

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MA157FK

Low Voltage Quad 2-Channel Multiplexer with 3.6 V Tolerant Inputs and Outputs

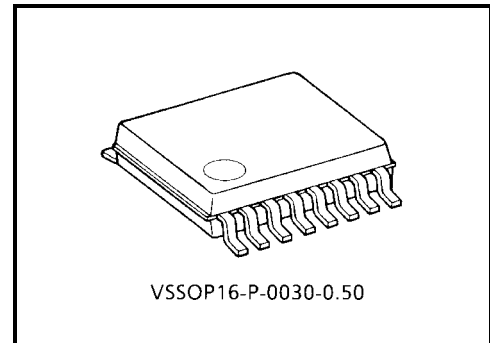
The TC7MA157FK is a high performance CMOS multiplexer which is guaranteed to operate from 1.2-V to 3.6-V. Designed for use in 1.5 V, 1.8 V, 2.5 V or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

It consists of four 2-input digital multiplexers with common select and strobe inputs.

When the \overline{ST} input is held "H" level, selection of data is inhibited and all the outputs become "L" level. The SELECT decoding determines whether the A or B inputs get routed to their corresponding Y outputs.

All inputs are equipped with protection circuits against static discharge.

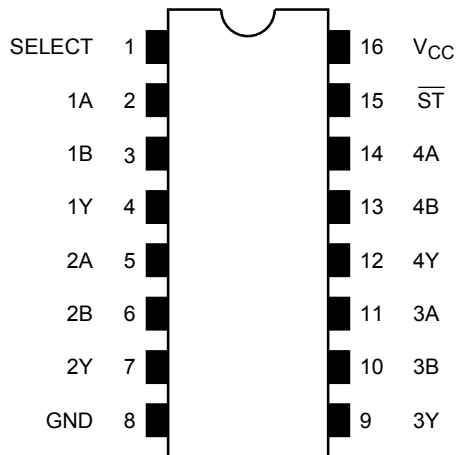


Weight: 0.02 g (typ.)

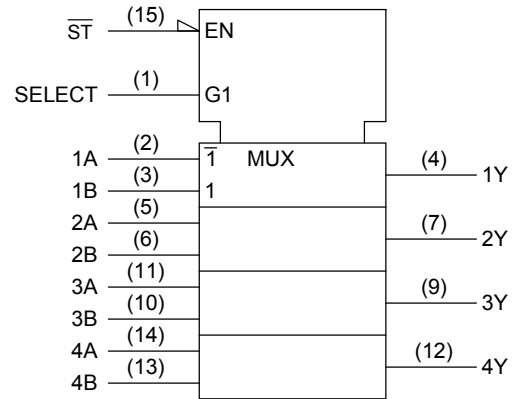
Features

- Low voltage operation: $V_{CC} = 1.2\sim 3.6\text{ V}$
- High speed operation: $t_{pd} = 3.0\text{ ns (max) (}V_{CC} = 3.0\sim 3.6\text{ V)}$
 $t_{pd} = 3.5\text{ ns (max) (}V_{CC} = 2.3\sim 2.7\text{ V)}$
 $t_{pd} = 7.0\text{ ns (max) (}V_{CC} = 1.65\sim 1.95\text{ V)}$
 $t_{pd} = 14.0\text{ ns (max) (}V_{CC} = 1.4\sim 1.6\text{ V)}$
 $t_{pd} = 35.0\text{ ns (max) (}V_{CC} = 1.2\text{ V)}$
- 3.6 V tolerant inputs and outputs.
- Output current: $I_{OH}/I_{OL} = \pm 24\text{ mA (min) (}V_{CC} = 3.0\text{ V)}$
 $I_{OH}/I_{OL} = \pm 18\text{ mA (min) (}V_{CC} = 2.3\text{ V)}$
 $I_{OH}/I_{OL} = \pm 6\text{ mA (min) (}V_{CC} = 1.65\text{ V)}$
 $I_{OH}/I_{OL} = \pm 2\text{ mA (min) (}V_{CC} = 1.4\text{ V)}$
- Latch-up performance: $\pm 300\text{ mA}$
- ESD performance: Machine model $> \pm 200\text{ V}$
Human body model $> \pm 2000\text{ V}$
- Package: VSSOP (US16)
- Power down protection is provided on all inputs and outputs.

