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.

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} = ±24 mA (min) (V_{CC} = 3.0 V)

 $I_{OH}/I_{OL} = \pm 18 \text{ mA (min) (V}_{CC} = 2.3 \text{ V)}$

 $I_{OH}/I_{OL} = \pm 6 \text{ mA (min) (V}_{CC} = 1.65 \text{ V)}$

 $I_{OH}/I_{OL} = \pm 2 \text{ mA (min)} (V_{CC} = 1.4 \text{ V})$

- Latch-up performance: –300 mA
- ESD performance: Machine model ≥ ±200 V

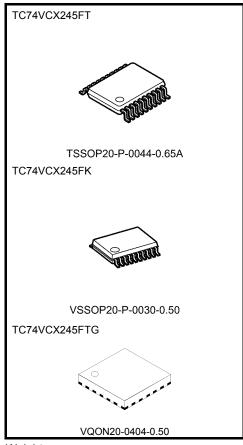
Human body model $\geq \pm 2000 \text{ V}$

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)



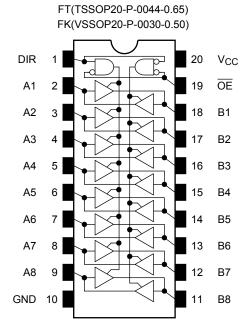
Weight

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.)

- 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.

Start of commercial production 1998-06

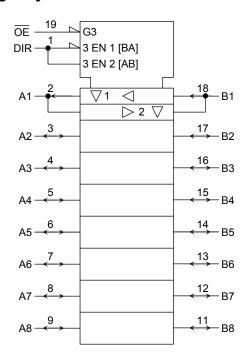
Pin Assignment (top view)



A1 DIR VCC OE В1 20 19 17 16 Α2 15 B2 2 А3 14 B3 A4 3 13 B4 Α5 12 B5 4 11 B6 A6 5 7 10 6 8 9 Α7 A8 GND B8 B7

FTG(VQON20-P-0404-0.50)

IEC Logic Symbol



Truth Table

Inp	uts	Outputs	Function		
ŌĒ	DIR	Outputs	A-Bus	B-Bus	
L	L	A = B	Output	Input	
L	Н	B = A	Input	Output	
Н	Х	Z	2	7_	

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, OE)	V _{IN}	-0.5 to 4.6	V	
		-0.5 to 4.6 (Note 2)	V	
DC bus I/O voltage	V _{I/O}	-0.5 to V _{CC} + 0.5 (Note 3)		
Input diode current	Ι _{ΙΚ}	-50	mA	
Output diode current	lok	±50 (Note 4)	mA	
DC output current	lout	±50	mA	
Power dissipation	PD	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.

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, $\overline{\text{OE}}$)	V _{IN}	-0.3 to 3.6	V	
Bus I/O voltage	Viva	0 to 3.6 (Note 2)	V	
Bus I/O voltage	V _{I/O}	0 to V _{CC} (Note 3)	V	
		±24 (Note 4)		
Output current	I _{OH} /I _{OI}	±18 (Note 5)	mA	
Output current	IOH/IOL	±6 (Note 6)		
		±2 (Note 7)		
Operating temperature	T _{opr}	-40 to 85	°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.

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Note 2: Off-state

Note 3: High or low state

Note 4: $V_{CC} = 3.0 \text{ to } 3.6 \text{ V}$

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

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

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

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 < V_{CC} ≤ 3.6 V)

