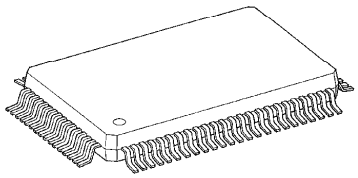
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

T6M23A, JT6M23A-AS

T6M23A, JT6M23A-AS CMOS 1 CHIP LSI FOR LCD ELECTRONIC CALCULATOR

The T6M23A, JT6M23A-AS is a CMOS 1 chip microcomputer for 14-digits capacity 2-memory or 12-digits capacity 2-memory electronic calculation.
T6M23A, JT6M23A-AS is the complete single chip CMOS LSI for electronic calculator with single power supply operation.
Wide operating voltage range and low power consumption make it suitable for 1.5V solar battery operated.
Besides T6M23A, JT6M23A-AS can selectable with a pin-programmable to function of Power timer and Memory hold. With the following features.



QFP80-P-1420-0.80A
Weight : 1.52g (Typ.)

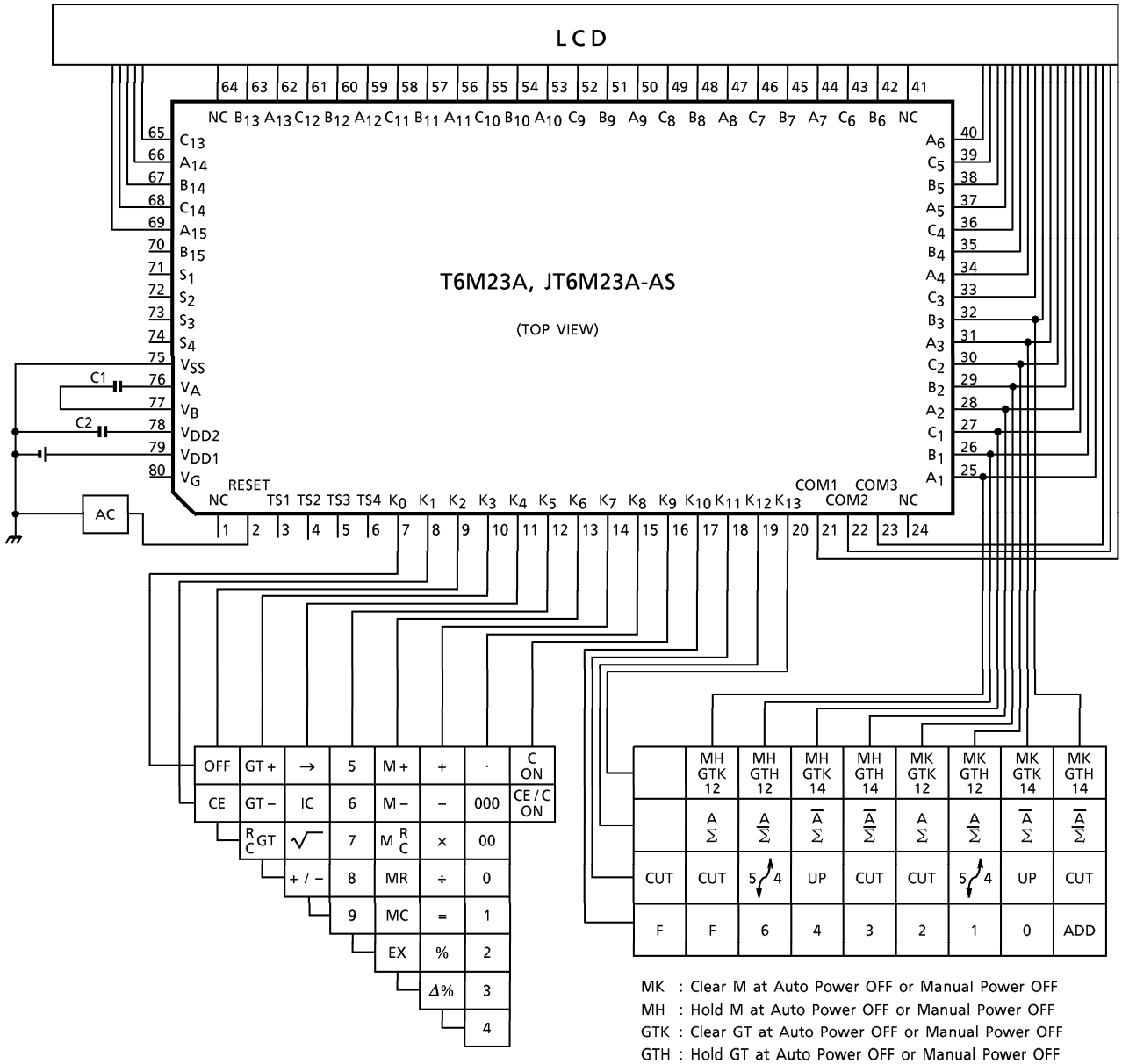
FEATURES

- Display : 14-digits or 12-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 markdown operations.
- Square root.
- Constant calculation.
- Chain calculation.
- Change sign.
- Floating point or momentary mode (selectable with a switch).
- 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.
- Key roll over function.
- Floating minus.

