

TC7MP245FK, TC7MP245FTG

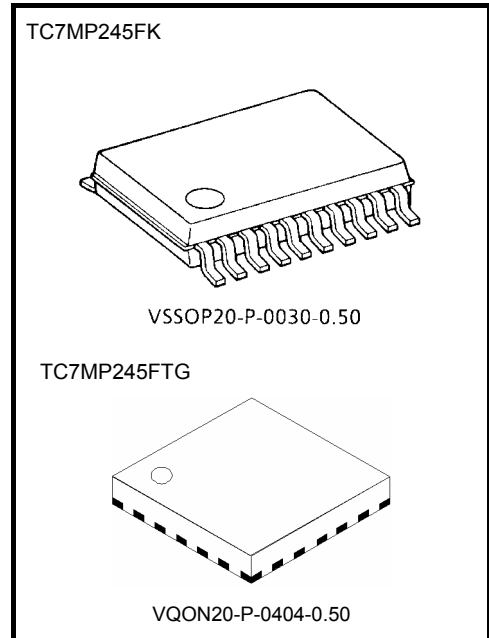
Low-Voltage/Low-Power Octal Bus Transceiver with Bus-hold

The TC7MP245 is a high-performance CMOS octal bus transceiver. By a low power consumption circuit, power consumption has been reduced when a bus terminal is disable state (\overline{OE} =High).

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

But, bus of a B bus side at floating state is maintained in an appropriate logic level due to a bus hold circuit to a B bus. Moreover, the bus-hold circuit which is added to a B bus is off when \overline{OE} is low.

All inputs are equipped with protection circuits against static discharge.



Weight:
 VSSOP20-P-0030-0.50 : 0.03 g (typ.)
 VQON20-P-0404-0.50 : 0.0145 g (typ.)

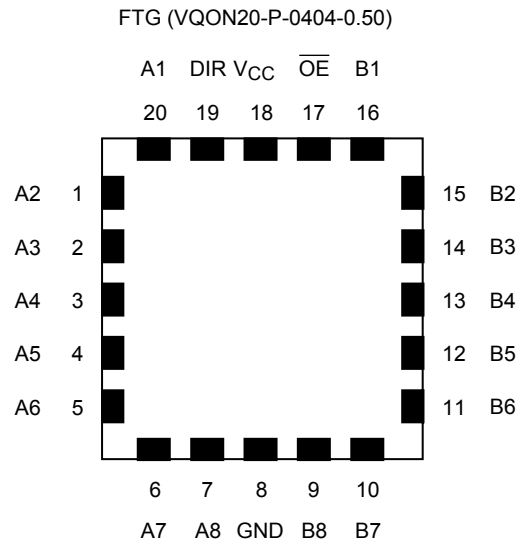
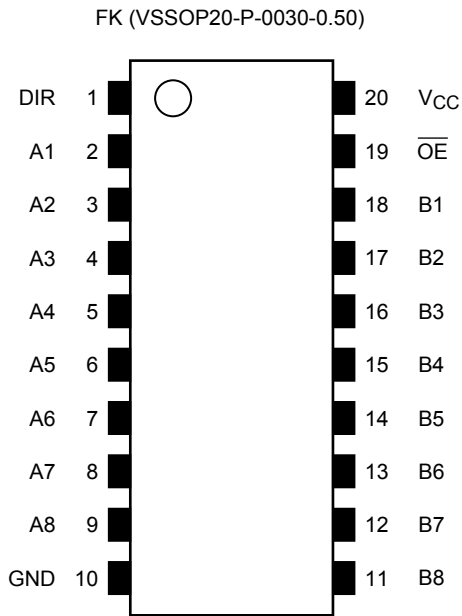
Features

