TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# JT6M57-AS

#### JT6M57-AS CMOS Single-Chip LSI for LCD Calculator

The JT6M57-AS is a single-chip microcomputer for 12-digit or 10-digit 2-memory calculator. JT6M57-AS can drive the liquid crystal display (LCD). Single power supply operation, wide operating voltage range and low-power consumption make it suitable for 1.5 V solar battery operated calculator. Besides JT6M57-AS can selectable with a pin-programmable to function of Power timer and Memory hold.

#### Features

#### **Operational Features**

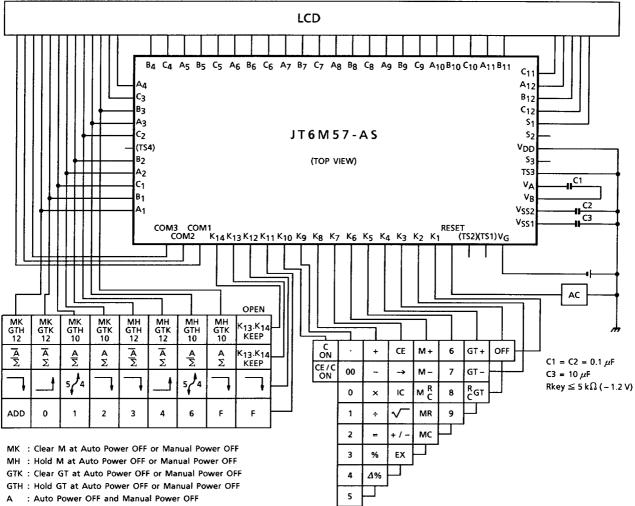
- 12 digits or 10 digits (selectable with a pin-programmable) of data, 2 digits of sign, error symbol, memory load symbol.
- Algebraic mode.
- Standard 4 functions (+, -, ×, ÷)
- Memory and grand total (GT) memory calculation.
- Accumulating GT memory register with count up (down) item counter.
- Automatic percentage operation with add-on, discount.
- Automatic delta percentage, mark-up and mark-down operations.
- Square root.
- Constant calculation.
- Chain calculation.
- Change sign.
- Floating minus.
- Key roll over function (2 keys).
- Fixed point ("0", "1", "2", "3", "4" or "6" places) or floating point (selectable with a switch).
- Adding point mode (selectable with a switch).
- Rounding switches (rounding up, down and off).
- Leading zero suppression.
- Trailing zero suppression.
- Punctuation on display, commas for thousands.
- Memory and GT memory contents indicator, turned on with non-zero in the memory and GT memory.
- Registration overflow, indicating that too many digits are entered (the most significant digit are protected).
- Result overflow, indicating during calculation (most function key are locked as it happened).
- Memory overflow indicating to flashing of memory load mark.

#### **Electrical Features**

- Complementary output buffer for direct driving of liquid crystal display (F. E. M LCD).
- Oscillator/clock generator internal to chip.
- Keyboard encoding internal to chip.
- Keyboard denouncing internal to chip.
- Automatic power on clear.
- Wide supply voltage range (-1.2~-2.0 V).
- Very low power consumption (3.3  $\mu W$  typ.).

