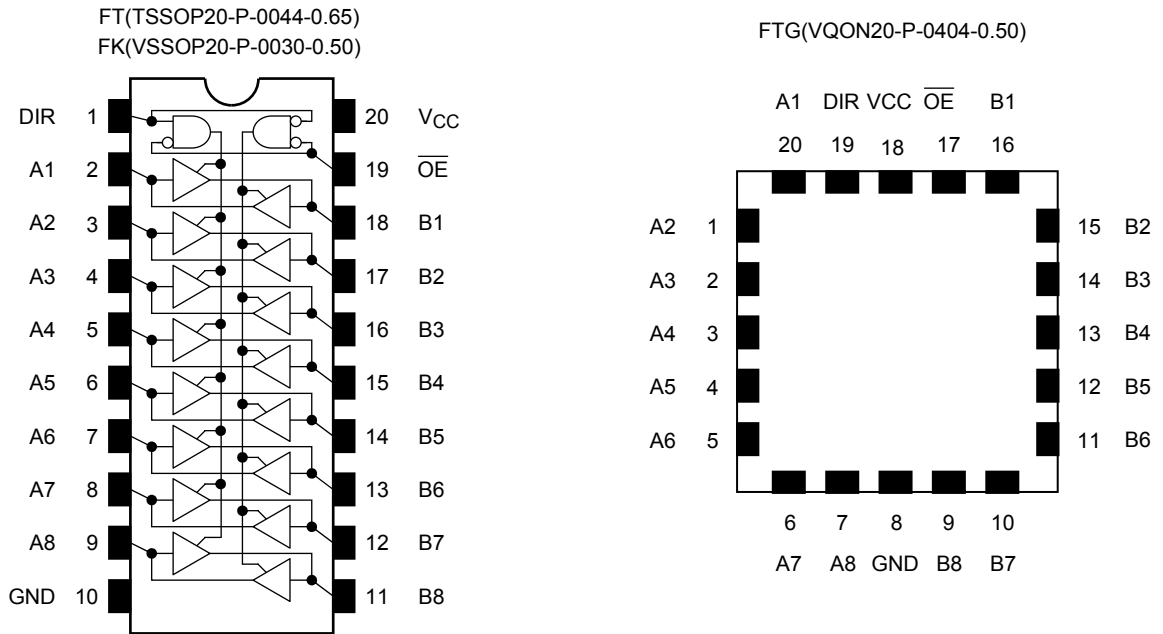
Note 3: When mounting VQON package, the type of recommended flux is RA or RMA.



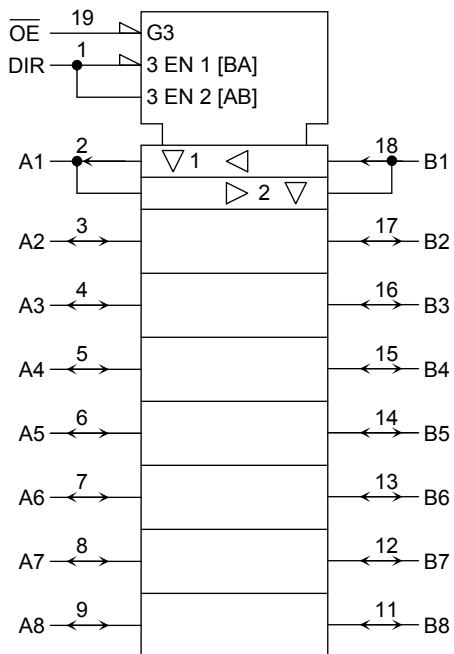
Weight	
TSSOP20-P-0044-0.65A	: 0.08 g (typ.)
VSSOP20-P-0030-0.50	: 0.03 g (typ.)
VQON20-P-0404-0.50	: 0.0145g (typ.)

