TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

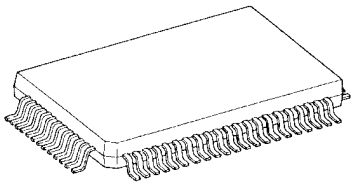
T6M45,JT6M45-AS

T6M45, JT6M45-AS CMOS Single-Chip LSI for LCD Calculator

The T6M45, JT6M45-AS is a single-chip microcomputer for 12-digit or 10-digit 2-memory calculator.

T6M45, JT6M45-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 T6M45, JT6M45-AS can selectable with a pin-programmable to function of Power timer and Memory hold.



QFP67-P-1420-0.80

Weight: 1.20 g (typ.)

Features

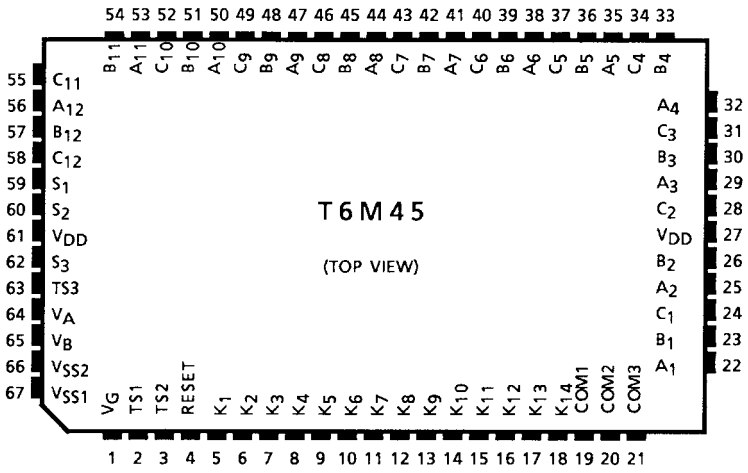
Operational Features:

- 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

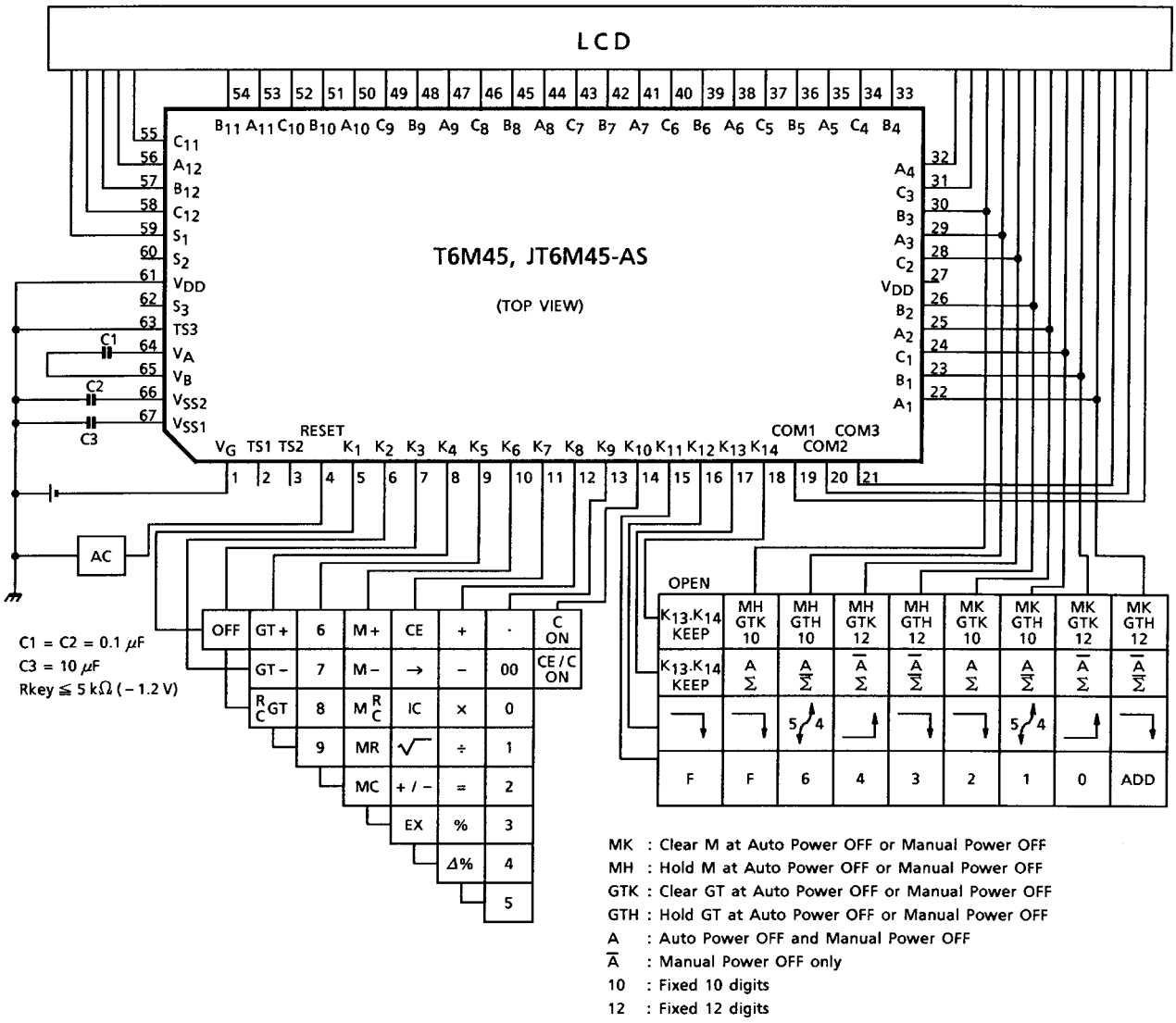
- Complementary output buffer for direct driving of liquid crystal display (F.E.M LCD).
- Oscillator/clock generator internal to chip.
- Keyboard encoding internal to chip.
- Keyboard denouncing internal to chip.
- Automatic power on clear.
- Wide supply voltage range (−1.2~−2.0 V).
- Very low power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

