

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MP245FK, TC7MP245FTG

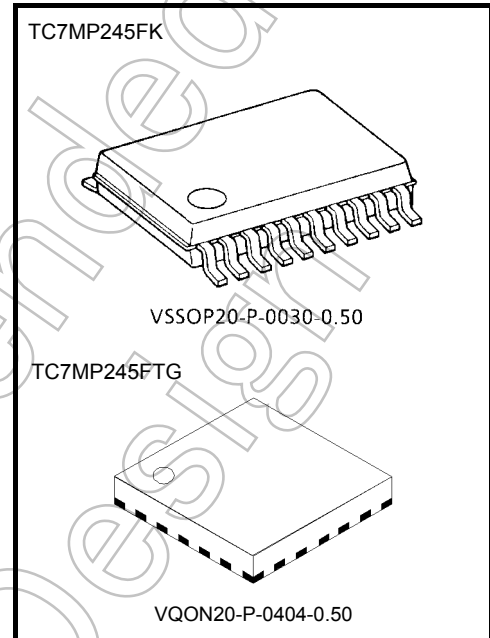
Low-Voltage/Low-Power Octal Bus Transceiver with Bus-hold

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

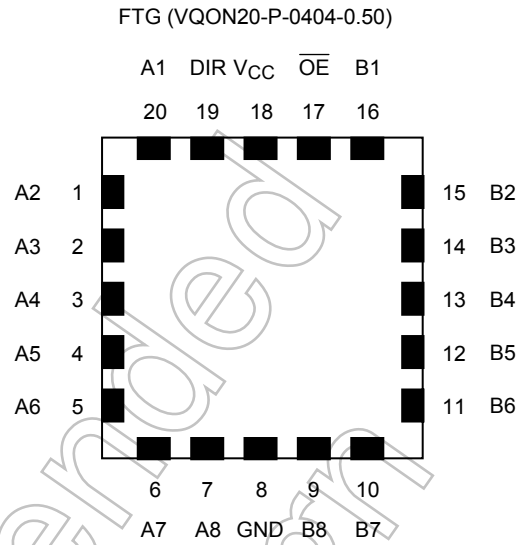
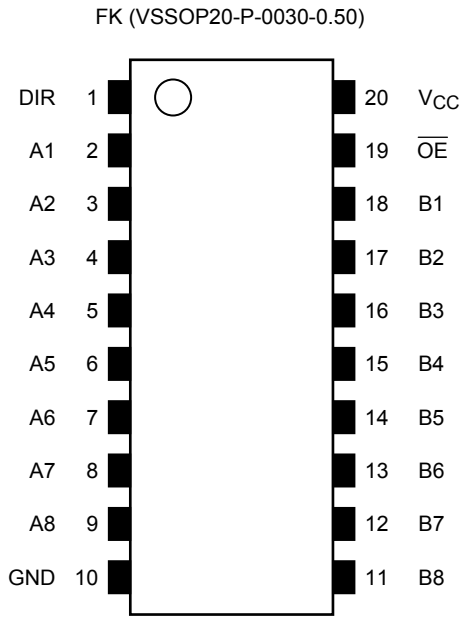
- Low-voltage operation : $V_{CC} = 1.65$ to 3.6 V
- Low power current consumption : By a new input circuit, power consumption in \overline{OE} =H is reduced largely.
 It is most suitable for battery drive products such as personal digital assistant or a cellular phone.
- Quiescent supply current : $I_{CC} = 5 \mu A$ (max) ($V_{CC}=3.6V$)
- High-speed operation : $t_{pd} = 3.0$ ns (max) ($V_{CC}=3.3\pm 0.3V$)
 $t_{pd} = 4.6$ ns (max) ($V_{CC}=2.5\pm 0.2V$)
 $t_{pd} = 10.0$ ns (max) ($V_{CC}=1.8\pm 0.15V$)
- Output current : I_{OHA}/I_{OLA} (A bus) = ± 12 mA (min) ($V_{CC}=3.0V$)
 I_{OHB}/I_{OLB} (B bus) = ± 24 mA (min) ($V_{CC}=3.0V$)
- Latch-up performance : ± 300 mA
- 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.