Character	istics	Symbol	Test C	Test Condition V _{CC} (V)		Min	Max	Unit
Input voltage	High level	V _{IH}	-	_	2.7 to 3.6	2.0	_	V
Input voltage	Low level	V _{IL}	-	_	2.7 to 3.6	_	0.8	V
High level Output voltage			$I_{OH} = -100 \mu A$	2.7 to 3.6	V _{CC} - 0.2	_		
	Voh	V _{IN} = V _{IH} or V _{IL}	$I_{OH} = -12 \text{ mA}$	2.7	2.2	_		
			I _{OH} = -18 mA	3.0	2.4	_		
				I _{OH} = -24 mA	3.0	2.2	_	V
, ,		level V _{OL}	V _{IN} = V _{IH} or V _{IL}	$I_{OL} = 100 \mu A$	2.7 to 3.6	_	0.2	
	Low level			I _{OL} = 12 mA	2.7	_	0.4	
	Low level			I _{OL} = 18 mA	3.0	_	0.4	
				I _{OL} = 24 mA	3.0	_	0.55	
Input leakage curre	ent	I _{IN}	V _{IN} = 0 to 3.6 V		2.7 to 3.6	_	±5.0	μА
3-state output off-state current		loz	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 3.6 V		2.7 to 3.6	_	±10.0	μА
Power off leakage	current	where I_{OFF} V_{IN} , $V_{OUT} = 0$ to 3.6 V		0	_	10.0	μА	
Quiescent supply current	loo	V _{IN} = V _{CC} or GND		2.7 to 3.6		20.0		
	Icc	V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		2.7 to 3.6	_	±20.0	μΑ	
Increase in I _{CC} per	input	Δl _{CC}	$V_{IH} = V_{CC} - 0.6 V$		2.7 to 3.6	_	750	

DC Characteristics (Ta = -40 to 85°C, 2.3 V \leq V_{CC} \leq 2.7 V)

Character	istics	Symbol	Test 0	Test Condition		Min	Max	Unit
Innut voltage	High level	V _{IH}		_	2.3 to 2.7	1.6	_	V
Input voltage	Low level	V _{IL}		_	2.3 to 2.7	_	0.7	V
			I _{OH} = -100 μA	2.3 to 2.7	V _{CC} - 0.2	_		
	High level	VoH	V _{IN} = V _{IH} or V _{IL}	$I_{OH} = -6 \text{ mA}$	2.3	2.0	_	
Output voltage				I _{OH} = -12 mA	2.3	1.8	_	V
				I _{OH} = -18 mA	2.3	1.7	_	
		w level V _{OL}	$V_{IN} = V_{IH}$ or V_{IL}	I _{OL} = 100 μA	2.3 to 2.7	_	0.2	
	Low level			I _{OL} = 12 mA	2.3	_	0.4	
				I _{OL} = 18 mA	2.3	_	0.6	
Input leakage curre	ent	I _{IN}	V _{IN} = 0 to 3.6 V		2.3 to 2.7	_	±5.0	μА
3-state output off-state current 107		$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 3.6 V		2.3 to 2.7	_	±10.0	μА	
Power off leakage	current	I _{OFF}	V _{IN} , V _{OUT} = 0 to 3.6 V		0	_	10.0	μА
Quiescent supply current		loo	V _{IN} = V _{CC} or GND		2.3 to 2.7	_	20.0	Δ
Quiescent supply t	unent	Icc	$V_{CC} \le (V_{IN}, V_{OUT}) \le 3$	3.6 V	2.3 to 2.7	_	±20.0	μА



DC Characteristics (Ta = -40 to 85° C, 1.65 V \leq V_{CC}< 2.3 V)

Characteris	stics	tics Symbol Test Condition			Min	Max	Unit	
					V _{CC} (V)			
Input voltage	High level	V _{IH}	_	-	1.65 to 2.3	0.65 × V _{CC}	_	V
input voitage	Low level	V _{IL}	_	-	1.65 to 2.3		0.2 × V _{CC}	V
High level Output voltage	High level	Voh	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100 \mu A$	1.65 to 2.3	V _{CC} - 0.2		
				$I_{OH} = -6 \text{ mA}$	1.65	1.25		V
	Low level	V _{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100 \ \mu A$	1.65 to 2.3		0.2	
	LOW level			I _{OL} = 6 mA	1.65		0.3	
Input leakage currer	nt	I _{IN}	$V_{IN} = 0$ to 3.6 V		1.65 to 2.3		±5.0	μΑ
3-state output off-state current		loz	V _{IN} = V _{IH} or V _{IL} V _{OUT} = 0 to 3.6 V		1.65 to 2.3		±10.0	μА
Power off leakage current I _{OFF} V _{IN} , V _{OUT} = 0 to 3.6 V			0	_	10.0	μА		
Quiescent supply cu	Ouissant supply supply	loo	V _{IN} = V _{CC} or GND		1.65 to 2.3	_	20.0	
Quiescent supply cu	in cill	Icc	$V_{CC} \le (V_{IN}, V_{OUT}) \le 3.6$		1.65 to 2.3	_	±20.0	μА