- Low-voltage operation : $V_{CC} = 1.65$ to 3.6 V
- Low power current consumption : By a new input circuit, power consumption in \overline{OE} =H is reduced largely.
 It is most suitable for battery drive products such as personal digital assistant or a cellular phone.
- Quiescent supply current : $I_{CC} = 5\mu A$ (max)($V_{CC}=3.6V$)
- High-speed operation : $t_{pd}=3.0ns$ (max)($V_{CC}=3.3\pm 0.3V$)
 $t_{pd}=4.6ns$ (max)($V_{CC}=2.5\pm 0.2V$)
 $t_{pd}=10.0ns$ (max)($V_{CC}=1.8\pm 0.15V$)
- Output current : I_{OHA}/I_{OLA} (A bus)= $\pm 12mA$ (min)($V_{CC}=3.0V$)
 I_{OHB}/I_{OLB} (B bus)= $\pm 24mA$ (min)($V_{CC}=3.0V$)
- Latch-up performance : $\pm 300mA$
- ESD performance : Machine model $\geq \pm 200$ V
 Human body model $\geq \pm 2000$ V
- Ultra-small package : VSSOP(US20), VQON20
- Bus hold circuit is built in only the B bus side.(Only in \overline{OE} =H, a former state is maintained.)
- Floating of A-bus and B-bus are permitted.(When \overline{OE} =H)
- Gate IC for control(TC7MP01FK) of DIR and \overline{OE} terminal are prepared.
- 3.6V tolerant function provided on A-bus terminal, DIR and \overline{OE} terminal.

Note 1: At the time bus terminal is enable state, please do not give a signal from the outside.

Note 2: When mounting VQON package, the type of recommended flux is RA or RMA.

Pin Assignment (top view)



Truth Table

Input		Bus state	Bus hold circuit (B bus)
DIR	\overline{OE}		
L	L	B→A(B=A)	OFF
H	L	A→B(A=B)	OFF
X	H	Z	ON*

X: Don't care

Z: High impedance

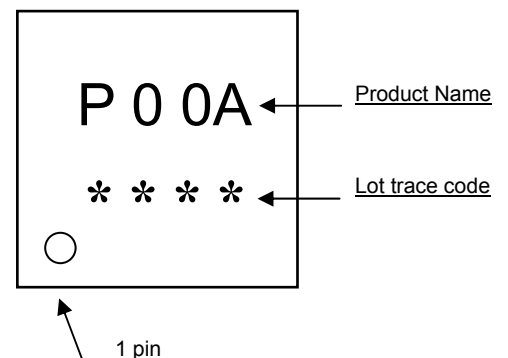
*: Logic state just before becoming disable is maintained.

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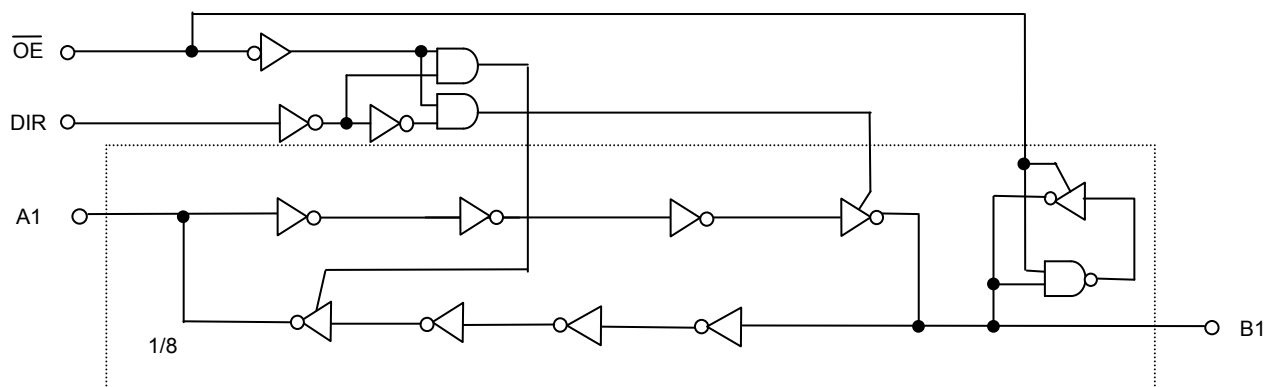
Note: When a bus input is in "H" state, and an output is switched to "enable" to "disable", Glitch such as "L" state during about 1 to 3ns occurs in an output. It is not generated when a bus input is in "L" state.