## System Block Diagram

### **Battery Type**

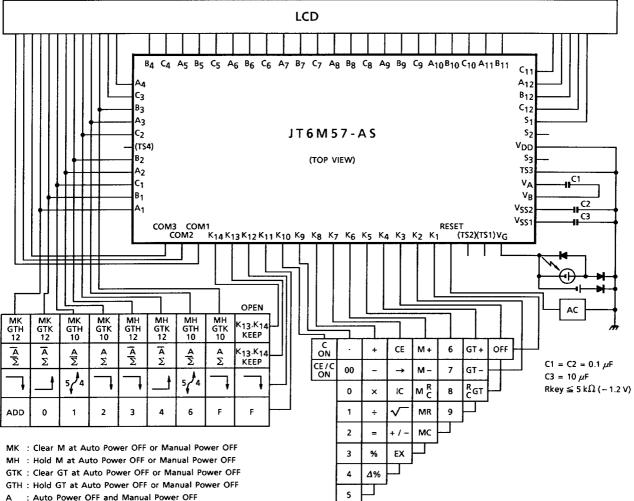


Ā : Manual Power OFF only

10 : Fixed 10 digits

12 : Fixed 12 digits

#### **Dual Type**



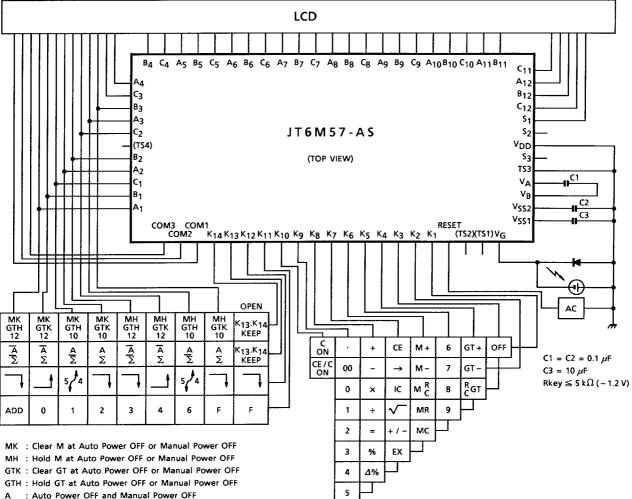
: Auto Power OFF and Manual Power OFF Α

Ā : Manual Power OFF only

10 : Fixed 10 digits

12 : Fixed 12 digits

#### Solar Type



: Auto Power OFF and Manual Power OFF Α

Ā : Manual Power OFF only

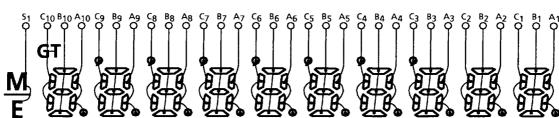
10 : Fixed 10 digits

12 : Fixed 12 digits

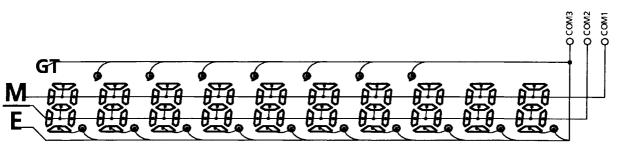
### **Connection of LCD**

#### Select of 10 Digits

Segment

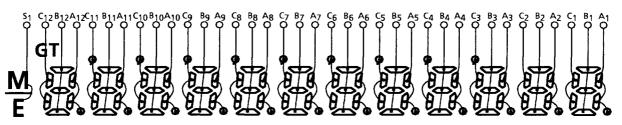


Common

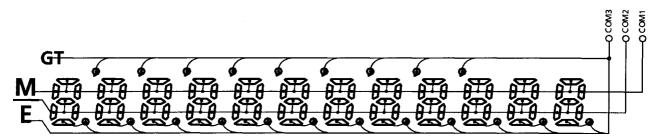


Select of 12 Digits

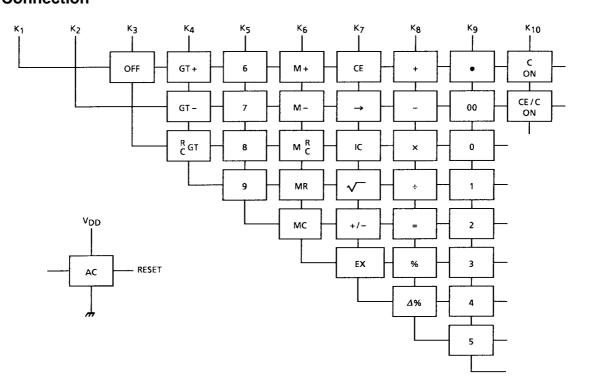
Segment



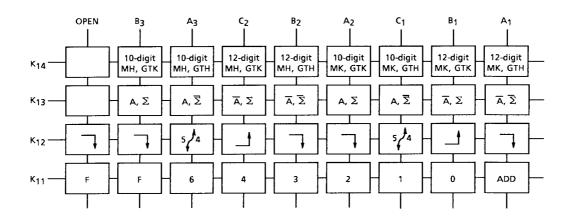
Common



# TOSHIBA Key Connection



**Touch Key** 





 $\ensuremath{\mathsf{K}_{14}}\xspace$  : Selectable with calculated digits and memory hold status.