DC Characteristics (Ta = -40 to 85°C, 1.4 V \leq V_{CC}< 1.65 V)

Characteris	stics	Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	_		1.4 to 1.65	0.65 × V _{CC}	_	V
Input voltage	Low level	V _{IL}	_		1.4 to 1.65	_	0.05 × V _{CC}	V
	High level V _{OH} V _{IN}	V _{IN} = V _{IH} or V _{IL}	$I_{OH} = -100 \mu A$	1.4 to 1.65	V _{CC} - 0.2	_		
Output voltage				I _{OH} = -2 mA	1.4	1.05	_	V
	Low level	V _{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100 \mu A$	1.4 to 1.65	_	0.05	
	Low level			I _{OL} = 2 mA	1.4	_	0.35	
Input leakage currer	nt	I _{IN}	V _{IN} = 0 to 3.6 V		1.4 to 1.65	_	±5.0	μΑ
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	μА		
Power off leakage current I _{OFF} V _{IN} , V _{OUT} = 0 to 3.6 V			0	_	10.0	μΑ		
Quiescent supply current		V _{IN} = V _{CC} or GND		1.4 to 1.65	_	20.0	μА	
Quiescent supply cu	iii c iii	Icc	$V_{CC} \le (V_{IN}, V_{OUT}) \le 3.6$	V	1.4 to 1.65	_	±20.0	μΑ

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DC Characteristics (Ta = -40 to 85° C, $1.2 \text{ V} \leq \text{V}_{\text{CC}} < 1.4 \text{ V})$

Characteris	stics	Symbol	Test Condition		V _{CC} (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	_	-	1.2 to 1.4	0.8 × V _{CC}	_	V
mput voltage	Low level	V _{IL}			1.2 to 1.4		0.05 × V _{CC}	V
Output voltage	High level	V _{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100 \mu A$	1.2	V _{CC} - 0.1		>
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	$I_{OL} = 100 \mu A$	1.2	_	0.05	
Input leakage currer	nt	I _{IN}	$V_{IN} = 0$ to 3.6 V		1.2		±5.0	μА
3-state output off-sta	ate current	loz	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0$ to 3.6 V		1.2	_	±10.0	μА
Power off leakage c	urrent	l _{OFF}	V_{IN} , $V_{OUT} = 0$ to 3.6 V		0	_	10.0	μА
Quiescent supply current		loo	V _{IN} = V _{CC} or GND		1.2		20.0	
Quiescent supply co	III CIII	Icc	V _{CC} ≤ (V _{IN} , V _{OUT}) ≤ 3.6 V		1.2	_	±20.0	μА

AC Characteristics (Ta = -40 to 85°C, Input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500~\Omega$) (Note 1)