Marking

FTG (VQON20-P-0404-0.50)



System Diagram



Absolute Maximum Ratings (Note 1)

Parameter	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 input/output voltage(A bus)	VI/OA	-0.5 to 4.6 (Note 2)	V
		-0.5 to V _{CC} +0.5 (Note 3)	
DC input/output voltage(B bus)	VI/OB	-0.5 to V _{CC} +0.5	V
Input diode current(DIR, \overline{OE})	I _{IHK}	-50	mA
Input/Output diode current	I _{I/OK}	±50	mA
Output current	I _{OUT}	±50	mA
DC VCC/ground current	I _{CC} /I _{GND}	±100	mA
Power dissipation	P _D	180	mW
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: V_{CC}=0V, or output off state.

Note 3: \overline{OE} ="L", DIR="L"

Operating Ranges (Note 1)

Parameter	Symbol	Rating	Unit
Power supply voltage	V _{CC}	1.65 to 3.6	V
		1.2 to 3.6 (Note 2)	
DC input voltage (DIR, \overline{OE})	V _{IN}	-0.3 to 3.6	V
DC input/output voltage(A bus)	VI/OA	0 to 3.6 (Note 3)	V
		0 to V _{CC} (Note 4)	
DC input/output voltage(B bus)	VI/OB	0 to V _{CC}	V
Output current (A bus)	I _{OHA} /I _{OLA}	±12 (Note 5)	mA
		±9 (Note 6)	
		±2 (Note 7)	
Output current(B bus)	I _{OHB} /I _{OLB}	±24 (Note 5)	mA
		±18 (Note 6)	
		±4 (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.

Note 2: Data retention only

Note 3: V_{CC}=0V, or output off state

Note 4: \overline{OE} ="L", DIR="L"

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

Note 6: V_{CC}=2.3 to 2.7V

Note 7: V_{CC}=1.65 to 1.95V

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

Electrical Characteristics

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

Parameter		Symbol	Test Condition	Vcc(V)	Min	Max	Unit	
DC 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 (A bus)	H-level	V _{OHA}	V _{IN} = V _{IH}	I _{OHA} =-100uA	2.7 to 3.6	V _{CC} -0.2	-	V
				I _{OH} =-6mA	2.7	2.2	-	
				I _{OH} =-9mA	3.0	2.4	-	
				I _{OH} =-12mA	3.0	2.2	-	
	L-level	V _{OLA}	V _{IN} = V _{IL}	I _{OLA} =100uA	2.7 to 3.6	-	0.2	
				I _{OL} =6mA	2.7	-	0.4	
				I _{OL} =9mA	3.0	-	0.4	
				I _{OL} =12mA	3.0	-	0.55	
Output voltage (B bus)	H-level	V _{OHB}	V _{IN} = V _{IH}	I _{OHB} =-100uA	2.7 to 3.6	V _{CC} -0.2	-	V
				I _{OHB} =-12mA	2.7	2.2	-	
				I _{OHB} =-18mA	3.0	2.4	-	
				I _{OHB} =-24mA	3.0	2.2	-	
	L-level	V _{OLB}	V _{IN} = V _{IL}	I _{OLB} =100uA	2.7 to 3.6	-	0.2	
				I _{OLB} =12mA	2.7	-	0.4	
				I _{OLB} =18mA	3.0	-	0.4	
				I _{OLB} =24mA	3.0	-	0.55	
Input leakage current(DIR./OE)		I _{IN}	V _{IN} =0 to 3.6V	2.7 to 3.6	-	±5.0	μA	
Power off leakage current		I _{OFF}	A,DIR./OE=0 to 3.6V	0	-	5.0	μA	
3-state output off-state current		I _{OZA}	V _{INA} =V _{IH} or V _{IL} Vout=0 to 3.6V	2.7 to 3.6	-	±5.0	μA	
		I _{OZB}	V _{INB} =V _{IH} or V _{IL} Vout=0 or V _{CC}	2.7 to 3.6	-	±5.0	μA	
Quiescent supply current		I _{CC}	V _{IN} =V _{CC} or GND	2.7 to 3.6	-	5.0	μA	
Increase in ICC per input		ΔI _{CC}	V _{IN} =V _{CC} -0.6V (per input)	2.7 to 3.6	-	750	μA	
Bushold input minimum drive hold current		I _{IHOLD}	V _{IN} =0.8V	3.0	75	-	μA	
			V _{IN} =2.0V		-75	-		
Bushold input over-drive current to change state (Note)		I _{IOD}	V _{IN} = "L" → "H"	3.6	-	550	μA	
			V _{IN} = "H" → "L"		-	-550		

Note: It is a necessary electric current to change the input in "L" or "H".