MH (memory hold), MK (memory kill), GTH (GT memory hold) and GTK (GT memory kill) at auto power OFF or OFF key.

 $\ensuremath{\mathsf{K}_{13}}\xspace$ : Selectable with auto power OFF mode and total switch.

K<sub>12</sub>: Rounding switches.

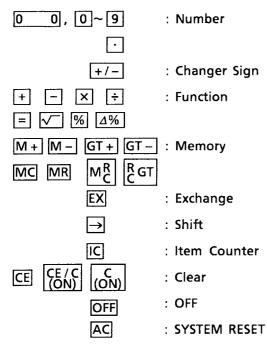
 $K_{11}$ : Selectable with fixed point or floating mode.

### **Specification of Calculator**

Speed of Caluculation (	standard oscillating frequency $f\phi = 48$ kHz)
-------------------------	--

Numeral	11.8	3~17.7 ms
Function	$\begin{cases} 1 + \dots \\ 1 + 2 + \dots \end{cases}$	25.6 ms
Addition and Subtract	{1 2 3 +1 = 9999999999 - 0.00000001 =	89.1 ms 111.8 ms
Multiply	{1 2 3 × 2 = 1 × 9999999999 =	109.6 ms 207.7 ms
Device	{1 2 3 ÷ 3 ≡ 9999999999 ÷1 ≡	147.9 ms 249.0 ms
Memory calculation	{2 M + 9999999999 ÷1 M +	143.3 ms 296.2 ms
Square root	{9999999999 🗸	167.7 ms 125.0 ms

#### **Keys for Calculator**



## **Operation Example**

### 1. Fixed Point Calculation

(1)	Key	Display	Fixed Point Place	(2)	Key	Display	Fixed Point Place
	C	0.	DP = 3 (5 / 4)		C	0.	DP = 0 ()
	2	2.			1	1.	
	÷	2.			·	1.	
	3	3.			2	1.2	
	=	0.667			3	1.23	
	2	2.			+	1.23	
	$\overline{\cdot}$	2.			1	1.	
	3	2.3			$\overline{\cdot}$	1.	
	+	2.3			1	1.1	
	4	4.			=	3.	
	M +	6.300			9	9.	
	1	1.				3.	
	·	1.			×	3.	
	2	1.2			1	1.	
	M +	1.200			$\overline{}$	1.	
					1	1.1	DP = F
	RM	7.5			=	3.3	

