TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MP245FK, TC7MP245FTG

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

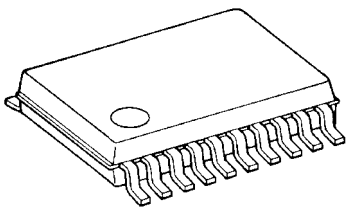
The TC7MP245 is a high-performance CMOS octal bus transceiver. By a low power consumption circuit, power consumption has been reduced when a bus terminal is disable state ($\overline{OE}$=High).

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.

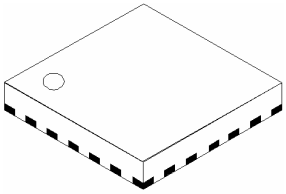
All inputs are equipped with protection circuits against static discharge.

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

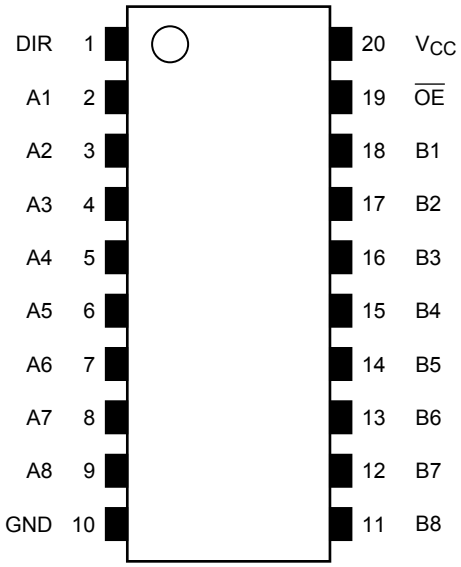
- Low-voltage operation : VCC = 1.65 to 3.6 V
- Low power current consumption : By a new input circuit, power consumption in $\overline{OE}$=H is reduced largely. It is most suitable for battery drive products such as personal digital assistant or a cellular phone.
- Quiescent supply current : I_{CC} = 5μA(max)(Vcc=3.6V)
- High-speed operation : tpd=3.0ns(max)(Vcc=3.3±0.3V)
  tpd=4.6ns(max)(Vcc=2.5±0.2V)
  tpd=10.0ns(max)(Vcc=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.

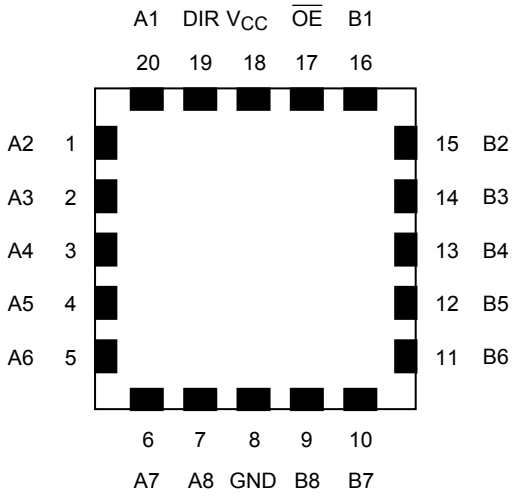
Note 2: When mounting VQON package, the type of recommended flux is RA or RMA.

Pin Assighment (top view)

FK (VSSOP20-P-0030-0.50)



FTG (VQON20-P-0404-0.50)



Truth Table

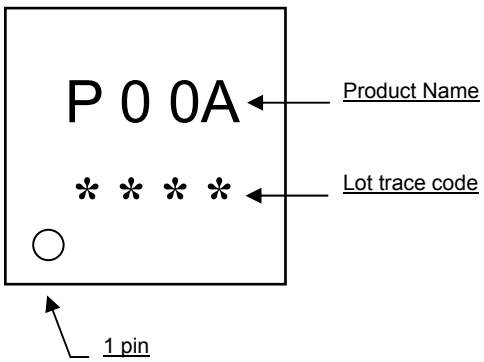
Input		Bus state	Bus hold circuit (B bus)
DIR	$\overline{OE}$		
L	L	B→A(B=A)	OFF
H	L	A→B(A=B)	OFF
X	H	Z	ON*