Pin Assignment (top view)



IEC Logic Symbol

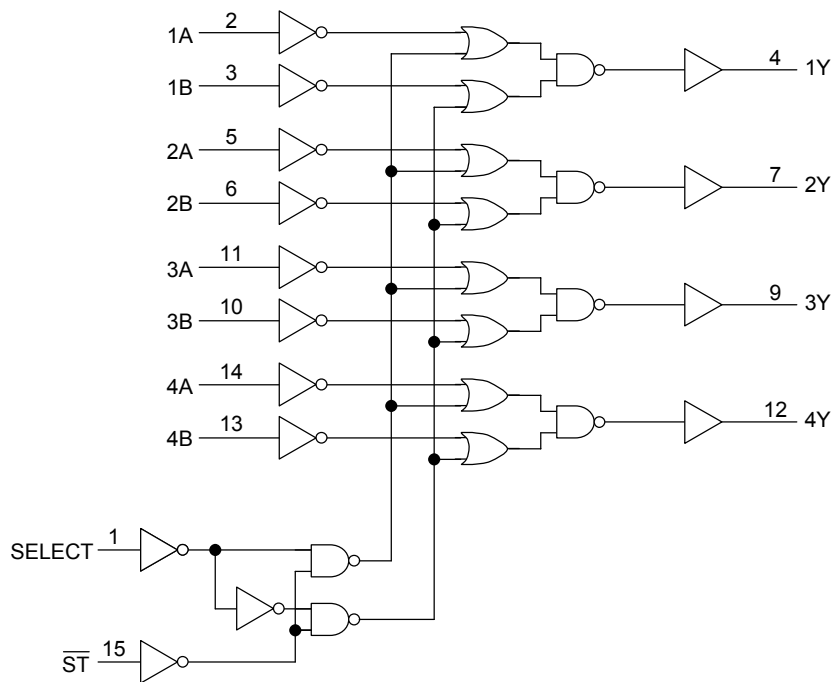


Truth Table

Inputs				Outputs
\overline{ST}	SELECT	A	B	Y
H	X	X	X	L
L	L	L	X	L
L	L	H	X	H
L	H	X	L	L
L	H	X	H	H

X: Don't care

System Diagram



Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{CC}	-0.5~4.6	V
DC input voltage	V_{IN}	-0.5~4.6	V
DC output voltage	V_{OUT}	-0.5~4.6 (Note1)	V
		-0.5~ $V_{CC} + 0.5$ (Note2)	
Input diode current	I_{IK}	-50	mA
Output diode current	I_{OK}	±50 (Note3)	mA
DC output current	I_{OUT}	±50	mA
Power dissipation	P_D	180	mW
DC V_{CC} /ground current	I_{CC}/I_{GND}	±100	mA
Storage temperature	T_{stg}	-65~150	°C

Note1: $V_{CC} = 0$ V

Note2: High or low state. I_{OUT} absolute maximum rating must be observed.

Note3: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Recommended Operating Range

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	1.2~3.6	V
Input voltage	V_{IN}	-0.3~3.6	V
Output voltage	V_{OUT}	0~3.6 (Note4)	V
		0~ V_{CC} (Note5)	
Output current	I_{OH}/I_{OL}	± 24 (Note6)	mA
		± 18 (Note7)	
		± 6 (Note8)	
		± 2 (Note9)	
Operating temperature	T_{opr}	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note10)	ns/V