Start of commercial production
1998-06

Pin Assignment (top view)



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 to 4.6	V
DC input voltage (DIR, \overline{OE})	V_{IN}	-0.5 to 4.6	V
DC bus I/O voltage	$V_{I/O}$	-0.5 to 4.6 (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 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 to 3.6	V
Input voltage (DIR, \overline{OE})	V_{IN}	-0.3 to 3.6	V
Bus I/O voltage	$V_{I/O}$	0 to 3.6 (Note 2)	V
		0 to 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 to 85	$^{\circ}C$
Input rise and fall time	dt/dv	0 to 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 V_{CC} or GND. Please connect both bus inputs and the bus outputs with V_{CC} 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: $V_{CC} = 3.0$ to 3.6 V

Note 5: $V_{CC} = 2.3$ to 2.7 V

Note 6: $V_{CC} = 1.65$ to 1.95 V

Note 7: $V_{CC} = 1.4$ to 1.6 V

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

Electrical Characteristics

DC Characteristics (Ta = -40 to 85°C, 2.7 V < VCC ≤ 3.6 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		2.7 to 3.6	2.0	—	V
	Low level	V _{IL}	—		2.7 to 3.6	—	0.8	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	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	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.7 to 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 to 3.6 V		2.7 to 3.6	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		2.7 to 3.6	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.7 to 3.6	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.7 to 3.6	—	±20.0	
Increase in I _{CC} per input		ΔI _{CC}	V _{IH} = V _{CC} - 0.6 V		2.7 to 3.6	—	750	

DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ VCC ≤ 2.7 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		2.3 to 2.7	1.6	—	V
	Low level	V _{IL}	—		2.3 to 2.7	—	0.7	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.3 to 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 to 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 to 3.6 V		2.3 to 2.7	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		2.3 to 2.7	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.3 to 2.7	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.3 to 2.7	—	±20.0	

DC Characteristics (Ta = -40 to 85°C, 1.65 V ≤ VCC < 2.3 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.65 to 2.3	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—		1.65 to 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 to 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 to 2.3	—	0.2	
				I _{OL} = 6 mA	1.65	—	0.3	
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		1.65 to 2.3	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		1.65 to 2.3	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.65 to 2.3	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.65 to 2.3	—	±20.0	

DC Characteristics (Ta = -40 to 85°C, 1.4 V ≤ VCC < 1.65 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.4 to 1.65	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—		1.4 to 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 to 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 to 1.65	—	0.05	
				I _{OL} = 2 mA	1.4	—	0.35	
Input leakage current		I _{IN}	V _{IN} = 0 to 3.6 V		1.4 to 1.65	—	±5.0	μA
3-state output off-state current		I _{OZ}	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		1.4 to 1.65	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.4 to 1.65	—	20.0	μA
			V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.4 to 1.65	—	±20.0	

DC Characteristics (Ta = -40 to 85°C, 1.2 V ≤ VCC < 1.4 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.2 to 1.4	0.8 × V _{CC}	—	V
	Low level	V _{IL}	—		1.2 to 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 to 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 to 3.6 V		1.2	—	±10.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0 to 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 to 85°C, Input: t_r = t_f = 2.0 ns, C_L = 30 pF, R_L = 500 Ω) (Note 1)

Characteristics		Symbol	Test Condition		VCC (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-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-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			
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: tr = tf = 2.0 ns, CL = 30 pF)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V (Note)	1.8	0.25	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	0.6	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	0.8	
Quiet output minimum dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V (Note)	1.8	-0.25	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	-0.6	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	-0.8	
Quiet output minimum dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V (Note)	1.8	1.5	V
		VIH = 2.5 V, VIL = 0 V (Note)	2.5	1.9	
		VIH = 3.3 V, VIL = 0 V (Note)	3.3	2.2	

Note: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

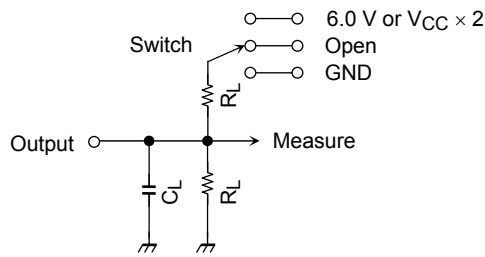
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	C _{I/O}	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note)	1.8, 2.5, 3.3	20	pF