Characteristics	Symbol	Test	Condition	V _{CC} (V)	Min	Max	Unit
			0 45 5 5 0 0 0	1.2	1.5	42.0	
			$C_L = 15 \text{ pF}, R_L = 2 \text{ k}\Omega$	1.5 ± 0.1	1.0	16.8	
Propagation delay time	t _{pLH}	Figure 1, Figure 2		1.8 ± 0.15	1.5	8.4	ns
	t _{pHL}		$C_L = 30 \text{ pF}, R_L = 500 \Omega$	2.5 ± 0.2	0.8	4.2	
				3.3 ± 0.3	0.6	3.5	
			$C_{I} = 15 pF, R_{I} = 2 k\Omega$	1.2	1.5	49.0	
	.	Figure 1, Figure 3	OL = 13 pi , NL = 2 KΩ	1.5 ± 0.1	1.0	19.6	
3-state output enable time	t _{pZL} t _{pZH}		$C_L = 30 \text{ pF}, R_L = 500 \Omega$	1.8 ± 0.15	1.5	9.8	ns
				2.5 ± 0.2	8.0	5.6	
				3.3 ± 0.3	0.6	4.5	
			$C_L = 15 \text{ pF}, R_L = 2 \text{ k}\Omega$	1.2	1.5	36.0	ns
	+			1.5 ± 0.1	1.0	14.4	
3-state output disable time	t _{pLZ}	Figure 1, Figure 3		1.8 ± 0.15	1.5	7.2	
	t _{pHZ}		$C_L = 30 \text{ pF}, R_L = 500 \Omega$	2.5 ± 0.2	8.0	4.0	
				3.3 ± 0.3	0.6	3.6	
			$C_L = 15 \text{ pF}, R_L = 2 \text{ k}\Omega$	1.2	_	1.5	
Output to output skew	•		Ο[– 15 μι , Κ[= 2 ΚΩ	1.5 ± 0.1	_	1.5	ns
	tosLH	(Note 2)	$C_L = 30$ pF, $R_L = 500 \Omega$	1.8 ± 0.15	_	0.5	
	t _{osHL}			2.5 ± 0.2	_	0.5	
				3.3 ± 0.3	_	0.5	

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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)	Тур.	Unit
		$V_{IH} = 1.8 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 1.8	0.25	
Quiet output maximum dynamic V _{OL}	V _{OLP}	$V_{IH} = 2.5 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 2.5	0.6	V
		$V_{IH} = 3.3 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 3.3	0.8	
	V _{OLV}	$V_{IH} = 1.8 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 1.8	-0.25	
Quiet output minimum dynamic $V_{\mbox{OL}}$		$V_{IH} = 2.5 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 2.5	-0.6	V
		$V_{IH} = 3.3 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 3.3	-0.8	
Quiet output minimum dynamic V _{OH}	V _{OHV}	$V_{IH} = 1.8 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 1.8	1.5	
		$V_{IH} = 2.5 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 2.5	1.9	V
		$V_{IH} = 3.3 \text{ V}, V_{IL} = 0 \text{ V}$ (No.	te) 3.3	2.2	

Note: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

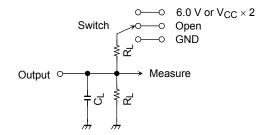
Characteristics	Symbol	Symbol Test Condition		Тур.	Unit
Characteristics	Syllibol	rest Condition	V _{CC} (V)	ιyp.	Offic
Input capacitance	C _{IN}	_	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	C _{I/O}	_	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C _{PD}	$f_{IN} = 10 \text{ MHz}$ (No	te) 1.8, 2.5, 3.3	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}	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	
t _{pHZ} , t _{pZH}	GND	

Symbol	Vcc		
	$3.3 \pm 0.3 \text{ V} \\ 2.5 \pm 0.2 \text{ V} \\ 1.8 \pm 0.15 \text{ V}$	1.5 ± 0.1 V 1.2 V	
R_L	500Ω	2kΩ	
C_L	30pF	15pF	

Figure 1

AC Waveform

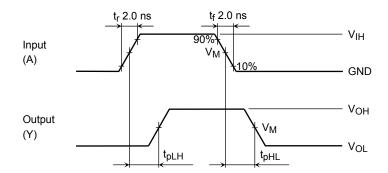


Figure 2 t_{pLH}, t_{pHL}

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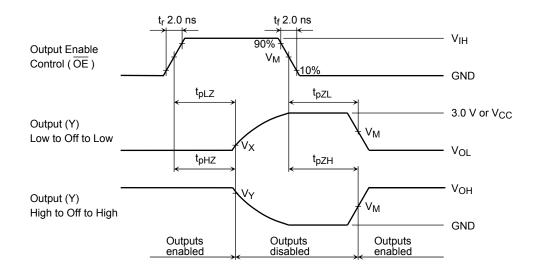