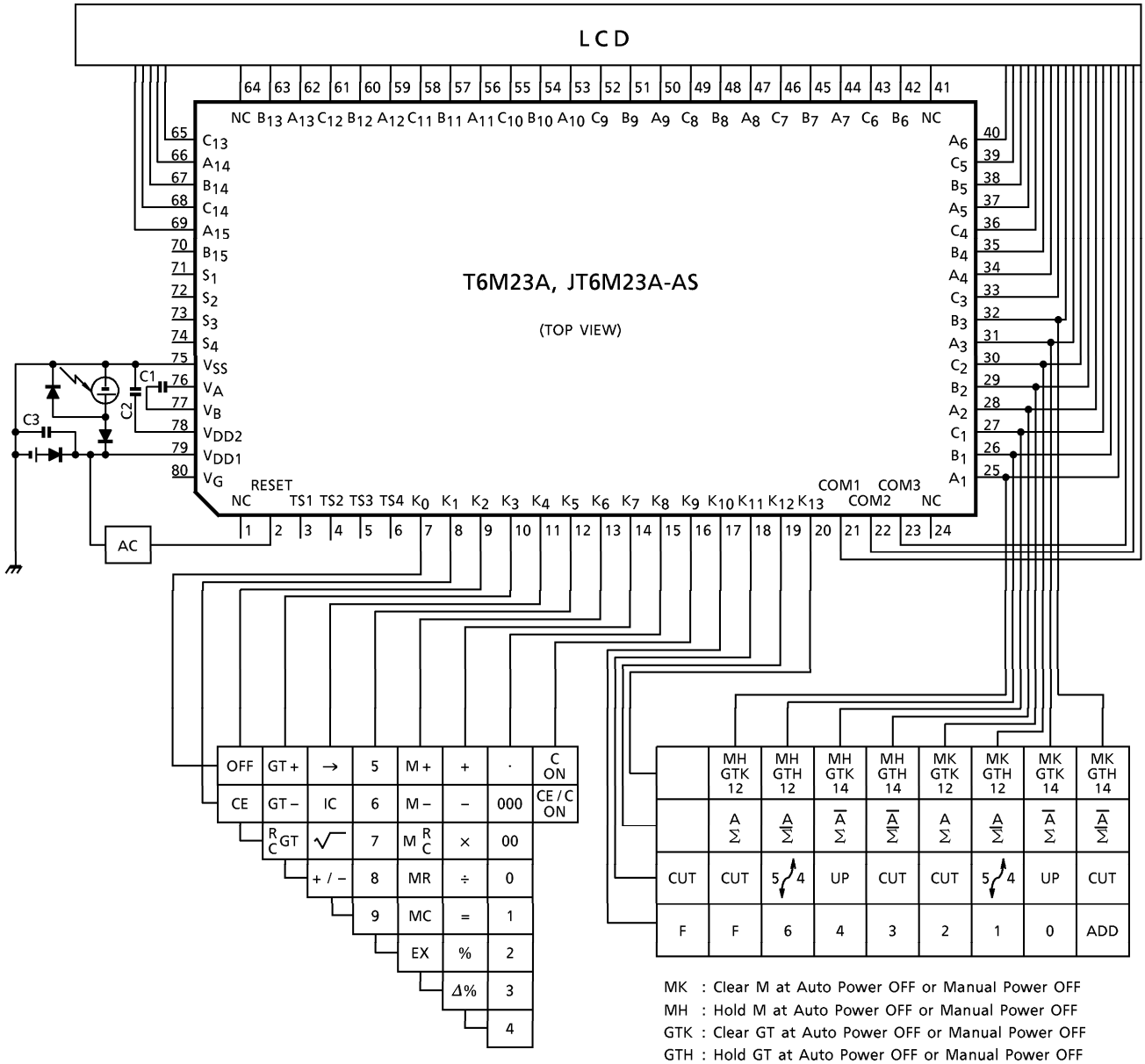
SYSTEM BLOCK DIAGRAM

Battery Type



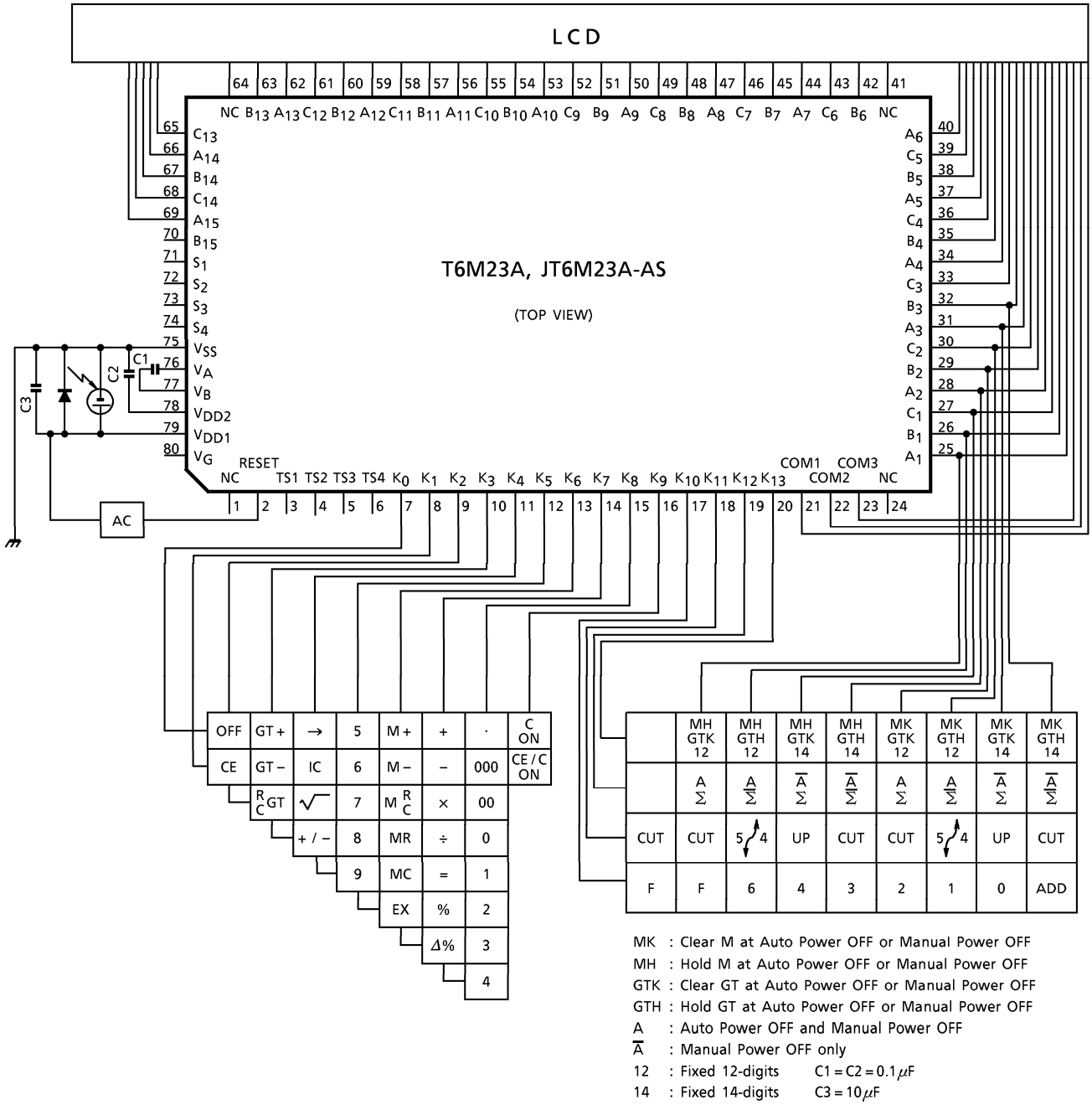
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
GTK : Clear GT at Auto Power OFF or Manual Power OFF
GTH : Hold GT at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
12 : Fixed 12-digits C1 = C2 = 0.1 μF
14 : Fixed 14-digits