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:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/8 \text{ (per bit)}$$

AC Test Circuit



Parameter	Switch
t_{pLH}, t_{pHL}	Open
t_{pLZ}, t_{pZL}	6.0 V $V_{CC} \times 2$ @ $V_{CC} = 3.3 \pm 0.3$ V @ $V_{CC} = 2.5 \pm 0.2$ V @ $V_{CC} = 1.8 \pm 0.15$ V @ $V_{CC} = 1.5 \pm 0.1$ 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
R_L	500 Ω	2k Ω
C_L	30pF	15pF

Figure 1

AC Waveform

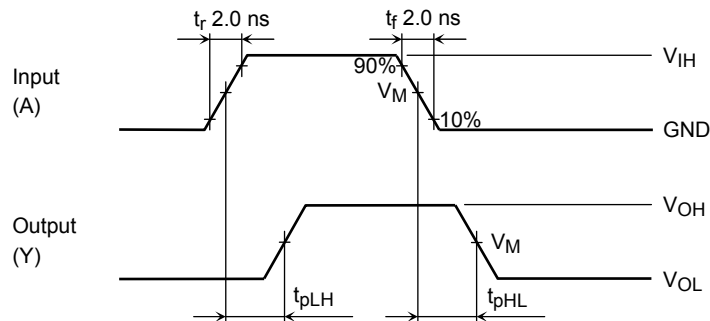


Figure 2 t_{pLH}, t_{pHL}

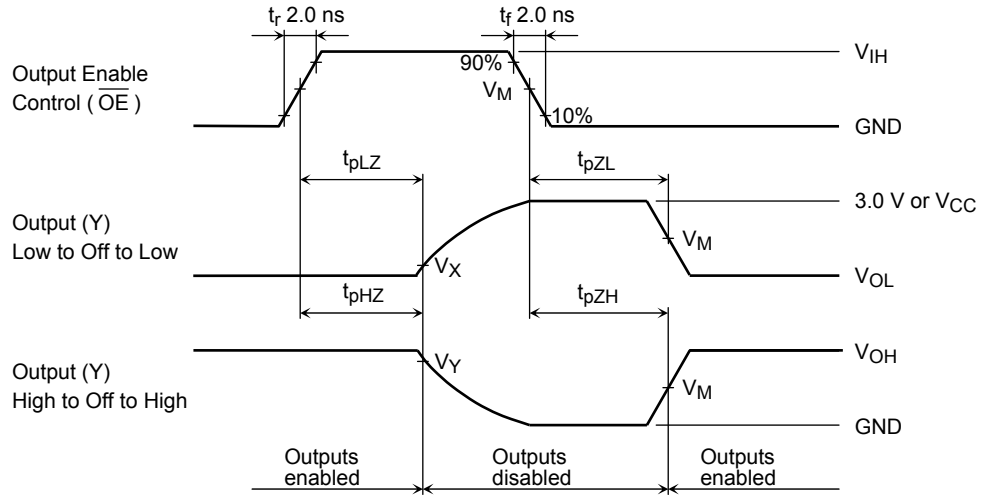


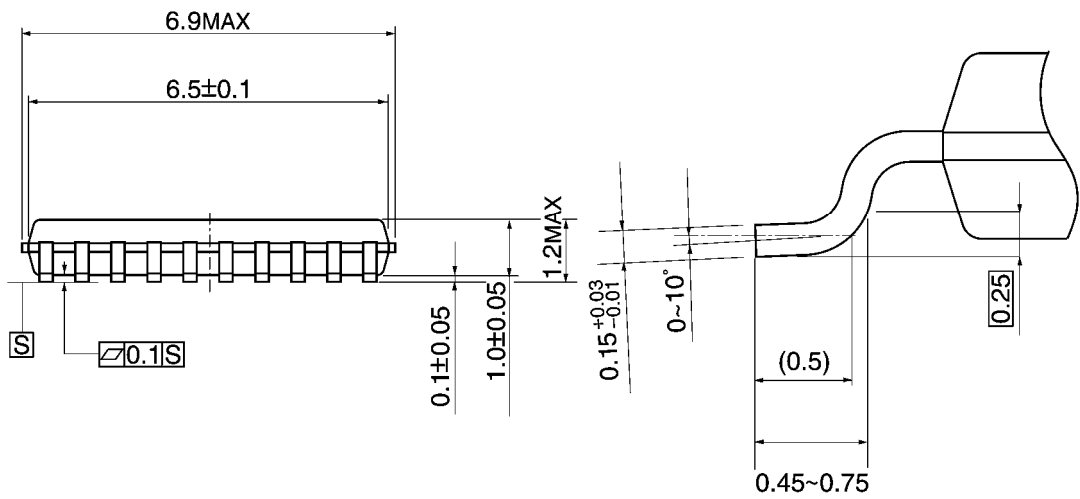
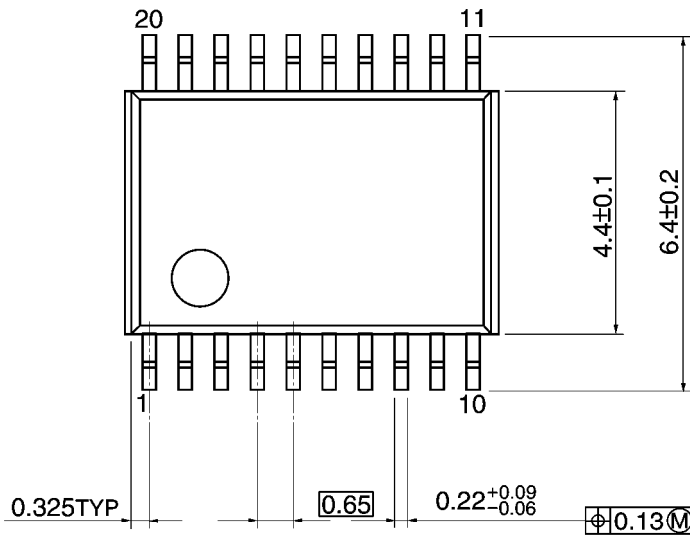
Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