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

Parameter		Symbol	Test Condition	Vcc(V)	Min	Max	Unit	
DC input voltage	H-level	V _{IH}	-	2.3 to 2.7	1.6	-	V	
	L-level	V _{IL}	-	2.3 to 2.7	-	0.7		
Output voltage (A bus)	H-level	V _{OHA}	V _{IN} = V _{IH}	I _{OHA} =-100μA	2.3 to 2.7	V _{CC} -0.2	-	V
				I _{OHA} =-3mA	2.3	2.0	-	
				I _{OHA} =-6mA	2.3	1.8	-	
				I _{OHA} =-9mA	2.3	1.7	-	
	L-level	V _{OLA}	V _{IN} = V _{IL}	I _{OLA} =100μA	2.3 to 2.7	-	0.2	
				I _{OLA} =6mA	2.3	-	0.4	
I _{OLA} =9mA				2.3	-	0.6		
Output voltage (B bus)	H-level	V _{OHB}	V _{IN} = V _{IH}	I _{OHB} =-100μA	2.3 to 2.7	V _{CC} -0.2	-	V
				I _{OHB} =-6mA	2.3	2.0	-	
				I _{OHB} =-12mA	2.3	1.8	-	
				I _{OHB} =-18mA	2.3	1.7	-	
	L-level	V _{OLB}	V _{IN} = V _{IL}	I _{OLB} =100μA	2.3 to 2.7	-	0.2	
				I _{OLB} =12mA	2.3	-	0.4	
I _{OLB} =18mA				2.3	-	0.6		
Input leakage current(DIR,/OE)		I _{IN}	V _{IN} =0 to 3.6V	2.3 to 2.7	-	±5.0	μA	
Power off leakage current		I _{OFF}	A,DIR,/OE=0 to 3.6V	0	-	5.0	μA	
3-state output off-state current	I _{OZA}	V _{INA} =V _{IH} or V _{IL} V _{out} =0 to 3.6V	2.3 to 2.7	-	±5.0	μA		
	I _{OZB}	V _{INB} =V _{IH} or V _{IL} V _{out} =0 or V _{CC}	2.3 to 2.7	-	±5.0	μA		
Quiescent supply current		I _{CC}	V _{IN} =V _{CC} or GND	2.3 to 2.7	-	5.0	μA	
Bushold input minimum drive hold current	I _{IHOLD}	V _{IN} =0.7V	2.3	45	-	μA		
		V _{IN} =1.6V		-45	-			
Bushold input over-drive current to change state (Note)	I _{IOD}	V _{IN} = "L" → "H"	2.7	-	400	μA		
		V _{IN} = "H" → "L"		-	-400			

Note: It is a necessary electric current to change the input in "L" or "H".

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

Parameter		Symbol	Test Condition	Vcc(V)	Min	Max	Unit	
DC input voltage	H-level	V _{IH}	-	1.65 to 2.3	V _{CC} ×0.7	-	V	
	L-level	V _{IL}	-	1.65 to 2.3	-	V _{CC} ×0.2		
Output voltage (A bus)	H-level	V _{OHA}	V _{IN} = V _{IH}	I _{OHA} =-100μA	1.65	V _{CC} -0.2	-	V
				I _{OHA} =-2mA	1.65	1.3	-	
Output voltage (A bus)	L-level	V _{OLA}	V _{IN} = V _{IL}	I _{OLA} =2mA	1.65	-	0.2	V
Output voltage (B bus)	H-level	V _{OHB}	V _{IN} = V _{IH}	I _{OHB} =-100μA	1.65	V _{CC} -0.2	-	V
				I _{OHB} =-4mA	1.65	1.3	-	
Output voltage (B bus)	L-level	V _{OLB}	V _{IN} = V _{IL}	I _{OLB} =4mA	1.65	-	0.2	V
Input leakage current(DIR,OE)	I _{IN}	V _{IN} =0 to 3.6V	1.65 to 2.3	-	±5.0	μA		
Power off leakage current	I _{OFF}	A,DIR,OE=0 to 3.6V	0	-	5.0	μA		
3-state output off-state current	I _{OZA}	V _{INA} =V _{IH} or V _{IL} V _{out} =0 to 3.6V	1.65 to 2.3	-	±5.0	μA		
	I _{OZB}	V _{INB} =V _{IH} or V _{IL} V _{out} =0 or V _{CC}	1.65 to 2.3	-	±5.0	μA		
Quiescent supply current	I _{CC}	V _{IN} =V _{CC} or GND	1.65 to 2.3	-	5.0	μA		
Bushold input minimum drive hold current	I _{I(HOLD)}	V _{IN} =0.33V	1.65	20	-	μA		
		V _{IN} =1.16V		-20	-			
Bushold input over-drive current to change state (Note)	I _{I(OD)}	V _{IN} = "L" → "H"	1.95	-	300	μA		
		V _{IN} = "H" → "L"		-	-300			