Pin Assignment (top view)



System Block Diagram

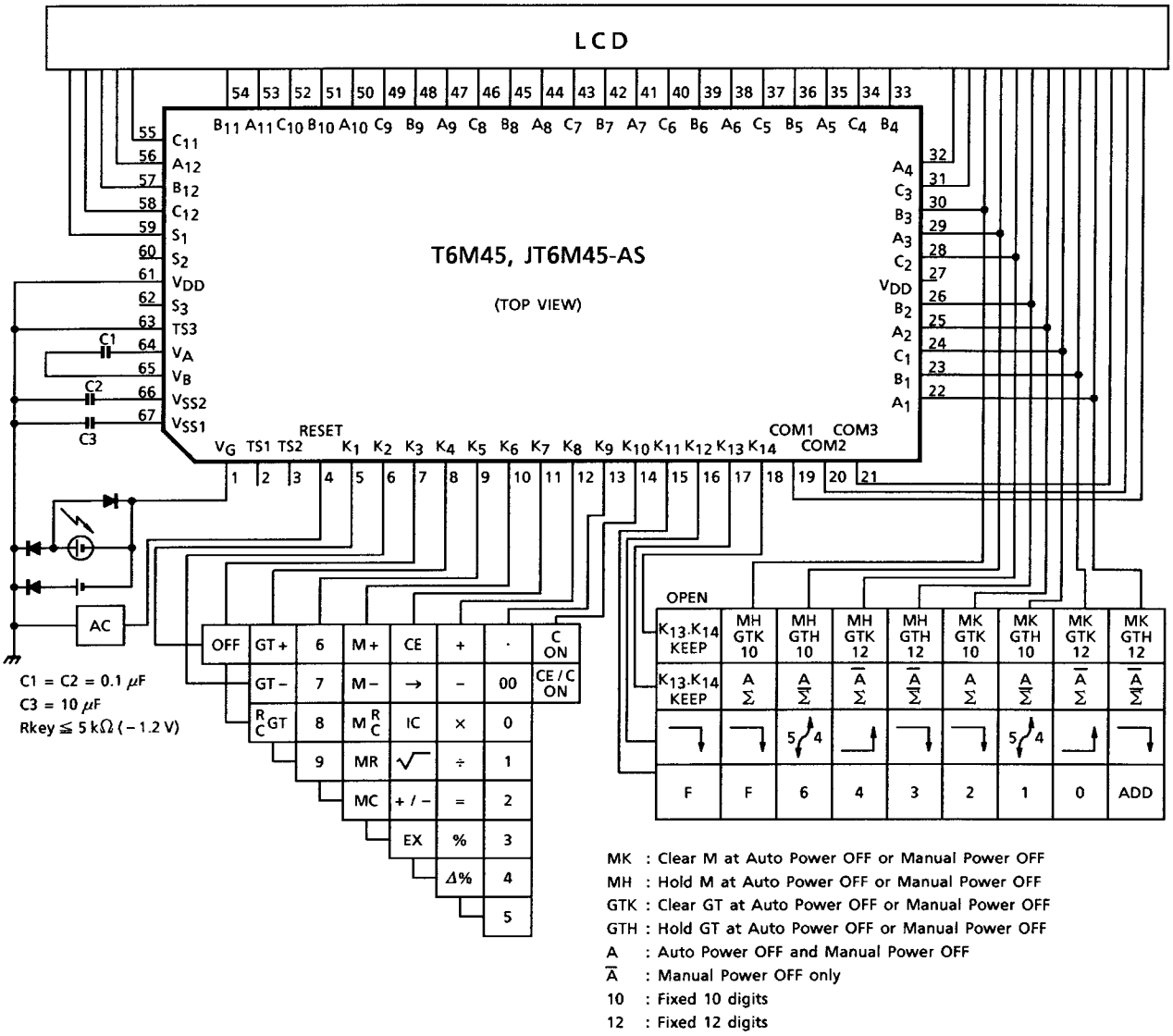
Battery Type



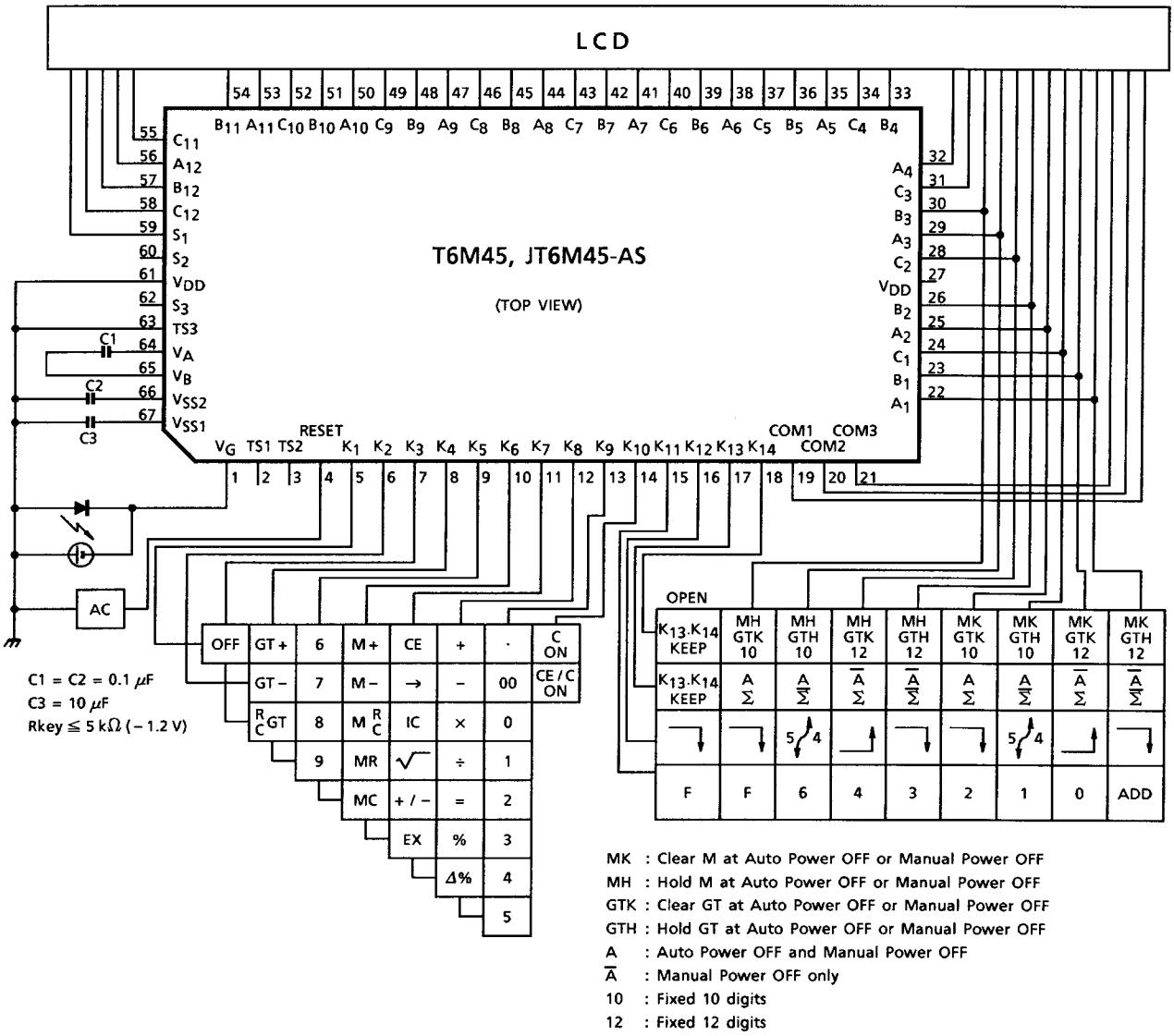
C1 = C2 = 0.1 μF
C3 = 10 μF
Rkey ≦ 5 kΩ (−1.2 V)

MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
GTK : Clear GT at Auto Power OFF or Manual Power OFF
GTH : Hold GT at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
10 : Fixed 10 digits
12 : Fixed 12 digits

Dual Type


LCD
T6M45, JT6M45-AS
(TOP VIEW)
C1 = C2 = 0.1 μF
C3 = 10 μF
Rkey ≦ 5 kΩ (−1.2 V)
OPEN
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