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

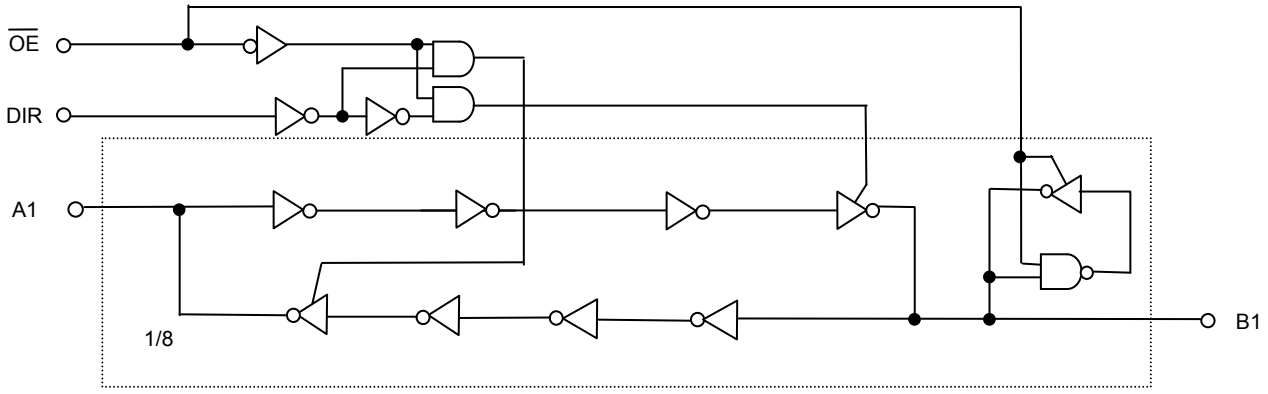
Note: When a bus input is in "H" state ,and an output is switched to "enable" to "disable", Glitch such as "L" state during about 1 to 3ns occurs in an output. It is not generated when a bus input is in "L" state.

Marking

FTG (VQON20-P-0404-0.50)



System Diagram



Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Rating	Unit
Power supply voltage	Vcc	-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 Vcc+0.5 (Note 3)	
DC input/output voltage(B bus)	VI/OB	-0.5 to Vcc+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: VCC=0V, or output off state.

Note 3: $\overline{OE}$=”L”, DIR=”L”

Operating Ranges (Note 1)

Parameter	Symbol	Rating	Unit
Power supply voltage	Vcc	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 Vcc (Note 4)	
DC input/output voltage(B bus)	VI/OB	0 to Vcc	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 VCC or GND. Please connect both bus inputs and the bus outputs with VCC 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<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_{0HA}	V_{IN}= V_{IH}	I_{OHA}=-100uA	2.7 to 3.6	Vcc-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	Vcc-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 3.6V		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℃, 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_{0HA}	V_{IN}= V_{IH}	I_{OHA}=-100uA	2.3 to 2.7	Vcc-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	Vcc-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 3.6V		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} 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}=0.7V		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℃, 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	Vcc×0.7	-	V
	L-level	V_{IL}	-		1.65 to 2.3	-	Vcc×0.2	
Output voltage (A bus)	H-level	V_{0HA}	V_{IN}= V_{IH}	I_{OHA}=-100uA	1.65	Vcc-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	Vcc-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 3.6V		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} Vout=0 to 3.6V		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}=0.33V		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℃,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 C_L=50pF, add approximately 300ps to the AC maximum specification.

Note: Parameter guaranteed by design.
($tosLH=|t_{pLHm}-t_{pLHn}|$, $tosHL=|t_{pHLm}-t_{pHLn}|$)

Capacitive Characteristics(Ta=25℃)

Characteristics	Symbol	Test Condition	Vcc(V)	Typ.	Unit
Input capacitance	C_{IN}		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	$\overline{OE}$= "L" ,finA=100MHz Table 1 (Note)	1.8,2.5,3.3	20	pF
		$\overline{OE}$= "H" ,finA=100MHz Table 1 (Note)		0	pF
Power dissipation capacitance (B bus input)	CPDB	$\overline{OE}$= "L" ,finB=100MHz Table 1 (Note)	1.8,2.5,3.3	16	pF
		$\overline{OE}$= "H" ,finB=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-

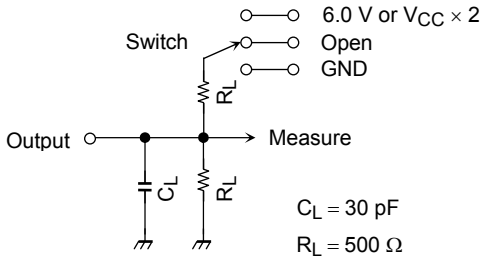
V=V_{CC}(+3.3V) X=Don't care(Fixed to V_{CC} or GND)

G=GND(0V) O=Open

H=Logic1(VCC) C=Connect a condenser(30pF) between output terminal and GND.