Dual Type



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
12 : Fixed 12-digits C1 = C2 = 0.1 μF
14 : Fixed 14-digits C3 = 10 μF

Solar Type

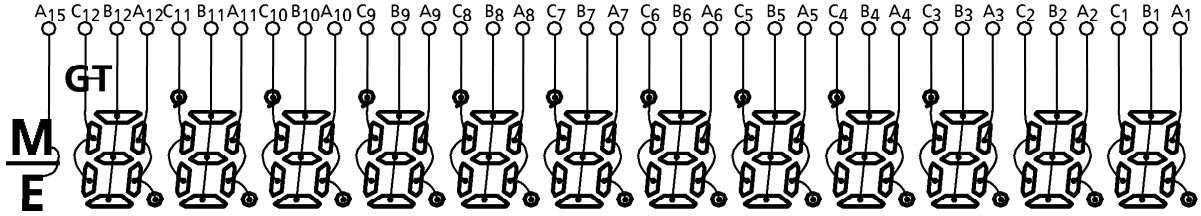


MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
GTK : Clear GT at Auto Power OFF or Manual Power OFF
GTH : Hold GT at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
12 : Fixed 12-digits $C1 = C2 = 0.1\mu F$
14 : Fixed 14-digits $C3 = 10\mu F$

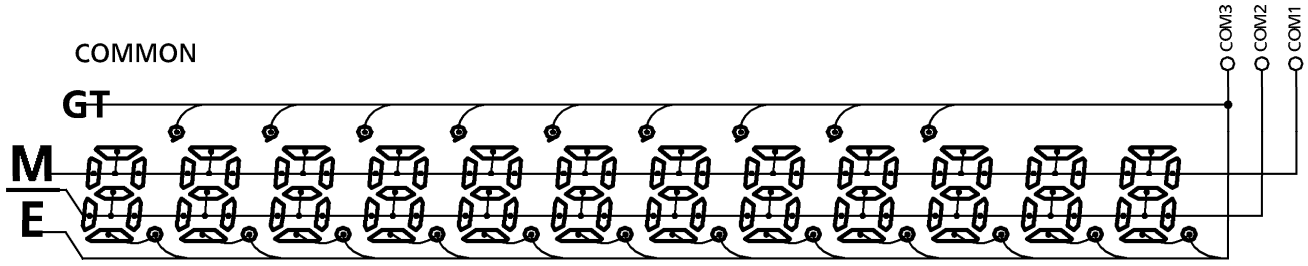
CONNECTION OF LCD

(1) Select of 12-digits

SEGMENT

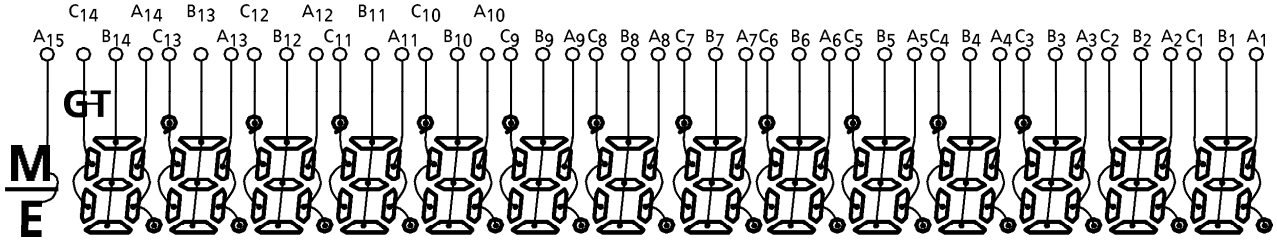