Note4: $V_{CC} = 0$ V

Note5: High or low state

Note6: $V_{CC} = 3.0\sim 3.6$ V

Note7: $V_{CC} = 2.3\sim 2.7$ V

Note8: $V_{CC} = 1.65\sim 1.95$ V

Note9: $V_{CC} = 1.4\sim 1.6$ V

Note10: $V_{IN} = 0.8\sim 2.0$ V, $V_{CC} = 3.0$ V

Electrical Characteristics

DC Characteristics ($T_a = -40\sim 85^\circ\text{C}$, $2.7\text{ V} < V_{CC} \leq 3.6\text{ V}$)

Characteristics		Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—	2.7~3.6	2.0	—	V
	Low level	V_{IL}	—	2.7~3.6	—	0.8	
Output voltage	High level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100\ \mu\text{A}$	2.7~3.6	$V_{CC} - 0.2$	V
				$I_{OH} = -12\ \text{mA}$	2.7	2.2	
				$I_{OH} = -18\ \text{mA}$	3.0	2.4	
				$I_{OH} = -24\ \text{mA}$	3.0	2.2	
	Low level	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 100\ \mu\text{A}$	2.7~3.6	—	0.2
				$I_{OL} = 12\ \text{mA}$	2.7	—	0.4
				$I_{OL} = 18\ \text{mA}$	3.0	—	0.4
				$I_{OL} = 24\ \text{mA}$	3.0	—	0.55
Input leakage current	I_{IN}	$V_{IN} = 0\sim 3.6\text{ V}$	2.7~3.6	—	± 5.0	μA	
Power off leakage current	I_{OFF}	$V_{IN}, V_{OUT} = 0\sim 3.6\text{ V}$	0	—	10.0	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	2.7~3.6	—	20.0	μA	
		$V_{CC} \leq V_{IN} \leq 3.6\text{ V}$	2.7~3.6	—	± 20.0		
Increase in I_{CC} per input	ΔI_{CC}	$V_{IH} = V_{CC} - 0.6\text{ V}$	2.7~3.6	—	750		

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

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		2.3~2.7	1.6	—	V
	Low level	V _{IL}	—		2.3~2.7	—	0.7	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	2.3~2.7	V _{CC} - 0.2	—	V
				I _{OH} = -6 mA	2.3	2.0	—	
				I _{OH} = -12 mA	2.3	1.8	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	2.3~2.7	—	0.2	
				I _{OL} = 12 mA	2.3	—	0.4	
				I _{OL} = 18 mA	2.3	—	0.6	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		2.3~2.7	—	±5.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		2.3~2.7	—	20.0	μA
			V _{CC} ≤ V _{IN} ≤ 3.6 V		2.3~2.7	—	±20.0	

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

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.65~2.3	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—		1.65~2.3	—	0.2 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.65~2.3	V _{CC} - 0.2	—	V
				I _{OH} = -6 mA	1.65	1.25	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.65~2.3	—	0.2	
				I _{OL} = 6 mA	1.65	—	0.3	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		1.65~2.3	—	±5.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.65~2.3	—	20.0	μA
			V _{CC} ≤ V _{IN} ≤ 3.6 V		1.65~2.3	—	±20.0	

DC Characteristics (Ta = -40~85°C, 1.4 V ≤ VCC ≤ 1.65 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.4~1.65	0.65 × V _{CC}	—	V
	Low level	V _{IL}	—		1.4~1.65	—	0.05 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.4~1.65	V _{CC} - 0.2	—	V
				I _{OH} = -2 mA	1.4	1.05	—	
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.4~1.65	—	0.05	
				I _{OL} = 2 mA	1.4	—	0.35	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		1.4~1.65	—	±5.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.4~1.65	—	20.0	μA
			V _{CC} ≤ V _{IN} ≤ 3.6 V		1.4~1.65	—	±20.0	

DC Characteristics (Ta = -40~85°C, 1.2 V ≤ VCC < 1.4 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V _{IH}	—		1.2~1.4	0.8 × V _{CC}	—	V
	Low level	V _{IL}	—		1.2~1.4	—	0.05 × V _{CC}	
Output voltage	High level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	1.2	V _{CC} - 0.1	—	V
	Low level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	1.2	—	0.05	
Input leakage current		I _{IN}	V _{IN} = 0~3.6 V		1.2	—	±5.0	μA
Power off leakage current		I _{OFF}	V _{IN} , V _{OUT} = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I _{CC}	V _{IN} = V _{CC} or GND		1.2	—	20.0	μA
			V _{CC} ≤ V _{IN} ≤ 3.6 V		1.2	—	±20.0	

