TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MP245FK, TC7MP245FTG

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

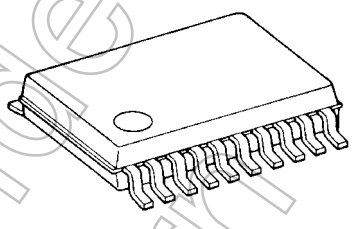
The TC7MP245 is a high-performance CMOS octal bus transceiver. By a low power consumption circuit, power consumption has been reduced when a bus terminal is disable state ($\overline{OE}$=High).

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.

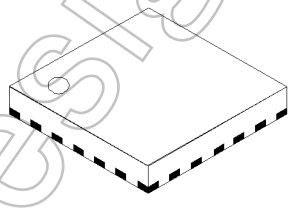
All inputs are equipped with protection circuits against static discharge.

TC7MP245FK



VSSOP20-P-0030-0.50

TC7MP245FTG



VQON20-P-0404-0.50

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 μA (max) (V_{CC}=3.6V)
- High-speed operation : t_{pd} = 3.0 ns(max) (V_{CC}=3.3±0.3V)
  t_{pd} = 4.6 ns (max) (V_{CC}=2.5±0.2V)
  t_{pd} = 10.0 ns (max) (V_{CC}=1.8±0.15V)
- Output current : I_{OHA}/I_{OLA} (A bus) = ±12mA (min) (V_{CC}=3.0V)
  : I_{OHB}/I_{OLB} (B bus) = ±24mA (min) (V_{CC}=3.0V)
- Latch-up performance : ±300mA
- ESD performance : Machine model ≥ ±200 V
  Human body model ≥ ±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.

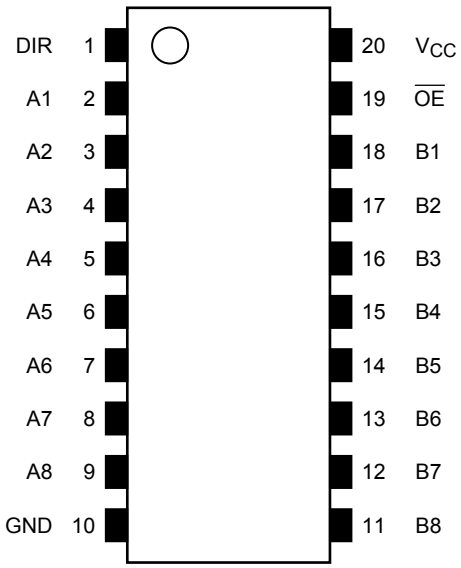
Note 1: At the time bus terminal is enable state, please do not give a signal from the outside.

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

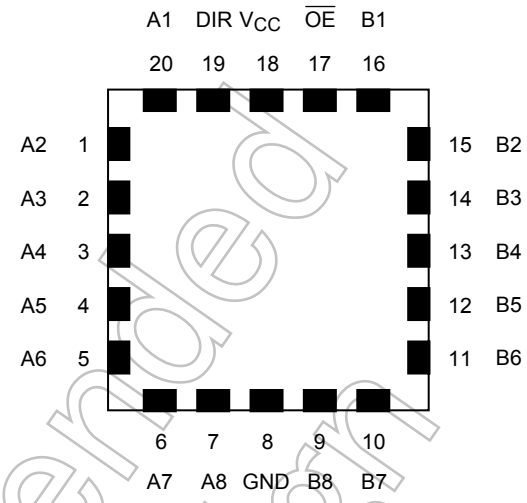
Start of commercial production
2002-03

Pin Assignment (top view)

FK (VSSOP20-P-0030-0.50)



FTG (VQON20-P-0404-0.50)



Truth Table

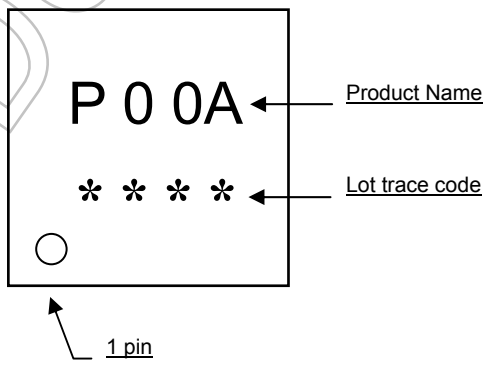
Input		Bus state	Bus hold circuit (B bus)
DIR	$\overline{OE}$		
L	L	B→A(B=A)	OFF
H	L	A→B(A=B)	OFF
X	H	Z	ON*