COMMON

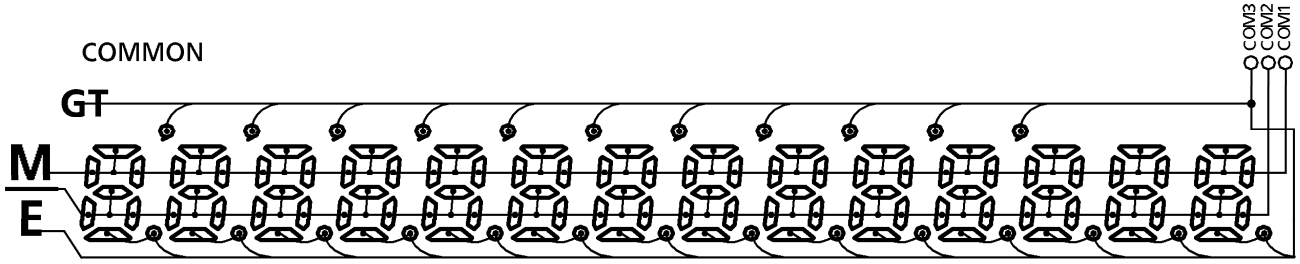


(2) Select of 14-digits

SEGMENT

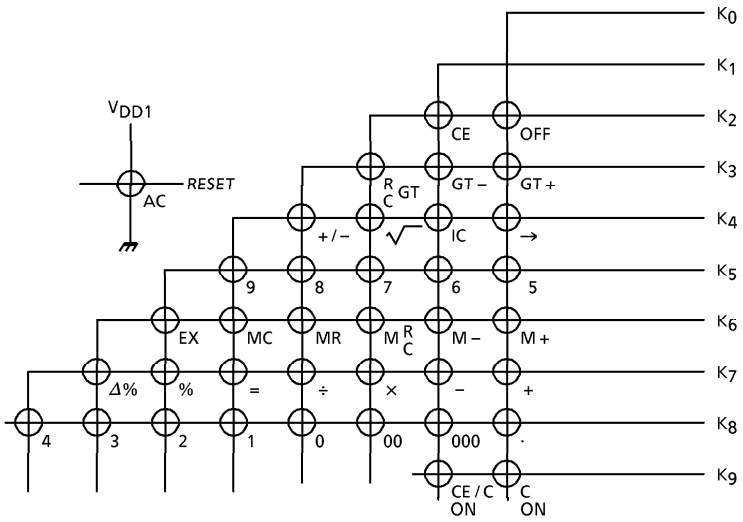


COMMON

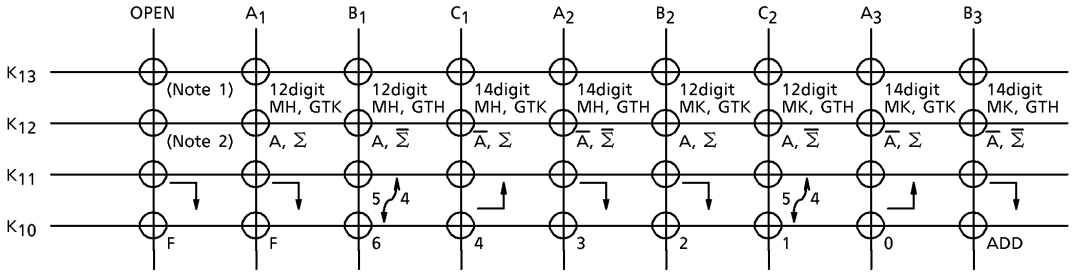


KEY LAYOUT

- Touch key



- Lock key

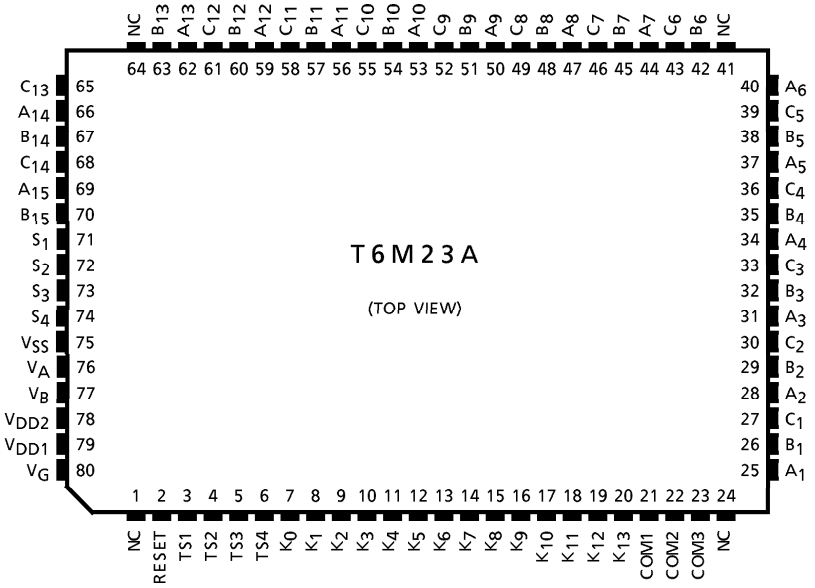


K_{13} ... Selectable with Calculated Digits and Memory Hold Status.
MH (Memory Hold), MK (Memory Kill), GTH (GT memory Hold) and GTK (GT memory Kill) at Auto Power OFF or OFF Key.
K_{12} ... Selectable with Auto Power OFF mode and Total switch.
K_{11} ... Rounding switches.
K_{10} ... Selectable with Fixed point or Floating mode.