Start of commercial production
 2002-03

Pin Assignment (top view)



Truth Table

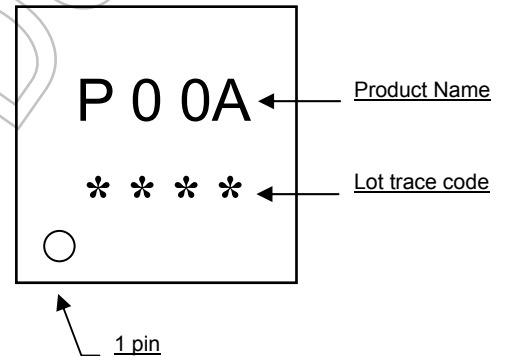
Input		Bus state	Bus hold circuit (B bus)
DIR	\overline{OE}		
L	L	B→A(B=A)	OFF
H	L	A→B(A=B)	OFF
X	H	Z	ON*

X: Don't care
 Z: High impedance
 *: Logic state just before becoming disable is maintained.

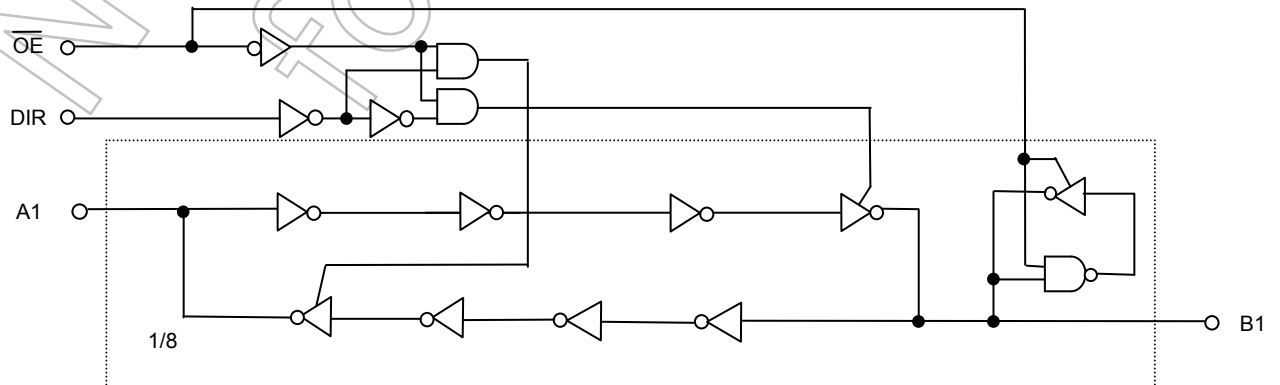
Note: When a bus input is in "H" state and an output is switched to "enable" to "disable", Glitch such as "L" state during about 1 to 3ns occurs in an output. It is not generated when a bus input is in "L" state.

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)	$V_{I/OA}$	-0.5 to 4.6 (Note 2)	V
		-0.5 to $V_{CC}+0.5$ (Note 3)	
DC input/output voltage(B bus)	$V_{I/OB}$	-0.5 to $V_{CC}+0.5$	V
Input diode current(DIR, \overline{OE})	$I_{I/K}$	-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	$^{\circ}C$

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: $V_{CC}=0V$, 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)	$V_{I/OA}$	0 to 3.6 (Note 3)	V
		0 to V_{CC} (Note 4)	
DC input/output voltage(B bus)	$V_{I/OB}$	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	$^{\circ}C$
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: 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<V_{CC} ≤ 3.6V)