L=Logic0(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

AC Waveform

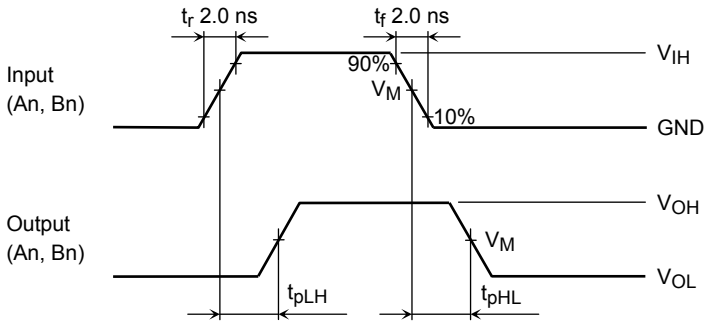


Figure 2 t_{pLH}, t_{pHL}

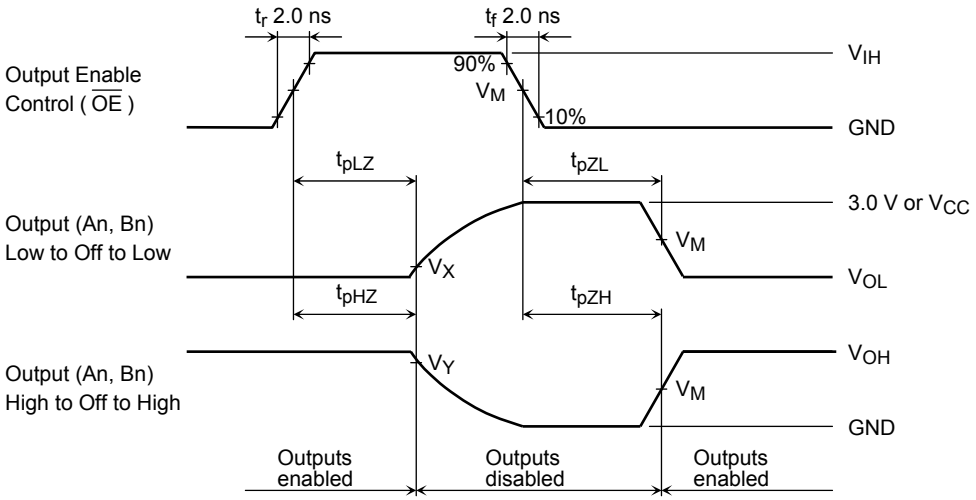
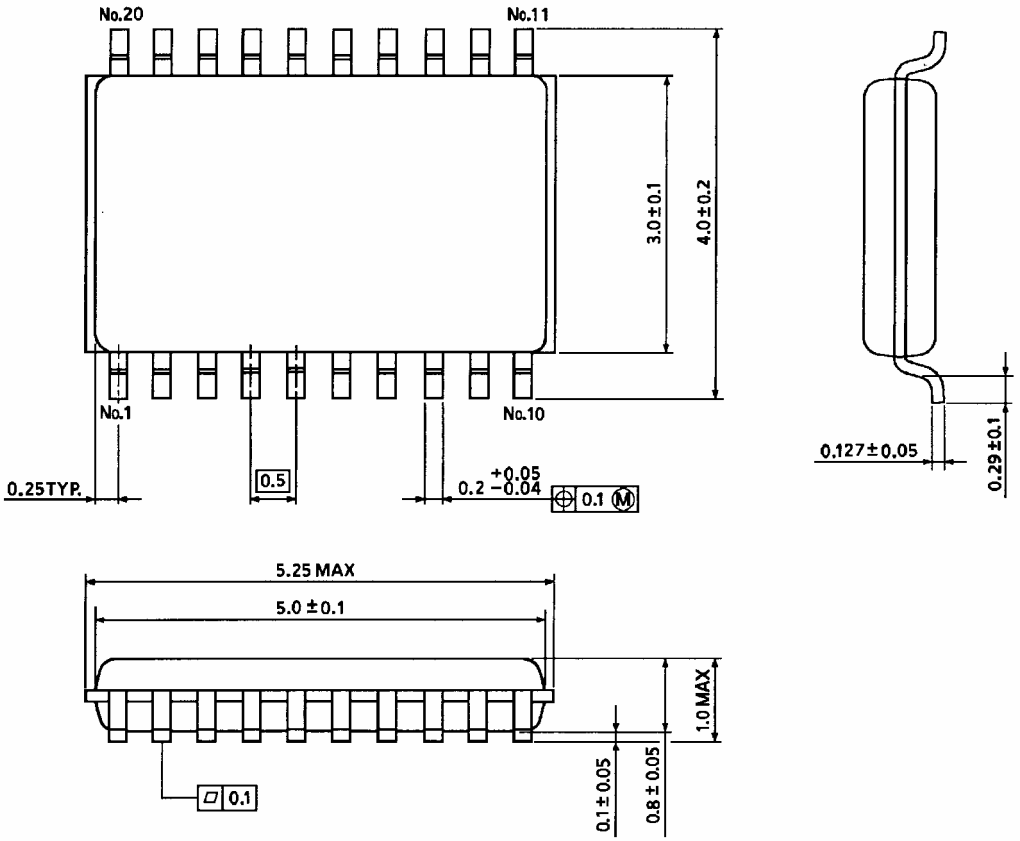