Note: It is a necessary electric current to change the input in "L" or "H".

AC Characteristics (Ta=-40 to 85°C, Input: tr=tf=2.0ns, CL=30pF, RL=500Ω)

Parameter	Symbol	Test Condition	Vcc(V)	Min	Max	Unit
Propagation delay time	tpLH tpHL	Figure 1, Figure 2	1.8±0.15	1.0	10.0	ns
			2.5±0.2	0.8	4.6	
			3.3±0.3	0.6	3.0	
3-state output enable time	tpZL tpZH	Figure 1, Figure 3	1.8±0.15	1.0	15.0	ns
			2.5±0.2	0.8	7.8	
			3.3±0.3	0.6	5.6	
3-state output disable time	tpLZ tpHZ	Figure 1, Figure 3	1.8±0.15	1.0	6.5	ns
			2.5±0.2	0.8	4.3	
			3.3±0.3	0.6	3.9	
Output to output skew	tosLH tosHL	(Note)	1.8±0.15	-	0.5	ns
			2.5±0.2	-	0.5	
			3.3±0.3	-	0.5	

For CL=50pF, add approximately 300ps to the AC maximum specification.

Note: Parameter guaranteed by design.

$$(\text{tosLH} = |t_{pLHm} - t_{pLHn}|, \text{tosHL} = |t_{pHLm} - t_{pHLn}|)$$

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	CI/O		1.8,2.5,3.3	7	pF
Power dissipation capacitance (A bus input)	CPDA	$\overline{\text{OE}} = \text{"L"} , \text{finA} = 100\text{MHz}$ Table 1 (Note)	1.8,2.5,3.3	20	pF
		$\overline{\text{OE}} = \text{"H"} , \text{finA} = 100\text{MHz}$ Table 1 (Note)		0	pF
Power dissipation capacitance (B bus input)	CPDB	$\overline{\text{OE}} = \text{"L"} , \text{finB} = 100\text{MHz}$ Table 1 (Note)	1.8,2.5,3.3	16	pF
		$\overline{\text{OE}} = \text{"H"} , \text{finB} = 100\text{MHz}$ Table 1 (Note)		1	pF

Note: CPD 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.

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

Table1 CPD Test Condition

Function	Pin																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
A bus /OE= "L"	H	P	X	X	X	X	X	X	X	G	O	O	O	O	O	O	O	C	L	V	
A bus /OE= "H"	H	P	O	O	O	O	O	O	O	G	O	O	O	O	O	O	O	O	O	H	V
B bus /OE= "L"	L	C	O	O	O	O	O	O	O	G	X	X	X	X	X	X	X	P	L	V	
B bus /OE= "H"	L	O	O	O	O	O	O	O	O	G	O	O	O	O	O	O	O	P	H	V	

-Symbol explanation-

V=V_{CC}(+3.3V)

G=GND(0V)

H=Logic1(V_{CC})

L=Logic0(GND)

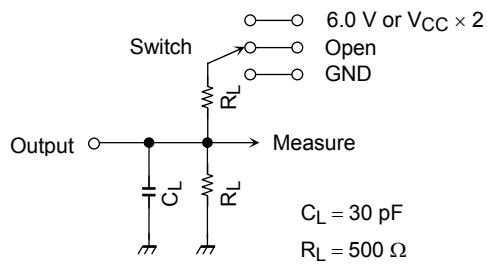
X=Don't care(Fixed to V_{CC} or GND)

O=Open

C=Connect a condenser(30pF) between output terminal and GND.