Parameter	Symbol	Test Condition	V _{CC} (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 _{OHA}	V _{IN} = V _{IL}	I _{OHA} =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 _{OH} =-12mA	2.7	2.2	-	
				I _{OH} =-18mA	3.0	2.4	-	
				I _{OH} =-24mA	3.0	2.2	-	
	L-level	V _{OHB}	V _{IN} = V _{IL}	I _{OHB} =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 3.6 V	2.7 to 3.6	-	±5.0	μA		
Power off leakage current	I _{OFF}	A,DIR,/OE= 0 to 3.6 V	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	2.7 to 3.6	-	±5.0	μA		
	I _{OZB}	V _{INB} = V _{IH} or V _{IL} V _{out} = 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} - 0.6 V (per input)	2.7 to 3.6	-	750	μA		
Bushold input minimum drive hold current	I _{IHOLD}	V _{IN} = 0.8 V	3.0	75	-	μA		
		V _{IN} = 2.0 V		-75	-			
Bushold input over-drive current to change state	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 ≤ V_{CC} ≤ 2.7V)

Parameter	Symbol	Test Condition	V _{CC} (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} =-100uA	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} =100uA	2.3 to 2.7	-	0.2	
				I _{OLA} =6mA	2.3	-	0.4	
Output voltage (B bus)	H-level	V _{OHB}	V _{IN} = V _{IH}	I _{OHB} =-100uA	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} =100uA	2.3 to 2.7	-	0.2	
				I _{OLB} =12mA	2.3	-	0.4	
L-level	V _{OLB}	V _{IN} = V _{IL}	I _{OLB} =18mA	2.3	-	0.6		
Input leakage current(DIR,/OE)	I _{IN}	V _{IN} = 0 to 3.6 V	2.3 to 2.7	-	±5.0	μA		
Power off leakage current	I _{OFF}	A,DIR,/OE=0 to 3.6 V	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} = 0.7 V	2.3	45	-	μA		
		V _{IN} = 1.6 V		-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 ≤ V_{CC}<2.3V)

Parameter	Symbol	Test Condition	V _{CC} (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	-	
	L-level	V _{OLA}	V _{IN} = V _{IL}	I _{OLA} =2mA	1.65	-	0.2	
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	-	
	L-level	V _{OLB}	V _{IN} = V _{IL}	I _{OLB} =4mA	1.65	-	0.2	
Input leakage current(DIR,/OE)	I _{IN}	V _{IN} =0 to 3.6 V	1.65 to 2.3	-	±5.0	μA		
Power off leakage current	I _{OFF}	A,DIR,/OE=0 to 3.6 V	0	-	5.0	μA		
3-state output off-state current	I _{OZA}	V _{INA} =V _{IH} or V _{IL} V _{out} =0 to 3.6 V	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} =0.33 V	1.65	20	-	μA		
		V _{IN} =1.16 V		-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: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500$ Ω)

Parameter	Symbol	Test Condition	V _{CC} (V)	Min	Max	Unit
Propagation delay time	t_{pLH} t_{pHL}	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	t_{pZL} t_{pZH}	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	t_{pLZ} t_{pHZ}	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	t_{osLH} t_{osHL}	(Note)	1.8±0.15	-	0.5	ns
			2.5±0.2	-	0.5	
			3.3±0.3	-	0.5	

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

Note: Parameter guaranteed by design.

$$(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$$

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 (A bus input)	C_{PDA}	$\overline{OE} = "L"$, $f_{INA}=100$ MHz Table 1 (Note)	1.8,2.5,3.3	20	pF
		$\overline{OE} = "H"$, $f_{INA}=100$ MHz Table 1 (Note)		0	pF
Power dissipation capacitance (B bus input)	C_{PDB}	$\overline{OE} = "L"$, $f_{INB}=100$ MHz Table 1 (Note)	1.8,2.5,3.3	16	pF
		$\overline{OE} = "H"$, $f_{INB}=100$ MHz Table 1 (Note)		1	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.

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

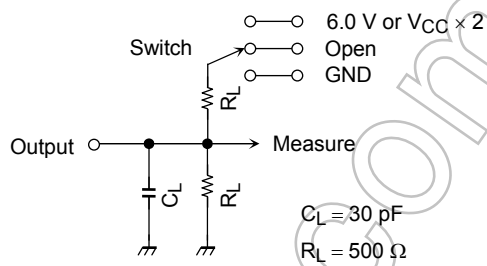
Table1 CPD Test Condition

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	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 = Logic 1 (V_{CC})
- L = Logic 0 (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} = 3.3 ± 0.3 V
	V _{CC} × 2 @V _{CC} = 2.5 ± 0.2 V @V _{CC} = 1.8 ± 0.15 V
t _{pHZ} , t _{pZH}	GND