(Note 1, Note 2)

K_{12} or K_{13} line is No choose then keep condition.
K_{12} or K_{13} line is No choose at the system power on then initial condition is 12-digits $\overline{A}$, $\overline{\Sigma}$ Mode selected.

PIN LAYOUT



SPECIFICATION OF CALCULATOR

Speed of calculation

Numeral		22.4~38.5ms
Function	1 [+]	45.5ms
	1 [+] 2 [+]	80.7ms
Addition and Subtract	1 2 3 [+] 1 [=]	106.2ms
	99999999999999 [−] 0.0000000000001 [=]	135.4ms
Multiply	1 2 3 [×] 2 [=]	125.9ms
	1 [×] 99999999999999 [=]	291.9ms
Device	1 2 3 [÷] 3 [=]	171.2ms
	99999999999999 [÷] 1 [=]	334.8ms
Memory calculation	2 [M+]	90.5ms
	99999999999999 [÷] 1 [M+]	329.1ms
Square root	99999999999999 [√]	132.6ms
	2 [√]	131.7ms

Operation Example

1. Fixed point calculations

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	DP = 4

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 calculations

Key	Display	Key	Display	Key	Display
C	0.	M+	0.02M	=	33.27M –
1	1.	3	3.M	2	2.M
23	123	·	3.M	+	0.02M
+	1.23	123	3.123M	9	9.M
3	3.	M+	3.12M	·	9.M
=	1.26	MR	3.14M	√	3.M
3	3.	C	0.M	=	3.02M
2	32.	1	1.M		
×	32.	23	123M		
3	3.	–	1.23M		
·	3.	3	3.M		
000	3.000	4	34.M		
=	96.00	·	34.M		
2	2.	5	34.5M		

3. Constant calculations

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

Key	Display	Constant
k	k	
[×]	k	
a	a	
[%]	k·a / 100	k ×
b	b	k ×
[%]	k·b / 100	k ×

⑥ Percentage

Key	Display	Constant
a	a	
[÷]	a	
k	k	
[%]	100·a / k	÷ k
b	b	÷ k
[%]	100·b / k	÷ k

⑦ Add-on

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

⑧ Discount

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

4. Δ% calculations

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 calculations

① Mark-up

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

② Mark-down

Key	Display
a	a
[÷]	a
b	b
[+/−]	− b
[Δ%]	a / (1 + b / 100)
[Δ%]	a / (1 + b / 100) − a1

6. Add-on, discount calculations

Add-on

	Key	Display
①	a	a
	[×]	a
	b	b
	[%]	a·b / 100
	[+]	a·b / 100
	[=]	a (1 + b / 100)
③	a	a
	[+]	a
	b	b
	[%]	a (1 + b / 100)
⑤	a	a
	[×]	a
	b	b
	[Δ%]	a·(1 + b / 100)

Discount

	Key	Display
②	a	a
	[×]	a
	b	b
	[%]	a·b / 100
	[−]	a·b / 100
	[=]	a (1 − b / 100)
④	a	a
	[−]	a
	b	b
	[%]	a (1 − b / 100)
⑥	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