GTK : Clear GT at Auto Power OFF or Manual Power OFF
GTH : Hold GT at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
Ā : Manual Power OFF only
10 : Fixed 10 digits
12 : Fixed 12 digits

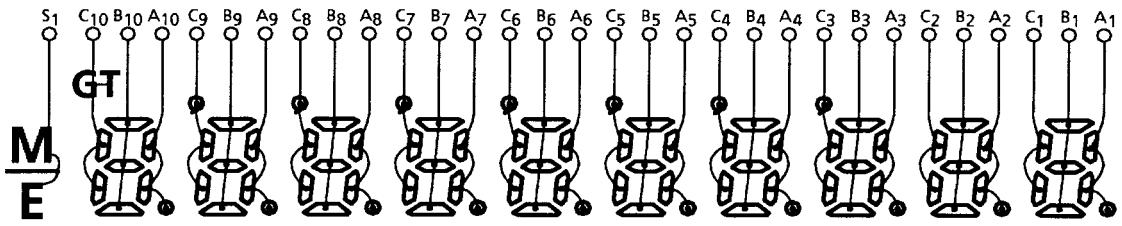
Solar Type


LCD
T6M45, JT6M45-AS
(TOP VIEW)
C1 = C2 = 0.1 μF
C3 = 10 μF
Rkey ≦ 5 kΩ (−1.2 V)
OPEN
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
GTK : Clear GT at Auto Power OFF or Manual Power OFF
GTH : Hold GT at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
Ā : Manual Power OFF only
10 : Fixed 10 digits
12 : Fixed 12 digits