#### 2. Adding Point Mode Calculation

/ (a a i		aloulation			
Key	Display	Key	Display	Key Displa	у
C	0.	M +	0.02M	= 33.27M ·	_
1	1.	3	3.M	2 2.1	N
23	123.	•	3.M	+ 0.02M	N
+	1.23	123	3.123M	9 9.N	N
3	3.	M +	3.12M	· 9.N	N
=	1.26	RM	3.14M	<u>√</u> 3.M	N
3	3.	С	0.M	= 3.02N	Л
2	32.	1	1.M		
×	32.	23	123.M		
3	3.	_	1.23M		
$\overline{\cdot}$	3.	3	3.M		
000	3.000	4	34.M		
=	96.00	·	34.M		
2	2.	5	34.5M		
	Key C 1 23 + 3 2 X 3 () 000 =	Key       Display         C       0.         1       1.         23       123.         +       1.23         3       3.         =       1.26         3       3.         2       32.         ×       32.         3       3.         •       3.         000       3.000         =       96.00	Key       Display       Key $C$ 0. $M+$ 1       1.       3         23       123. $\cdot$ $+$ 1.23       123         3       3. $M+$ $=$ 1.26       RM         3       3. $C$ 2       32.       1 $\times$ 32.       23         3       3. $C$ 2       32.       1 $\times$ 32.       23         3       3. $ \cdot$ 3. $3$ 000       3.000       4 $=$ 96.00 $\cdot$	KeyDisplayKeyDisplay $C$ 0. $M+$ 0.02M11.33.M23123. $\cdot$ 3.M $+$ 1.231233.123M33. $M+$ 3.12M $=$ 1.26RM3.14M $3$ 3. $C$ 0.M $2$ 32.11.M $\times$ 32.23123.M $3$ 3. $-$ 1.23M $\cdot$ 3.3. $M+$ $=$ 96.00 $4$ 34.M	KeyDisplayKeyDisplayKeyDisplay $C$ 0. $M+$ 0.02M $\equiv$ $33.27M$ 11.3 $3.M$ 2 $2.M$ 23123. $\cdot$ $3.M$ $\ddagger$ 0.02M $+$ 1.23123 $3.123M$ 9 $9.M$ $+$ 1.23123 $3.123M$ 9 $9.M$ $3$ $3.$ $M+$ $3.123M$ 9 $9.M$ $=$ 1.26 $RM$ $3.14M$ $\sqrt{-}$ $3.M$ $2$ 32.1 $1.M$ $\sqrt{-}$ $3.02M$ $2$ 32.1 $1.M$ $\sqrt{-}$ $3.02M$ $2$ 32.23123.M $3.M$ $3$ $3.$ $ 1.23M$ $ \cdot$ $3.000$ $4$ $34.M$ $ =$ 96.00 $\cdot$ $34.M$

## 3. Constant Calculation

(1)		plication		(2)	Divis		
	Key	Display	Constant		Key	Display	Constant
	k जि	k F			a	a	
	×	k			÷	а	
	a	а			k	k	
	=	k∙a	k×		=	a/k	÷k
	b	Ь	k×		Ь	b	÷k
	=	k∙b	k×		=	b/k	÷k
(3)	Addit	ion		(4)	Subt	raction	
	а	а			а	а	
	+	а			-	а	
	k	k			k	k	
	=	a + k	+ k		=	a – k	k
	b	Ь	+ k		b	b	- k
	=	b + k	+ k		=	b – k	– k
(5)	Perce	ntage		(6)	Perce	entage	
	k	k			а	а	
	X	k			÷		
						a	
	a	a			k	k	
	%	k∙a / 100	k×		%	100∙a / k	+ k
	b	b	k×		b	b	÷k
	%	k·b / 100	k×		%	100·b/k	÷k
(7)	Add-o	n		(8)	Disco	ount	
	k	k			k	k	
	+	k			-	k	
	a	a			а	а	
	%	k∙(1 + a∕100)	k +		%	k∙(1 – a∕100)	k –
	b	ь	k +		b	b	k –
	%	k·(1 + b / 100)	k +		%	k· (1 − b / 100)	k –

### 4. ∆% Calculation

(1)	Key a	Display <b>a</b>
	+	а
	b	b
	∆%	100· (a + b) / b

#### 5. Mark-Up, Mark-Down Calculation

- (1) Mark-up Key Display

(2) Key Display
a a
a
b b
△% 100·(a - b)/b

(2)	Mark <sup>.</sup> Key	down Display
	а	a
	÷	а
	b	b
	+/-	- b
	Δ%	a/(1 + b/100)
	⊿%	a/(1 + b/100) - a

#### 6. Add-On, Discount Calculation

Add-	on		Disco	ount	
(1)	Key a	Display a	(2)	Key a	Display <b>a</b>
(1)	×		(2)	X	
		a			a
	b	Ь		b	b
	%	a·b / 100		%	a∙b / 100
	+	a·b / 100		-	a∙b / 100
	=	a (1 + b / 100)		=	a (1 – b / 100)
(3)	а	a	(4)	а	а
	+	a		<b>—</b>	a
	b	b		Ь	b
	%	a (1 + b / 100)		%	a (1 – b / 100)
(5)	а	a	(6)	а	a
	×	a		×	a
	b	b		b	b
				+/-	– b
	⊿%	a (1 + b / 100)		∆%	a (1 – b / 100)