P=Input pulse with 50% duty cycle.

AC Test Circuit



Parameter	Switch
t _{pLH} , t _{pHL}	Open
t _{pLZ} , t _{pZL}	6.0 V V _{CC} × 2 @V _{CC} = 3.3 ± 0.3 V @V _{CC} = 2.5 ± 0.2 V @V _{CC} = 1.8 ± 0.15 V
t _{pHZ} , t _{pZH}	GND

Figure 1

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AC Waveform

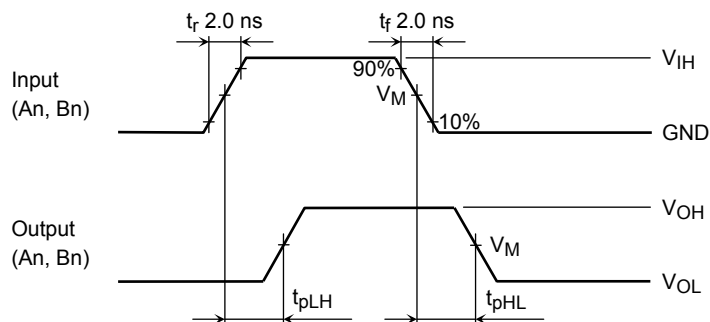


Figure 2 t_{pLH}, t_{pHL}

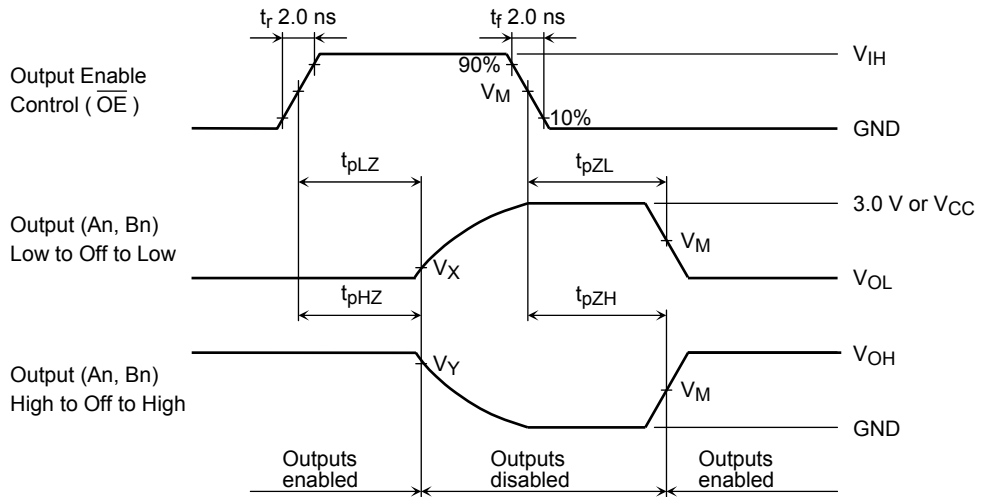


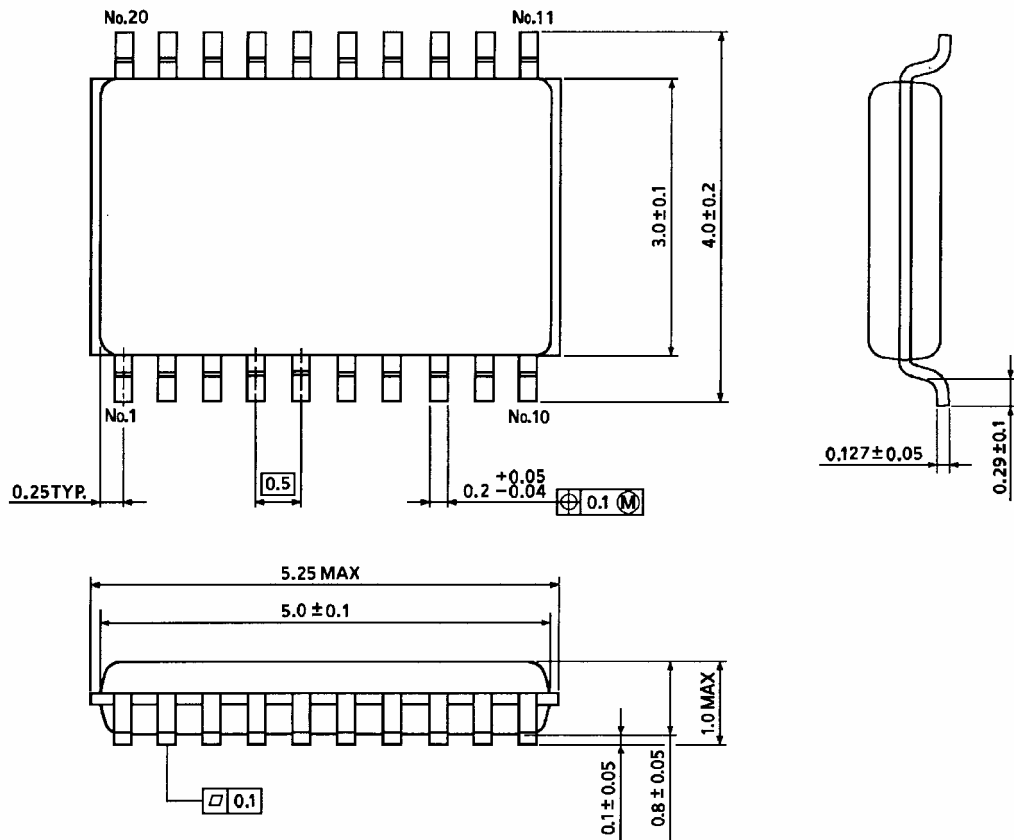
Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

Symbol	V_{CC}		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \pm 0.15 \text{ V}$