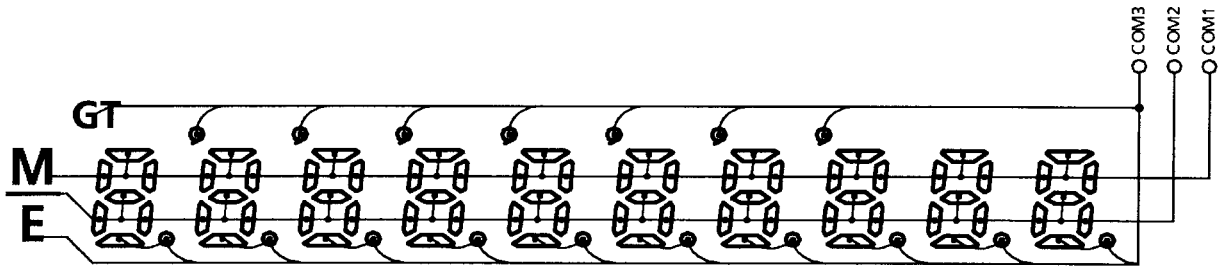
Connection of LCD

Select of 10 digits

Segment

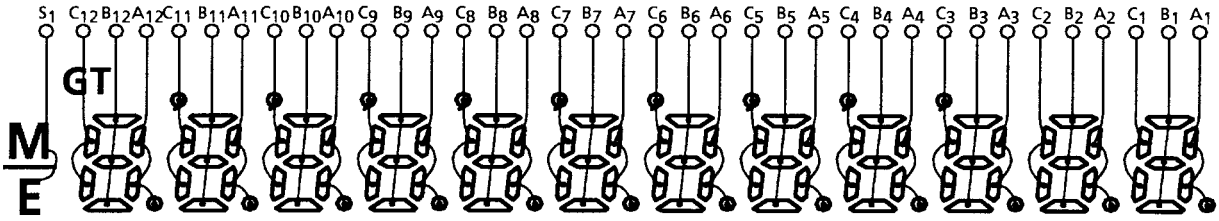


Common

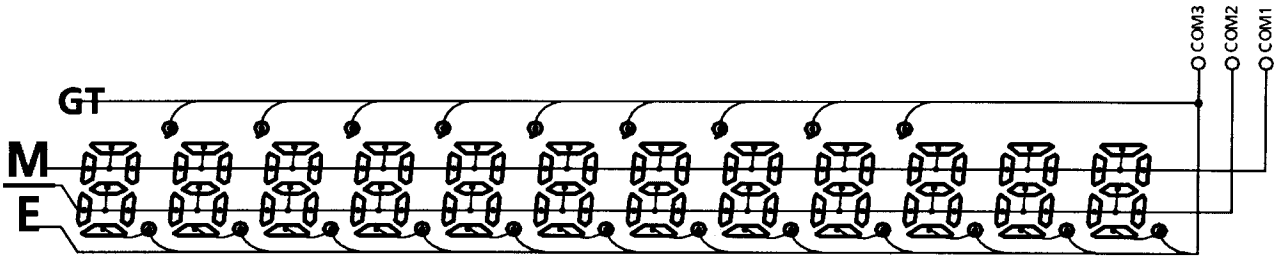


Select of 12 digits

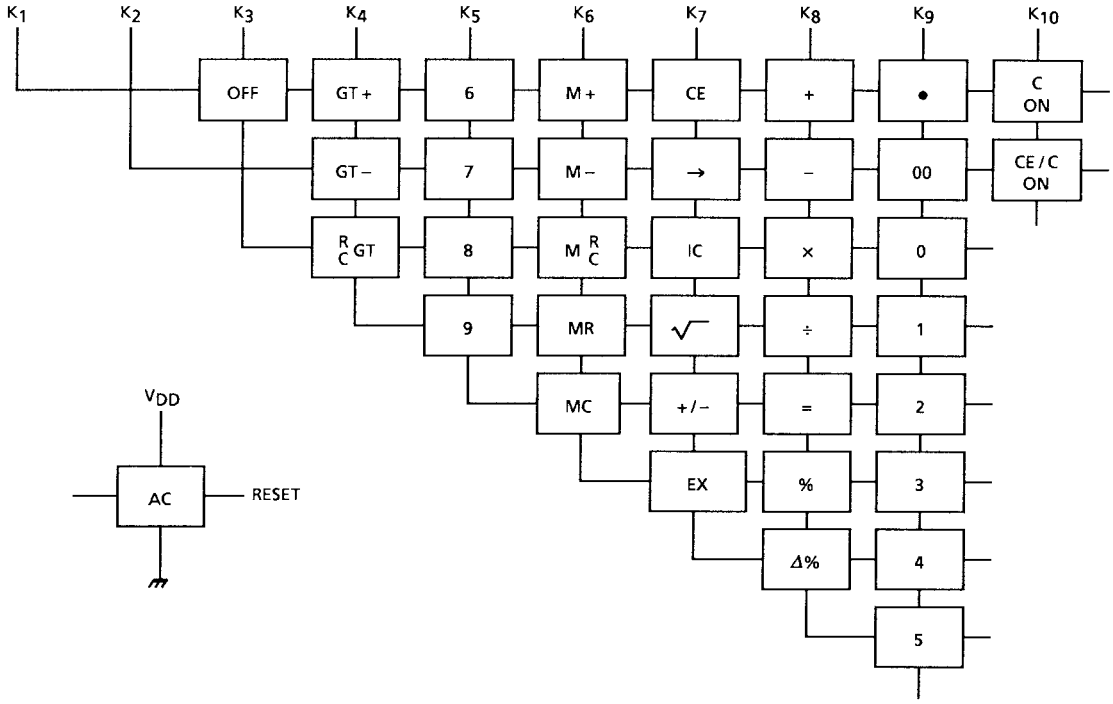
Segment



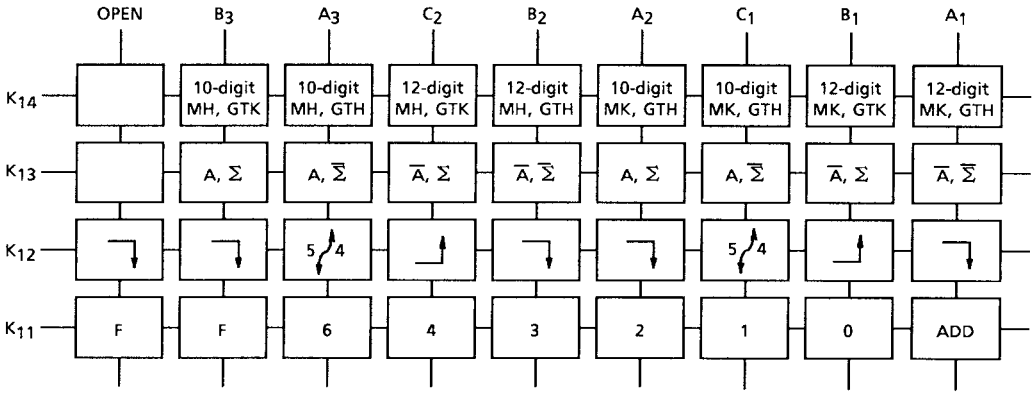
Common



Key Connection



Touch Key



Lock Key

K_{14}: 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.

K_{13}: Selectable with auto power OFF mode and total switch.

K_{12}: Rounding switches.

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

Specification of Calculator

Speed of Calculation (standard oscillating frequency fϕ = 48 kHz)

Numeral		11.8~17.7 ms
Function	1 [+]	25.6 ms
	1 [+] 2 [+]	95.2 ms
Addition and Subtract	1 2 3 [+] 1 [=]	89.1 ms
	9999999999 [−] 0.000000001 [=]	111.8 ms
Multiply	1 2 3 [×] 2 [=]	109.6 ms
	1 [×] 9999999999 [=]	207.7 ms
Device	1 2 3 [÷] 3 [=]	147.9 ms
	9999999999 [÷] 1 [=]	249.0 ms
Memory calculation	2 [M+]	143.3 ms
	9999999999 [÷] 1 [M+]	296.2 ms
Square root	9999999999 [√]	167.7 ms
	2 [√]	125.0 ms

Keys for Calculator

[0 0], [0]~[9]	: Number
[·]	
[+/−]	: Changer Sign
[+] [−] [×] [÷]	: Function
[=] [√] [%] [Δ%]	
[M+] [M−] [GT+] [GT−]	: Memory
[MC] [MR] [M R/C] [R/C GT]	
[EX]	: Exchange
[→]	: Shift
[IC]	: Item Counter
[CE] [CE/C (ON)] [C (ON)]	: Clear