# <u>TOSHIBA</u>

### 7. Average Operation Use of the Item Counter

Key	Display	Item Counter	Key	Display	Item Counter
Α	А	0	Ξ	A + B + C + D	2
+	А	1	D	D	2
В	В	1	+	A + B + C	3
+	A + B	2	E	E	3
С	С	2	=	A + B + C + E	4
+	A + B + C	3	÷	A + B + C + E	4
D	D	3	IC	4	4
+ A	+ B + C + D	4	=	(A + B + C + E)/4	1 5

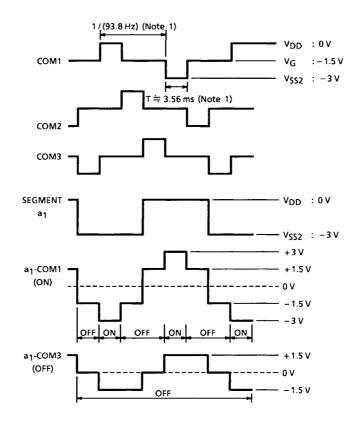
### **Maximum Ratings**

Characteristics	Symbol	Rating	Unit
Supply voltage	V <sub>G</sub>	+0.3~-2.0	V
Input voltage	V <sub>IN</sub>	$+0.3 \sim V_{G} - 0.3$	V
Operating temperature	T <sub>opr</sub>	0~40	°C
Storage temperature	T <sub>stg</sub>	-55~125	°C

#### Electrical Characteristics ( $V_G = -1.5 V \pm 0.2 V$ , $V_{SS2} = -3.0 \pm 0.4 V$ , $V_{DD} = 0 V$ , $Ta = 25^{\circ}C$ )

Chara	cteristics	Symbol	Test Circuit	Pin Name	Test Condition	Min	Тур.	Max	Unit
Operating vol	tage	VG			—	-1.2	-1.5	-2.0	V
"1" input volta	ge	V <sub>IH (1)</sub>	_	K <sub>3</sub> ~K <sub>10</sub> RESET	_	V <sub>G</sub> + 0.4	_	V <sub>G</sub>	V
"1" input volta	ge	V <sub>IH (2)</sub>	_	K <sub>11</sub> ~K <sub>14</sub>		V <sub>SS2</sub> + 0.4		V <sub>SS2</sub>	V
"0" input volta	ge	VIL	_	K <sub>3</sub> ~K <sub>14</sub> RESET	_	0	_	-0.4	V
"1" output volt	age	V <sub>OH (1)</sub>	_	SEGMENT COM1~3	_	V <sub>SS2</sub> + 0.2	_	V <sub>SS2</sub>	V
"0" output volt	age	V <sub>OL (1)</sub>		SEGMENT COM1~3	_	0	_	-0.2	V
"M" output vol	tage	V <sub>OM</sub>	_	COM1~3	_	V <sub>G</sub> + 0.2		V <sub>G</sub> – 0.2	V
"1" output volt	age	V <sub>OH (2)</sub>		K <sub>1</sub> ~K <sub>10</sub>	_	V <sub>G</sub> + 0.2		V <sub>G</sub>	V
"0" output voltage		V <sub>OL (2)</sub>	—	K <sub>1</sub> ~K <sub>14</sub>	—	0	_	-0.2	V
"1" output resi	istance	R <sub>OH</sub>	_	SEGMENT COM1~3	$V_{OUT} = V_{SS2} + 0.5 \text{ V}$	_	_	70	kΩ
"0" output resi	istance	R <sub>OL</sub>	_	SEGMENT COM1~3	$V_{OUT} = -0.5 V$	_	—	70	kΩ
	aistanaa	R <sub>KEYH (1)</sub>		RESET	$V_{OUT} = 0 V$	156		364	kΩ
Key pull up re	sistance	R <sub>KEYH (2)</sub>		K <sub>1</sub> ~K <sub>10</sub>	V <sub>OUT</sub> = 0 V	240		560	K12
Key read pull	up resistance	R <sub>KEYH (3)</sub>		K <sub>1</sub> ~K <sub>10</sub>	V <sub>OUT</sub> = 0 V	30		600	kΩ
Key pull dowr	n resistance	R <sub>KEYH</sub> (1)	_	RESET K <sub>1</sub> ~K <sub>10</sub>	V <sub>OUT</sub> = -0.5 V	_	_	10	kΩ
		R <sub>KEYH (2)</sub>		K <sub>11</sub> ~K <sub>14</sub>	$V_{OUT} = V_{SS2}$	120		800	
Oscillating	(WAIT)	føWAIT			$V_G = -1.5 V$	5.4	9.0	12.6	kHz
frequency	(OPERATE)	føOP	—		$V_{G} = -1.5 V$	28.8	48	67.2	
Frame freque	ncy	fF		SEGMENT COM1~3	$V_{G} = -1.5 V$	56.3	93.8	131	Hz
	1 (WAIT)	IDDWAIT			$V_{G} = -1.5 V$		2.2	3.4	
Supply current	2 (OPERATE)	IDDOP	_	_	$V_G = -1.2 V$	_	7.0	11.0	μA
	3 (OFF)	IDDOFF	_	_	$V_G = -1.5 V$	_	_	2.0	
Power off time	er times	Т	_		$V_{G} = -1.5 V$	429	600	1001	s