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$
V_X	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
V_Y	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$

Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



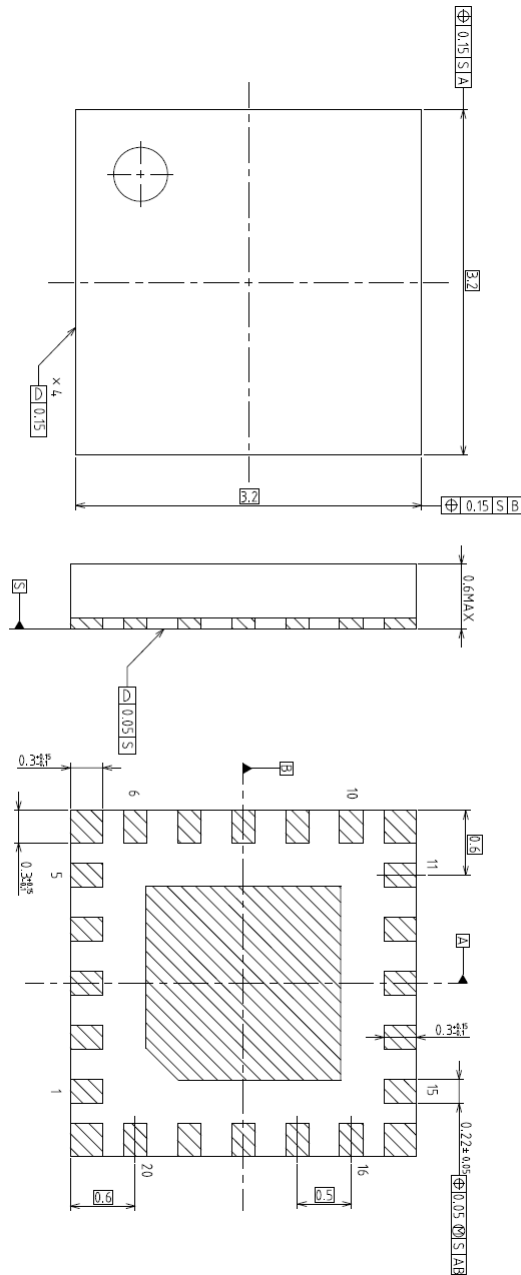
Weight: 0.03 g (typ.)

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Package Dimensions

Unit : mm

VQON20-P-0404-0.5



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Weight: 0.0145 g (typ.)

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