[OFF]	: OFF
[AC]	: SYSTEM RESET

Operation Example

1. Fixed Point Calculation

(1)

Key	Display	Fixed Point Place
C	0.	DP = 3 (5 / 4)
2	2.	
÷	2.	
3	3.	
=	0.667	
2	2.	
·	2.	
3	2.3	
+	2.3	
4	4.	
M+	6.300	
1	1.	
·	1.	
2	1.2	
M+	1.200	
MR	7.5	

(2)

Key	Display	Fixed Point Place
C	0.	DP = 0 (⊥↑)
1	1.	
·	1.	
2	1.2	
3	1.23	
+	1.23	
1	1.	
·	1.	
1	1.1	
=	3.	
9	9.	
√	3.	
×	3.	
1	1.	
·	1.	
1	1.1	DP = F
=	3.3	

2. Adding Point Mode Calculation

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
2	2.

Key	Display
M+	0.02M
3	3.M
·	3.M
123	3.123M
M+	3.12M
MR	3.14M
C	0.M
1	1.M
23	123.M
−	1.23M
3	3.M
4	34.M
·	34.M
5	34.5M

Key	Display
=	33.27M −
2	2.M
+	0.02M
9	9.M
·	9.M
√	3.M
=	3.02M

3. Constant Calculation

(1) Multiplication

Key	Display	Constant
k	k	
×	k	
a	a	
=	k·a	k×
b	b	k×
=	k·b	k×

(2) Division

Key	Display	Constant
a	a	
÷	a	
k	k	
=	a / k	÷k
b	b	÷k
=	b / k	÷k

(3) Addition

a	a	
+	a	
k	k	
=	a + k	+k
b	b	+k
=	b + k	+k

(4) Subtraction

a	a	
−	a	
k	k	
=	a − k	−k
b	b	−k
=	b − k	−k

(5) Percentage

k	k	
×	k	
a	a	
%	k·a / 100	k×
b	b	k×
%	k·b / 100	k×

(6) Percentage

a	a	
÷	a	
k	k	
%	100·a / k	+k
b	b	÷k
%	100·b / k	÷k

(7) Add-on

k	k	
+	k	
a	a	
%	k·(1 + a / 100)	k+
b	b	k+
%	k·(1 + b / 100)	k+

(8) Discount

k	k	
−	k	
a	a	
%	k·(1 − a / 100)	k−
b	b	k−
%	k·(1 − b / 100)	k−

4. Δ% Calculation

(1)