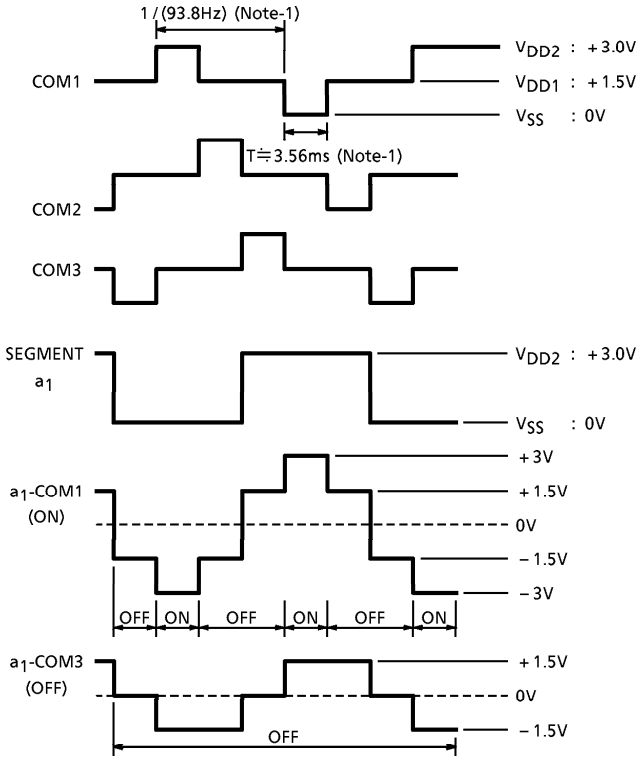
ITEM	SYMBOL	LIMITS	UNIT
Supply Voltage	V_{DD1}	−0.3~2.0	V
Input Voltage	V_{IN}	−0.3~V_{DD1}+0.3	V
Operating Temperature	T_{opr}	0~40	°C
Storage Temperature	T_{stg}	−55~125	°C

ELECTRICAL CHARACTERISTICS (V_{DD1} = 1.5±0.2V, V_{DD2} = 3.0±0.4V, V_{SS} = 0V, Ta = 25°C)

ITEM	SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	V_{DD1}	—	—	—	1.2	1.5	2.0	V
"1" Input Voltage	V_{IH} (1)	—	K_2~K_9 RESET	—	V_{DD1} −0.4	—	V_{DD1}	V
"1" Input Voltage	V_{IH} (2)	—	K_{10}~K_{13}	—	V_{DD2} −0.4	—	V_{DD2}	V
"0" Input Voltage	V_{IL}	—	K_2~K_{13} RESET	—	0	—	0.4	V
"1" Output Voltage	V_{OH} (1)	—	SEGMENT COM1~3	—	V_{DD2} −0.2	—	V_{DD2}	V
"0" Output Voltage	V_{OL} (1)	—	SEGMENT COM1~3	—	0	—	0.2	V
"M" Output Voltage	V_{OM}	—	COM1~3	—	V_{DD1} −0.2	—	V_{DD1} +0.2	V
"1" Output Voltage	V_{OH} (2)	—	K_1~K_9	—	V_{DD1} −0.2	—	V_{DD1}	V
"0" Output Voltage	V_{OL} (2)	—	K_1~K_{13}	—	0	—	0.2	V
"1" Output Resistance	R_{OH}	—	SEGMENT COM1~3	V_{OUT} = V_{DD2} − 0.5V	—	—	70	kΩ
"0" Output Resistance	R_{OL}	—	SEGMENT COM1~3	V_{OUT} = 0.5V	—	—	70	kΩ
KEY Pull Up Resistance	R_{KEYH} (1)	—	RESET	V_{OUT} = V_{DD1} − 0.5V	—	—	25	kΩ
	R_{KEYH} (2)	—	K_0~K_9	V_{OUT} = V_{DD1} − 0.5V	—	—	14	kΩ
	R_{KEYH} (3)	—	K_{10}~K_{13}	V_{OUT} = 0V	120	—	800	kΩ
KEY Pull Down Resistance	R_{KEYL} (1)	—	RESET (1)	V_{OUT} = V_{DD1}	100	—	300	kΩ
	R_{KEYL} (2)	—	RESET (2)	V_{OUT} = V_{DD1}	18	—	300	kΩ
	R_{KEYL} (3)	—	K_0~K_9 (1)	V_{OUT} = 0.5V	—	—	50	kΩ
	R_{KEYL} (4)	—	K_0~K_9 (2)	V_{OUT} = V_{DD1}	72	—	170	kΩ
Oscillating (WAIT)	$f\phi$WAIT	—	—	V_{DD1} = 1.5V	5.4	9.0	15.5	kHz
Frequency (OPERATE)	$f\phi$OP	—	—	V_{DD1} = 1.5V	20.0	34	61.3	kHz
Frame Frequency	f_F	—	SEGMENT COM1~3	V_{DD1} = 1.5V	56.3	93.8	161.5	Hz