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

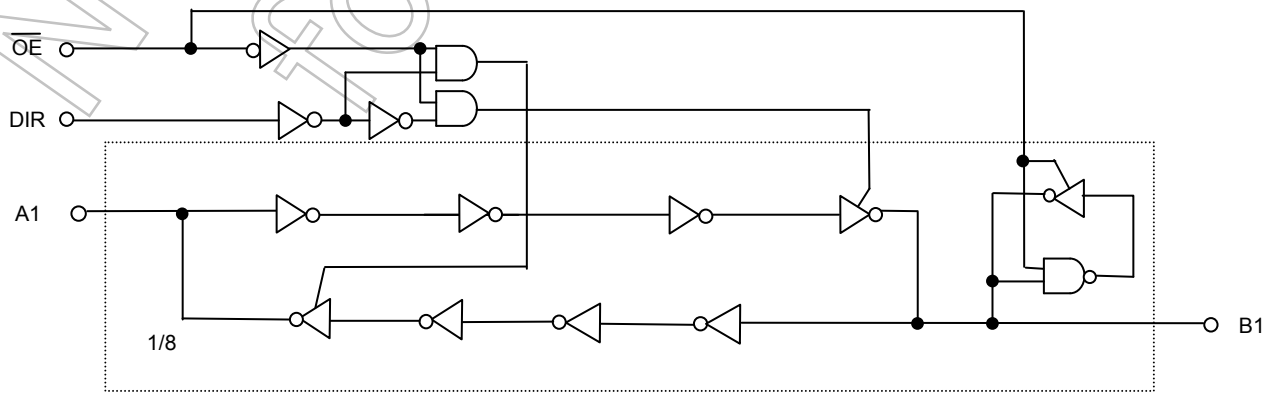
Note: When a bus input is in "H" state and an output is switched to "enable" to "disable", Glitch such as "L" state during about 1 to 3ns occurs in an output. It is not generated when a bus input is in "L" state.

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_{IIK}	-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	Tstg	-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)	$V_{I/OA}$	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	Topr	-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℃, 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_{0HA}	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_{0LA}	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_{0HB}	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_{0LB}	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 3.6 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_{0HA}	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_{0LA}	V_{IN}= V_{IL}	I_{OLA}=100uA	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_{0HB}	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_{0LB}	V_{IN}= V_{IL}	I_{OLB}=100uA	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 3.6 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} Vout=0 to 3.6V		2.3 to 2.7	-	±5.0	μA
		I_{OZB}	V_{INB}=V_{IH} or V_{IL} Vout=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_{0HA}	V_{IN}= V_{IH}	I_{OHA}=-100uA	1.65	V_{CC}-0.2	-	V
				I_{OHA}=-2mA	1.65	1.3	-	
	L-level	V_{0LA}	V_{IN}= V_{IL}	I_{OLA}=2mA	1.65	-	0.2	
Output voltage (B bus)	H-level	V_{0HB}	V_{IN}= V_{IH}	I_{OHB}=-100uA	1.65	V_{CC}-0.2	-	V
				I_{OHB}=-4mA	1.65	1.3	-	
	L-level	V_{0LB}	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} Vout=0 to 3.6 V		1.65 to 2.3	-	±5.0	μA
		I_{OZB}	V_{INB}=V_{IH} or V_{IL} Vout=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℃,Input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF, $R_L = 500\,\Omega$)

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=50pF, 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℃)

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}=100MHz Table 1 (Note)	1.8,2.5,3.3	20	pF
		$\overline{OE}$= “H”, f_{INA}=100MHz Table 1 (Note)		0	pF
Power dissipation capacitance (B bus input)	C_{PDB}	$\overline{OE}$= “L”, f_{INB}=100MHz Table 1 (Note)	1.8,2.5,3.3	16	pF
		$\overline{OE}$= “H”, f_{INB}=100MHz 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.
$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot V_{IN} + I_{CC}/8$(per bit)