Key	Display
a	a
[+]	a
b	b
[Δ%]	100·(a + b)/b

(2)

Key	Display
a	a
[−]	a
b	b
[Δ%]	100·(a − b)/b

5. Mark-Up, Mark-Down Calculation

(1) Mark-up

Key	Display
a	a
[÷]	a
b	b
[Δ%]	a/(1 − b/100)
[Δ%]	|a/(1 − b/100) − a|

(2) Mark-down

Key	Display
a	a
[÷]	a
b	b
[+/−]	−b
[Δ%]	a/(1 + b/100)
[Δ%]	|a/(1 + b/100) − a|

6. Add-On, Discount Calculation

Add-on

(1)

Key	Display
a	a
[×]	a
b	b
[%]	a·b/100
[+]	a·b/100
[=]	a(1 + b/100)

(3)

Key	Display
a	a
[+]	a
b	b
[%]	a(1 + b/100)

(5)

Key	Display
a	a
[×]	a
b	b
[Δ%]	a(1 + b/100)

Discount

(2)

Key	Display
a	a
[×]	a
b	b
[%]	a·b/100
[−]	a·b/100
[=]	a(1 − b/100)

(4)

Key	Display
a	a
[−]	a
b	b
[%]	a(1 − b/100)

(6)

Key	Display
a	a
[×]	a
b	b
[+/−]	−b
[Δ%]	a(1 − b/100)

7. Average Operation Use of the Item Counter

Key	Display	Item Counter
A	A	0
+	A	1
B	B	1
+	A + B	2
C	C	2
+	A + B + C	3
D	D	3
+	A + B + C + D	4

Key	Display	Item Counter
−	A + B + C + D	2
D	D	2
+	A + B + C	3
E	E	3
=	A + B + C + E	4
÷	A + B + C + E	4
IC	4	4
=	(A + B + C + E) / 4	5

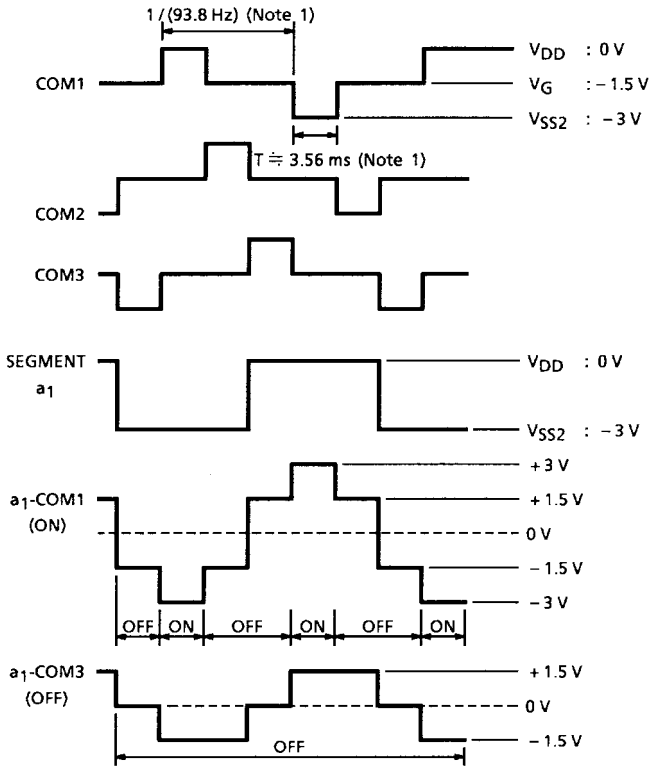
Maximum Ratings

Characteristics	Symbol	Rating	Unit
Supply voltage	V_G	+0.3~−2.0	V
Input voltage	V_{IN}	+0.3~V_G − 0.3	V
Operating temperature	T_{opr}	0~40	°C
Storage temperature	T_{stg}	−55~125	°C

Electrical Characteristics (V_G = –1.5 ± 0.2 V, V_{SS2} = –3.0 ± 0.4 V, V_{DD} = 0 V, Ta = 25°C)