Figure 3 t_{pLZ}, t_{pHZ}, t_{pZL}, t_{pZH}

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

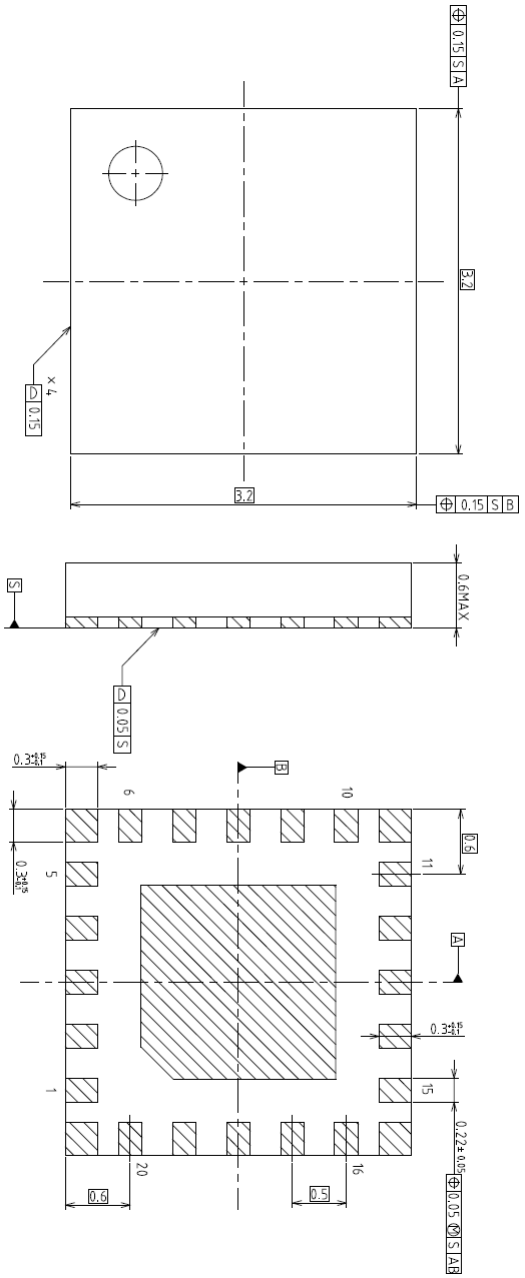


Weight: 0.03 g (typ.)

Package Dimensions

Unit : mm

VQON20-P-0404-0.5



Weight: 0.0145 g (typ.)

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20070701-EN

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