Figure 1

AC Waveform

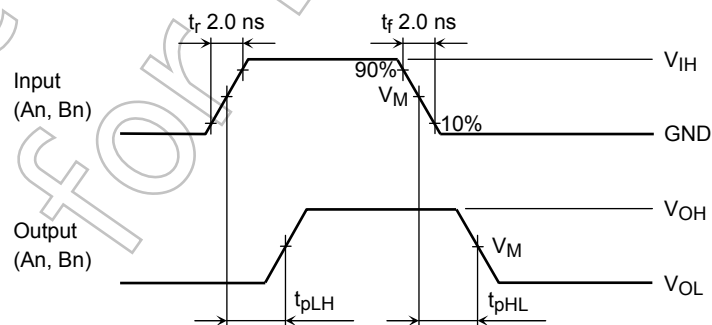


Figure 2 t_{pLH}, t_{pHL}

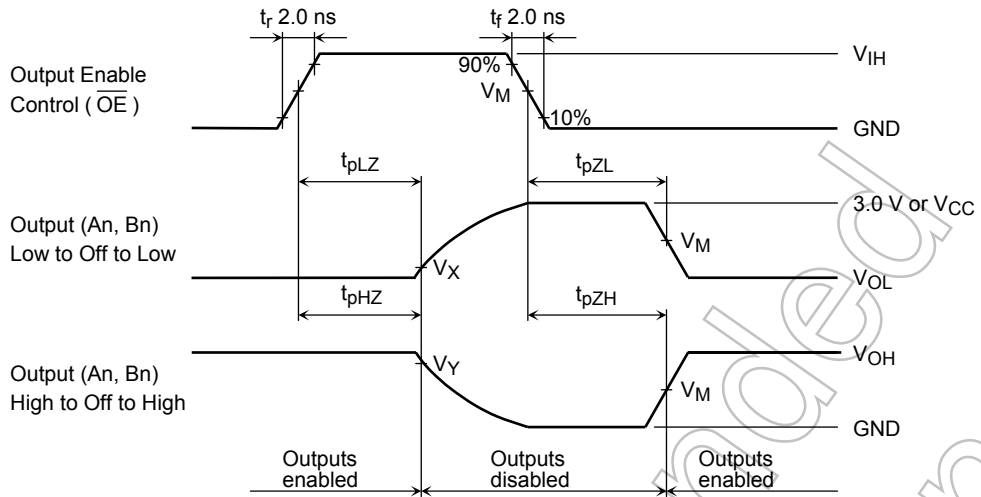


Figure 3 t_{pLZ} , t_{pHZ} , t_{pZL} , t_{pZH}

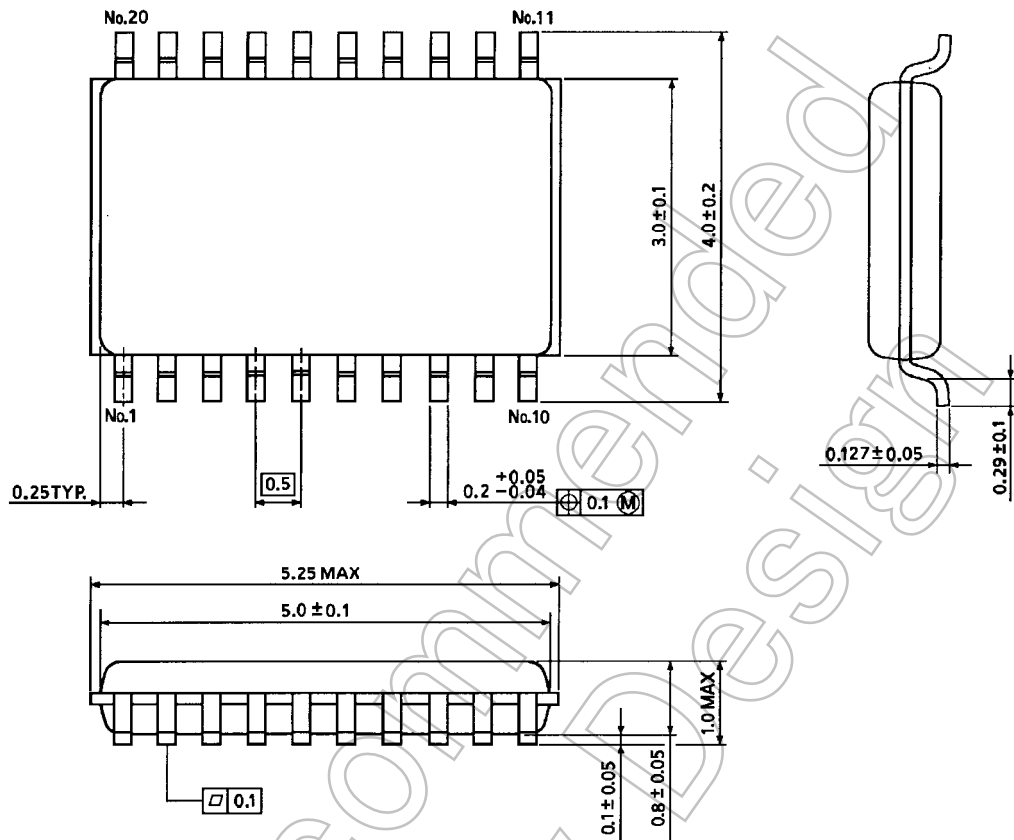
Symbol	V_{CC}		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \pm 0.15 \text{ V}$
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$
V_X	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