Characteristics		Symbol	Test Circuit	Pin Name	Test Condition	Min	Typ.	Max	Unit
Operating voltage		V_G	—	—	—	−1.2	−1.5	−2.0	V
“1” input voltage		$V_{IH\ (1)}$	—	K_3~K_{10} RESET	—	V_G + 0.4	—	V_G	V
“1” input voltage		$V_{IH\ (2)}$	—	K_{11}~K_{14}	—	V_{SS2} + 0.4	—	V_{SS2}	V
“0” input voltage		V_{IL}	—	K_3~K_{14} RESET	—	0	—	−0.4	V
“1” output voltage		$V_{OH\ (1)}$	—	SEGMENT COM1~3	—	V_{SS2} + 0.2	—	V_{SS2}	V
“0” output voltage		$V_{OL\ (1)}$	—	SEGMENT COM1~3	—	0	—	−0.2	V
“M” output voltage		V_{OM}	—	COM1~3	—	V_G + 0.2	—	V_G − 0.2	V
“1” output voltage		$V_{OH\ (2)}$	—	K_1~K_{10}	—	V_G + 0.2	—	V_G	V
“0” output voltage		$V_{OL\ (2)}$	—	K_1~K_{14}	—	0	—	−0.2	V
“1” output resistance		R_{OH}	—	SEGMENT COM1~3	V_{OUT} = V_{SS2} + 0.5 V	—	—	70	kΩ
“0” output resistance		R_{OL}	—	SEGMENT COM1~3	V_{OUT} = −0.5 V	—	—	70	kΩ
Key pull up resistance		$R_{KEYH\ (1)}$	—	RESET	V_{OUT} = 0 V	156	—	364	kΩ
		$R_{KEYH\ (2)}$	—	K_1~K_{10}	V_{OUT} = 0 V	240	—	560	
Key read pull up resistance		$R_{KEYH\ (3)}$	—	K_1~K_{10}	V_{OUT} = 0 V	30	—	600	kΩ
Key pull down resistance		$R_{KEYL\ (1)}$	—	RESET K_1~K_{10}	V_{OUT} = −0.5 V	—	—	10	kΩ
		$R_{KEYH\ (2)}$	—	K_{11}~K_{14}	V_{OUT} = V_{SS2}	120	—	800	
Oscillating frequency	(WAIT)	fϕWAIT	—	—	V_G = −1.5 V	5.4	9.0	12.6	kHz
	(OPERATE)	fϕOP	—	—	V_G = −1.5 V	28.8	48	67.2	
Frame frequency		f_F	—	SEGMENT COM1~3	V_G = −1.5 V	56.3	93.8	131	Hz
Supply current	1 (WAIT)	I_{DDWAIT}	—	—	V_G = −1.5 V	—	2.2	3.4	μA
	2 (OPERATE)	I_{DDOP}	—	—	V_G = −1.2 V	—	7.0	11.0	
	3 (OFF)	I_{DDOFF}	—	—	V_G = −1.5 V	—	—	2.0	
Power off timer times		T	—	—	V_G = −1.5 V	429	600	1001	s

Waveforms for Display



Note 1: At f_ϕ = 9 kHz

Pad Location Table

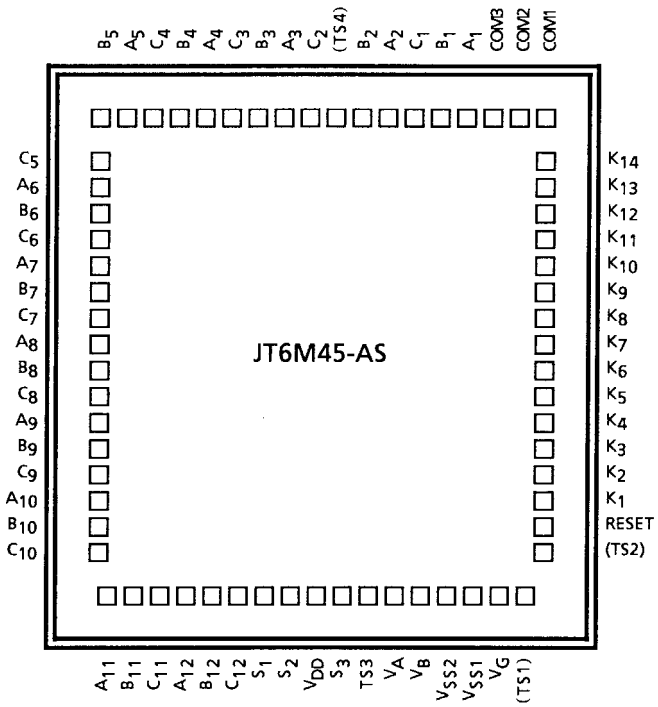
(μm)

Name	X Point	Y Point
V_{SS1}	971	−1469
V_{SS2}	775	−1469
V_B	609	−1469
V_A	424	−1469
TS3	252	−1469
S_3	100	−1469
V_{DD}	−52	−1469
S_2	−203	−1469
S_1	−355	−1469
C_{12}	−507	−1469
B_{12}	−659	−1469
A_{12}	−810	−1469
C_{11}	−980	−1469
B_{11}	−1162	−1469
A_{11}	−1358	−1469
C_{10}	−1408	−1193
B_{10}	−1408	−1042
A_{10}	−1408	−890
C_9	−1408	−738
B_9	−1408	−586
A_9	−1408	−435
C_8	−1408	−283
B_8	−1408	−131
A_8	−1408	20
C_7	−1408	172
B_7	−1408	324
A_7	−1408	475
C_6	−1408	627
B_6	−1408	779
A_6	−1408	936
C_5	−1408	1119
B_5	−1358	1469
A_5	−1169	1469

Name	X Point	Y Point
C_4	−999	1469
B_4	−847	1469
A_4	−696	1469
C_3	−544	1469
B_3	−392	1469
A_3	−240	1469
C_2	−89	1469
(TS4)	89	1469
B_2	241	1469
A_2	392	1469
C_1	544	1469
B_1	696	1469
A_1	847	1469
COM3	999	1469
COM2	1166	1469
COM1	1358	1469
K_{14}	1408	1175
K_{13}	1408	1023
K_{12}	1408	871
K_{11}	1408	720
K_{10}	1408	503
K_9	1408	352
K_8	1408	200
K_7	1408	48
K_6	1408	−104
K_5	1408	−255
K_4	1408	−407
K_3	1408	−559
K_2	1408	−710
K_1	1408	−862
RESET	1408	−1023
(TS2)	1408	−1175
(TS1)	1367	−1469
V_G	1160	−1469

Note 2: ( ) Do not connect.