### Waveforms for Display



Note 1: At  $f\phi = 9 \text{ kHz}$ 

# JT6M57-AS

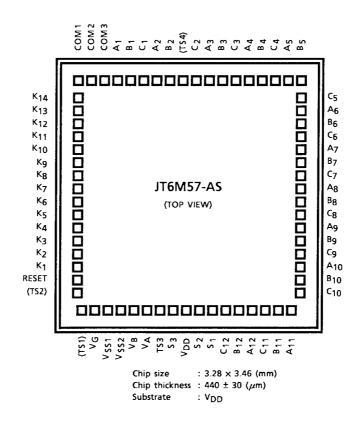
### **Pad Location Table**

Name	X Point	Y Point
(TS1)	-1367	-1469
VG	-1160	-1469
VSS1	-971	-1469
VSS2	-775	-1469
VB	-609	-1469
VA	-424	-1469
TS3	-252	-1469
S3	-100	-1469
VDD	52	-1469
S2	203	-1469
S1	355	-1469
C12	507	-1469
B12	659	-1469
A12	810	-1469
C11	980	-1469
B11	1162	-1469
A11	1358	-1469
C10	1408	-1193
B10	1408	-1042
A10	1408	-890
C9	1408	-738
B9	1408	-586
A9	1408	-435
C8	1408	-283
B8	1408	-131
A8	1408	20
C7	1408	172
B7	1408	324
A7	1408	475
C6	1408	627
B6	1408	779
A6	1408	936
C5	1408	1119
B5	1358	1469
A5	1169	1469
C4	999	1469
B4	847	1469
A4	696	1469

· · · · · ·		
Name	X Point	Y Point
C3	544	1469
B3	392	1469
A3	240	1469
C2	89	1469
(TS4)	-89	1469
B2	-240	1469
A2	-392	1469
C1	-544	1469
B1	-696	1469
A1	-847	1469
COM3	-999	1469
COM2	-1166	1469
COM1	-1358	1469
K14	-1408	1175
K13	-1408	1023
K12	-1408	871
K11	-1408	720
K10	-1408	503
K9	-1408	352
K8	-1408	200
K7	-1408	48
K6	-1408	-104
K5	-1408	-255
K4	-1408	-407
K3	-1408	-559
K2	-1408	-710
K1	-1408	-862
RESET	-1408	-1023
(TS2)	-1408	-1175

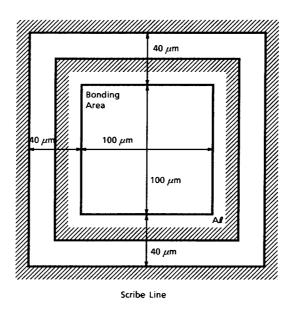
Note 2: ( ) Do not connect.

### **Chip Layout**



#### Pad Layout

**Active Element** 



PAD Pitch 160 µm

#### **RESTRICTIONS ON PRODUCT USE**

Handbook" etc..

- 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
- 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.