V_Y	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{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

Not Recommended for New Design

Package Dimensions

VSSOP20-P-0030-0.50

Unit : mm



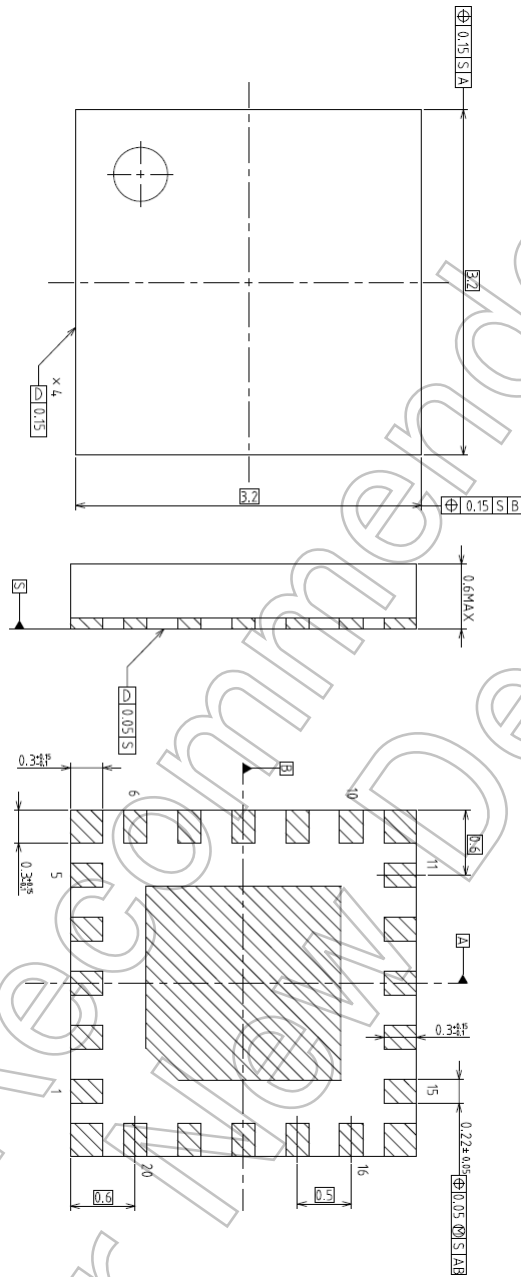
Weight: 0.03 g (typ.)

Not Recommended for New Design

Package Dimensions

Unit : mm

VQON20-P-0404-0.5



Weight: 0.0145 g (typ.)

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