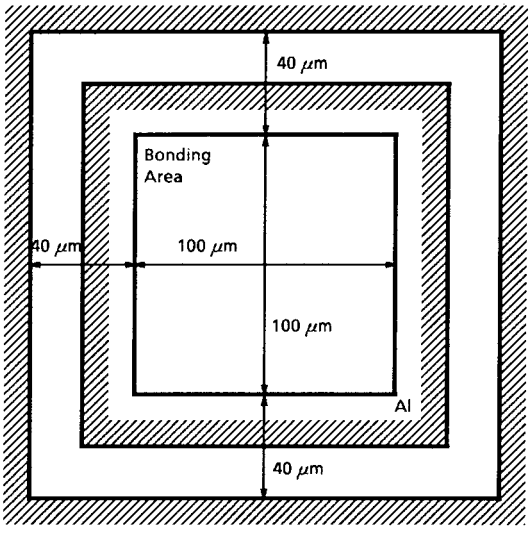
Chip Layout



Chip size : 3.28 x 3.46 (mm)
Chip thickness : 440 ± 30 μm
Substrate : V_{DD}

Pad Layout

Active Element

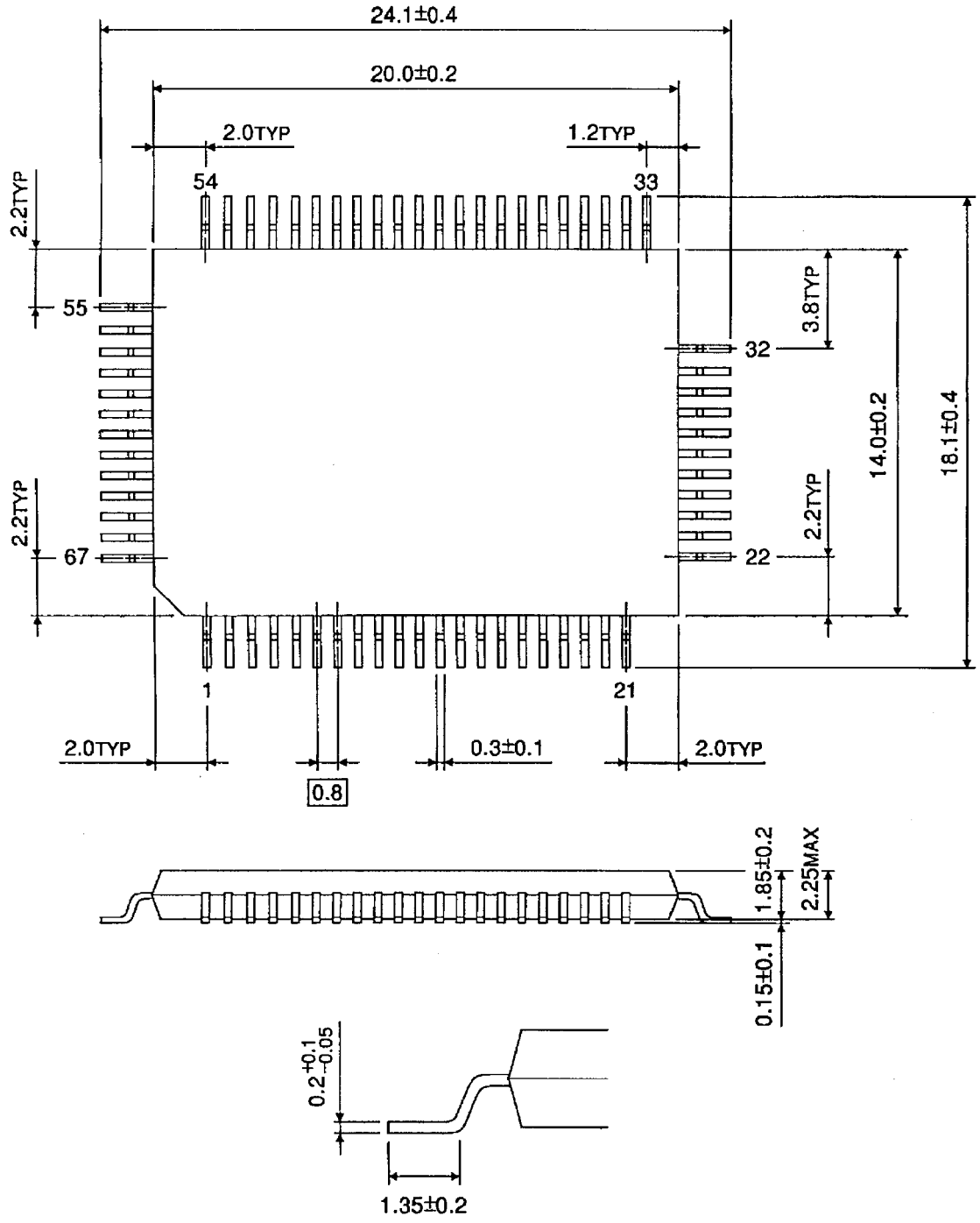


Scribe Line

PAD Pitch 160 μm

Package Dimensions

QFP67-P-1420-0.80 Unit : mm



Weight: 1.20 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.