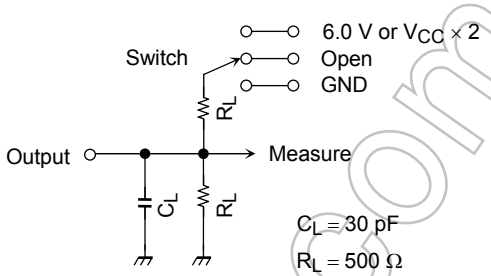
Table1 CPD Test Condition

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) X = Don't care(Fixed to V_{CC} or GND)
G = GND (0V) O = Open
H = Logic 1 (VCC) C = Connect a condenser(30pF) between output terminal and GND.
L = Logic 0 (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

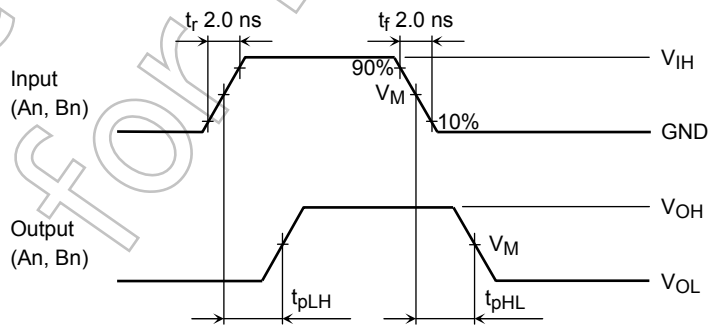


Figure 2 t_{pLH}, t_{pHL}

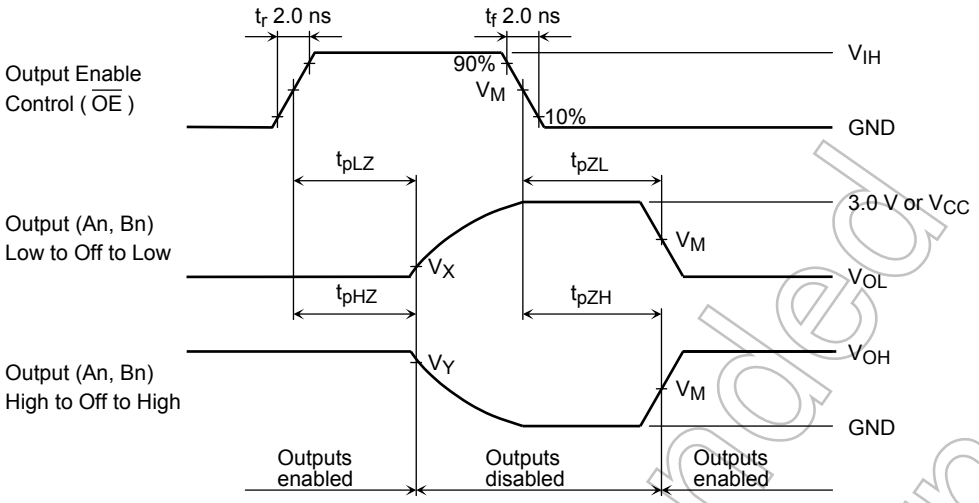
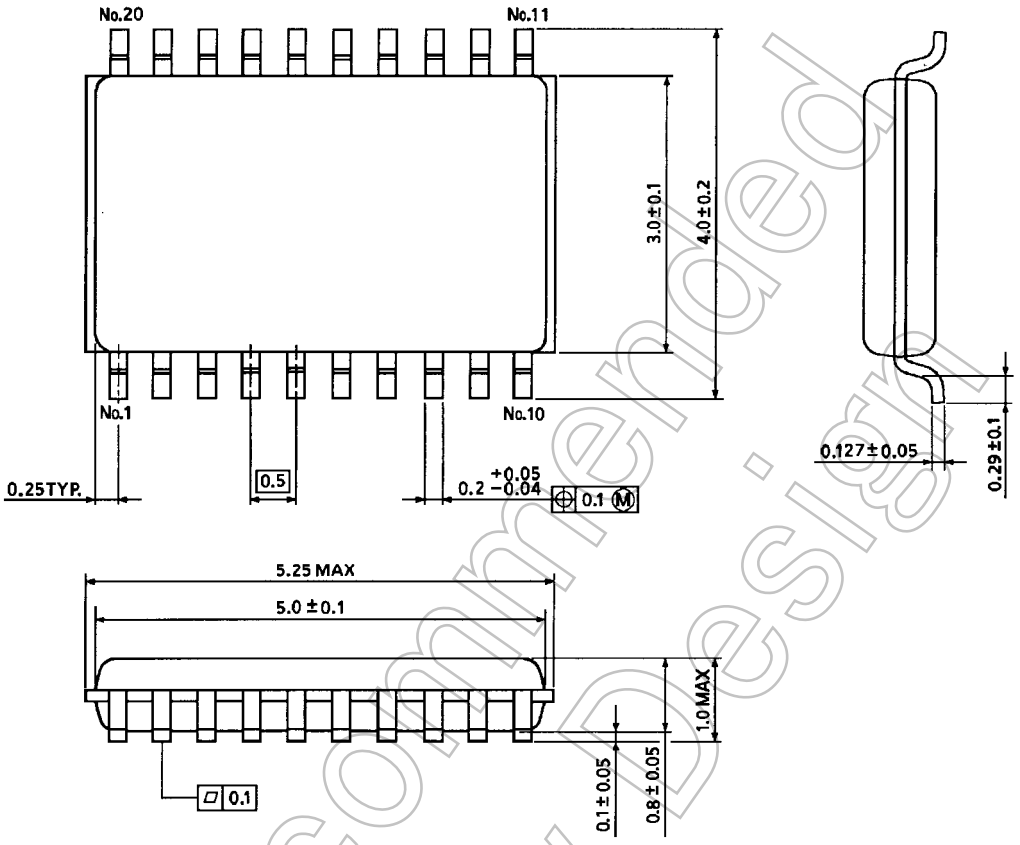


Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

Symbol	V_{CC}		
	3.3±0.3 V	2.5±0.2 V	1.8±0.15 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 V	V_{OL} + 0.15 V	V_{OL} + 0.15 V
V_Y	V_{OH} - 0.3 V	V_{OH} - 0.15 V	V_{OH} - 0.15 V

Package Dimensions

VSSOP20-P-0030-0.50 Unit : mm

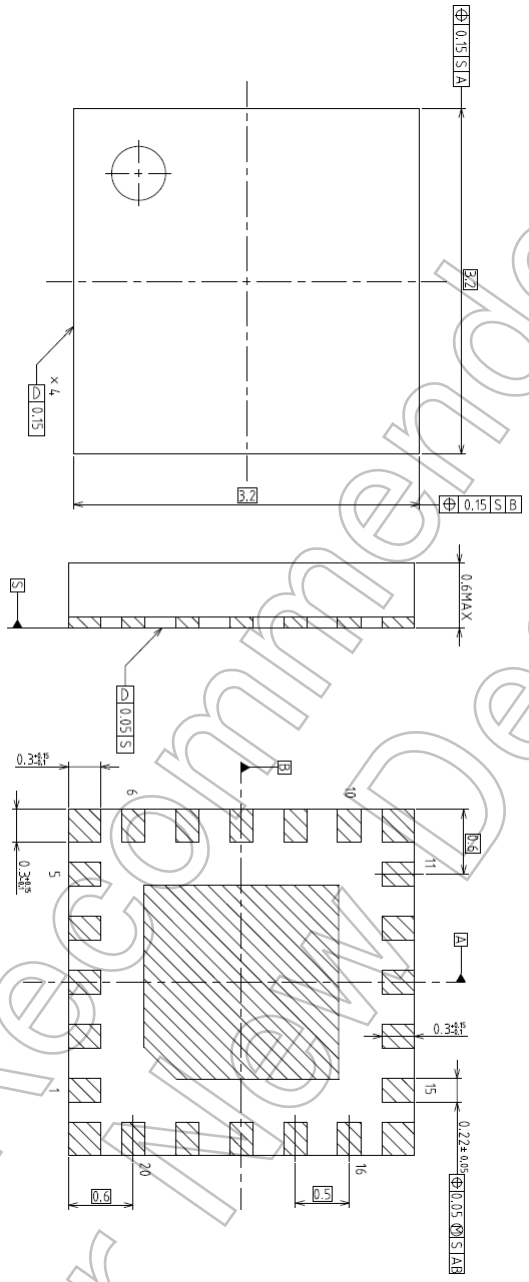


Weight: 0.03 g (typ.)

Package Dimensions

Unit : mm

VQON20-P-0404-0.5



Weight: 0.0145 g (typ.)

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