AC Characteristics (Ta = -40~85°C, Input: tr = tf = 2.0 ns)

Characteristics	Symbol	Test Condition		VCC (V)	Min	Max	Unit
Propagation delay time (A, B-Y)	tpLH tpHL	Figure 1, Figure 2	CL = 15 pF, RL = 2 kΩ	1.2	3.0	35.0	ns
				1.5 ± 0.1	2.0	14.0	
			CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	1.5	7.0	
				2.5 ± 0.2	0.8	3.5	
Propagation delay time (SELECT-Y)	tpLH tpHL	Figure 1, Figure 2	CL = 15 pF, RL = 2 kΩ	1.2	3.0	45.0	ns
				1.5 ± 0.1	2.0	18.0	
			CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	1.5	9.0	
				2.5 ± 0.2	0.8	4.5	
Propagation delay time (ST -Y)	tpLH tpHL	Figure 1, Figure 2	CL = 15 pF, RL = 2 kΩ	1.2	3.0	45.0	ns
				1.5 ± 0.1	2.0	18.0	
			CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	1.5	9.0	
				2.5 ± 0.2	0.8	4.5	
Output to output skew	tosLH tosHL	(Note11)	CL = 15 pF, RL = 2 kΩ	1.2	—	1.5	ns
				1.5 ± 0.1	—	1.5	
			CL = 30 pF, RL = 500 Ω	1.8 ± 0.15	—	0.5	
				2.5 ± 0.2	—	0.5	
				3.3 ± 0.3	0.6	3.0	

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

Note11: 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: tr = tf = 2.0 ns, CL = 30 pF)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	V _{OLP}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note12)	1.8	0.25	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note12)	2.5	0.6	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note12)	3.3	0.8	
Quiet output minimum dynamic VOL	V _{OLV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note12)	1.8	-0.25	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note12)	2.5	-0.6	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note12)	3.3	-0.8	
Quiet output minimum dynamic VOH	V _{OHV}	V _{IH} = 1.8 V, V _{IL} = 0 V (Note12)	1.8	1.5	V
		V _{IH} = 2.5 V, V _{IL} = 0 V (Note12)	2.5	1.9	
		V _{IH} = 3.3 V, V _{IL} = 0 V (Note12)	3.3	2.2	

Note12: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	C _{IN}	—	1.8, 2.5, 3.3	6	pF
Power dissipation capacitance	C _{PD}	f _{IN} = 10 MHz (Note13)	1.8, 2.5, 3.3	20	pF

Note13: 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:

$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

AC Test Circuit

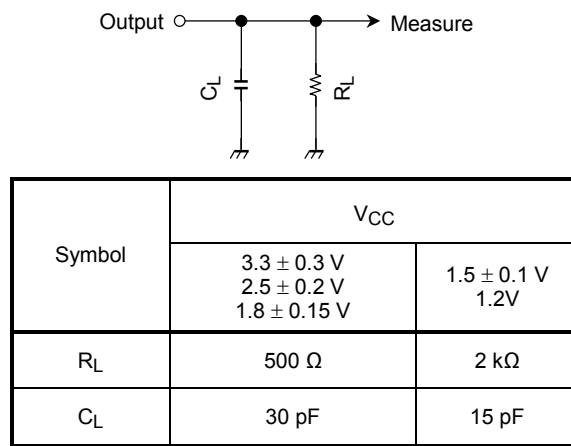
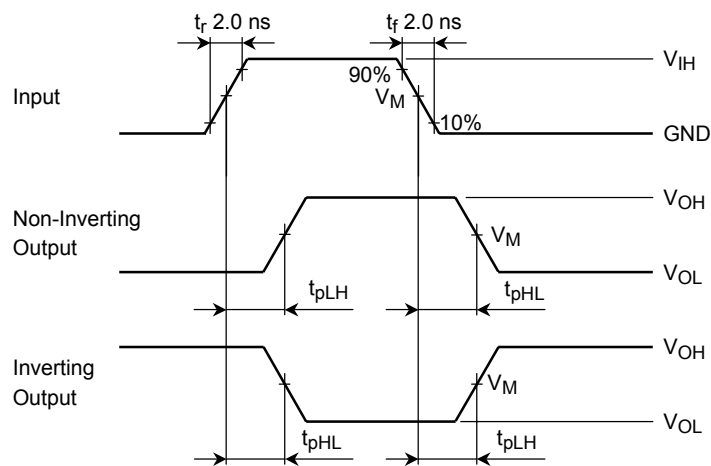