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

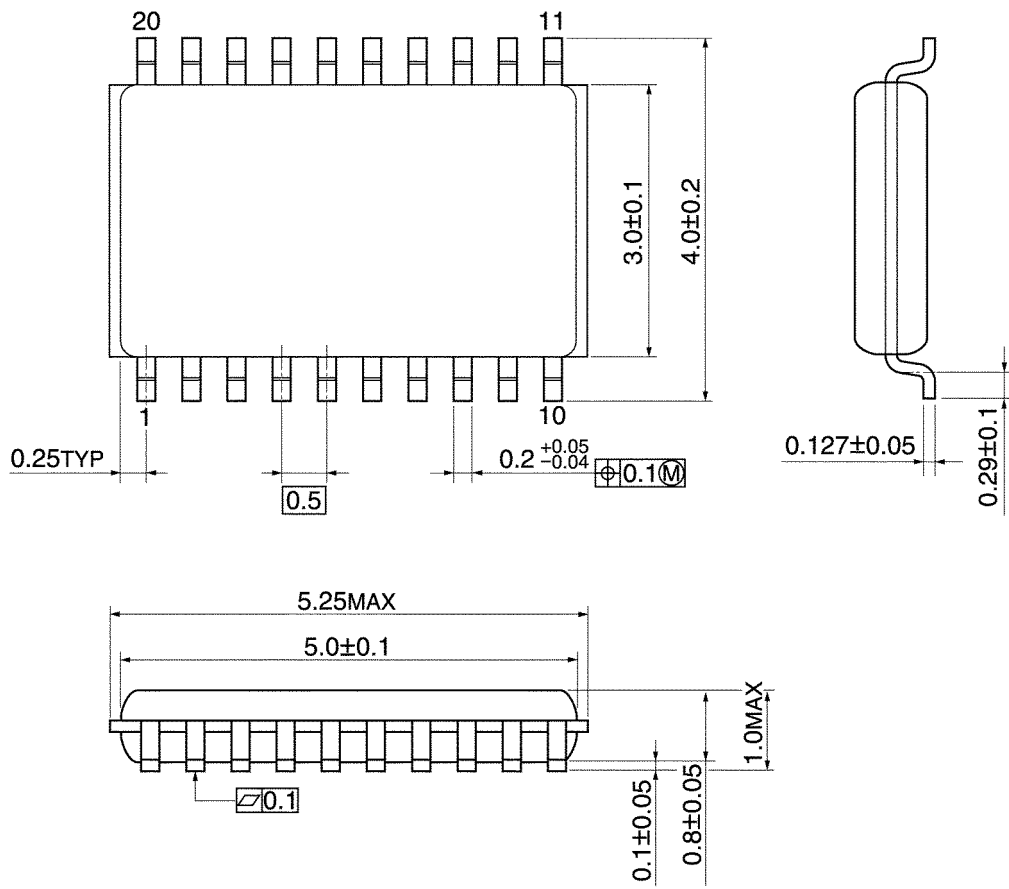


Weight: 0.08 g (typ.)

Package Dimensions

VSSOP20-P-0030-0.50

Unit: mm

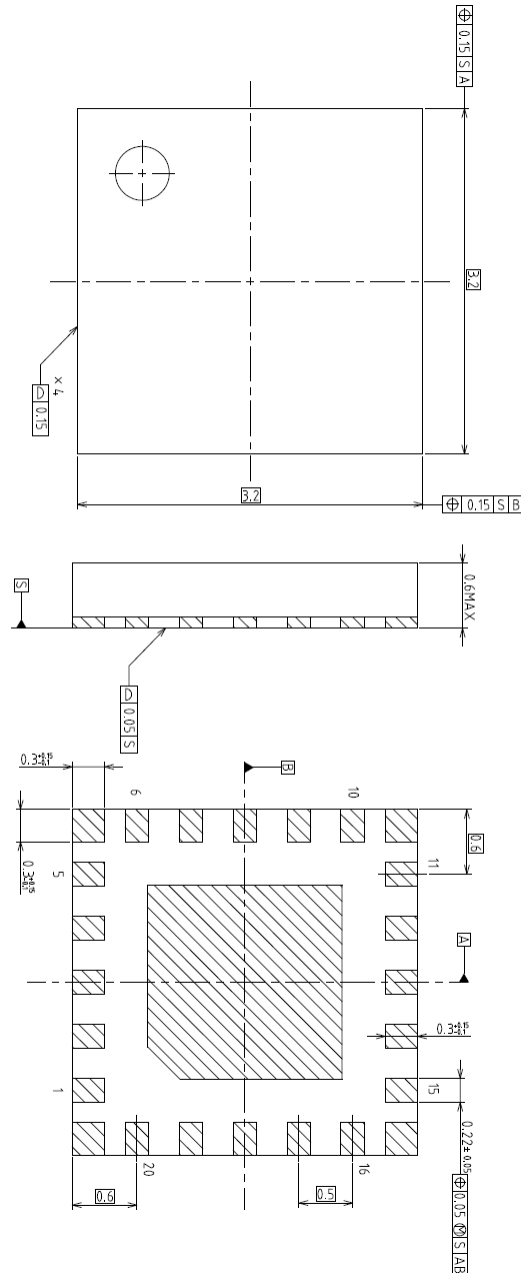


Weight: 0.03 g (typ.)

Package Dimensions

VQON20-P-0404-0.50

Unit: mm



Weight: 0.0145 g (typ.)

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