Figure 3 $t_{\text{pLZ}},\,t_{\text{pHZ}},\,t_{\text{pZL}},\,t_{\text{pZH}}$

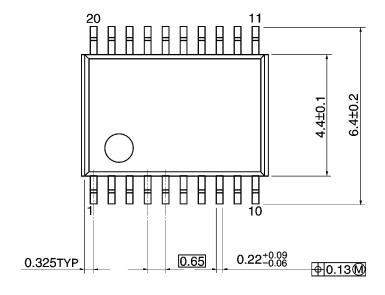
Symbol -	Vcc					
	$3.3\pm0.3~\textrm{V}$	$2.5\pm0.2\textrm{V}$	1.8 ± 0.15 V	1.5 ± 0.1 V	1.2 V	
V _{IH}	2.7 V	V _{CC}	V _{CC}	V _{CC}	V _{CC}	
V_{M}	1.5 V	V _{CC} /2	V _{CC} /2	V _{CC} /2	V _{CC} /2	
VX	V _{OL} + 0.3 V	V _{OL} + 0.15 V	V _{OL} + 0.15 V	V _{OL} + 0.1 V	V _{OL} + 0.1 V	
VY	V _{OH} – 0.3 V	V _{OH} – 0.15 V	V _{OH} – 0.15 V	V _{OH} – 0.1 V	V _{OH} – 0.1 V	

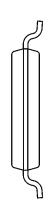
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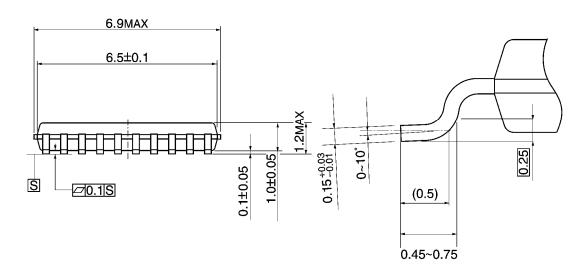
Package Dimensions

TSSOP20-P-0044-0.65A

Unit: mm



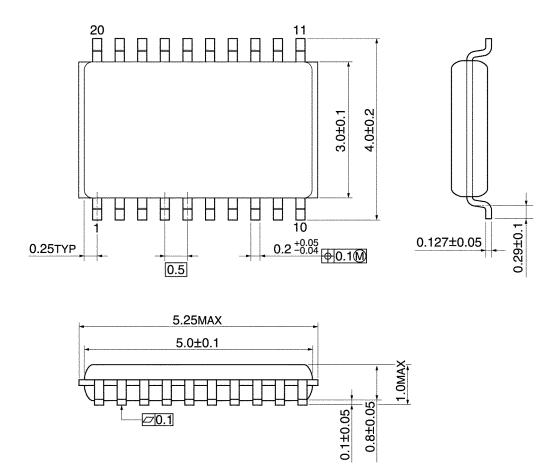




Weight: 0.08 g (typ.)

Package Dimensions

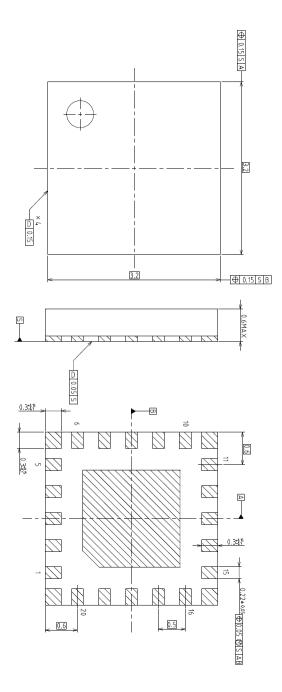
VSSOP20-P-0030-0.50 Unit: mm



Weight: 0.03 g (typ.)

Package Dimensions

VQON20-P-0404-0.50 Unit: mm



Weight: 0.0145 g (typ.)

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