Figure 1

AC Waveform



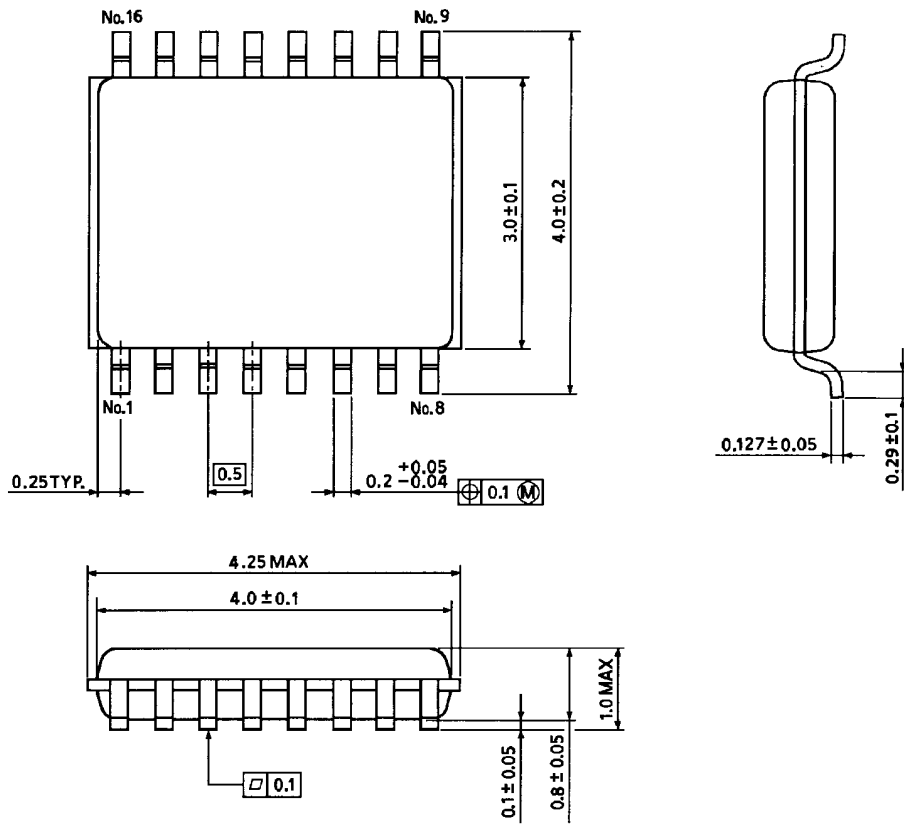
Symbol	V _{CC}				
	3.3 ± 0.3 V	2.5 ± 0.2 V	1.8 ± 0.15 V	1.5 ± 0.1 V	1.2 V
V _{IH}	2.7 V	V _{CC}	V _{CC}	V _{CC}	V _{CC}
V _M	1.5 V	V _{CC} /2	V _{CC} /2	V _{CC} /2	V _{CC} /2

Figure 2 t_{pLH}, t_{pHL}

Package Dimensions

VSSOP16-P-0030-0.50

Unit : mm



Weight: 0.02 g (typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.