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	1 (WAIT)	I_{DDWAIT}	—	—	V_{DD1} = 1.5V	—	—	3.3	μA
	2 (OPERATE)	I_{DDOP}	—	—	V_{DD1} = 1.2V	—	—	8.9	μA
	3 (OFF)	I_{DDOFF}	—	—	V_{DD1} = 1.5V	—	—	2.0	μA
Power Off Timer Times		T	—	—	V_{DD1} = 1.5V	429	600	1001	s

WAVEFORMS FOR DISPLAY



(Note-1) at f_ϕ = 9kHz

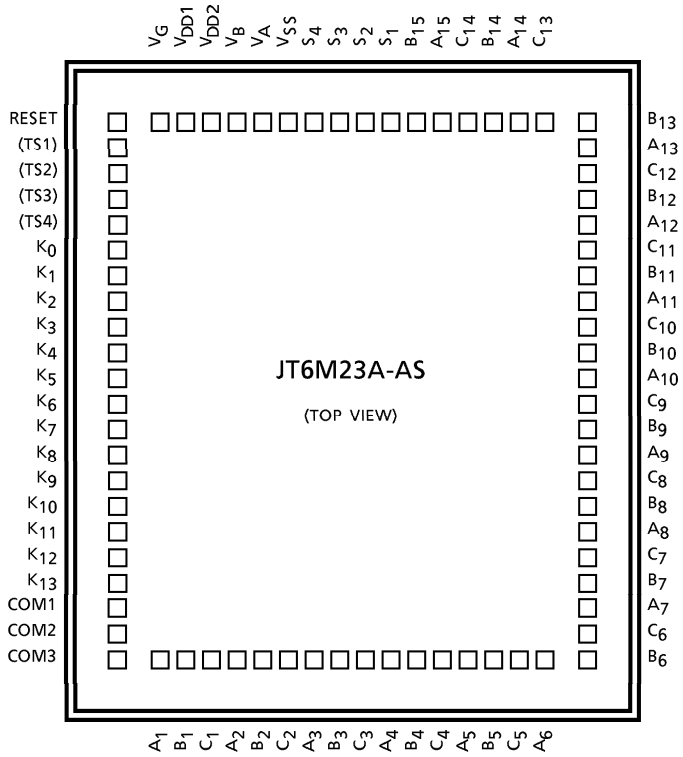
PAD LOCATION TABLE (μm)

NAME	X POINT	X POINT
COM3	– 1757	– 1680
COM2	– 1757	– 1520
COM1	– 1757	– 1360
K_{13}	– 1757	– 1200
K_{12}	– 1757	– 1040
K_{11}	– 1757	– 880
K_{10}	– 1757	– 720
K_9	– 1757	– 560
K_8	– 1757	– 400
K_7	– 1757	– 240
K_6	– 1757	– 80
K_5	– 1757	80
K_4	– 1757	240
K_3	– 1757	400
K_2	– 1757	560
K_1	– 1757	720
K_0	– 1757	880
*(TS4)	– 1757	1040
*(TS3)	– 1757	1200
*(TS2)	– 1757	1360
*(TS1)	– 1757	1520
RESET	– 1757	1680
V_G	– 1388	1753
V_{DD1}	– 1151	1753
V_{DD2}	– 991	1753
V_B	– 831	1753
V_A	– 671	1753
V_{SS}	– 511	1753
S_4	– 351	1753
S_3	– 191	1753
S_2	– 31	1753
S_1	129	1753
B_{15}	289	1753
A_{15}	449	1753
C_{14}	609	1753
B_{14}	769	1753
A_{14}	929	1753
C_{13}	1089	1753

NAME	X POINT	X POINT
B_{13}	1757	1680
A_{13}	1757	1520
C_{12}	1757	1360
B_{12}	1757	1200
A_{12}	1757	1040
C_{11}	1757	880
B_{11}	1757	720
A_{11}	1757	560
C_{10}	1757	400
B_{10}	1757	240
A_{10}	1757	80
C_9	1757	– 80
B_9	1757	– 240
A_9	1757	– 400
C_8	1757	– 560
B_8	1757	– 720
A_8	1757	– 880
C_7	1757	– 1040
B_7	1757	– 1200
A_7	1757	– 1360
C_6	1757	– 1520
B_6	1757	– 1680
A_6	1278	– 1752
C_5	1118	– 1752
B_5	958	– 1752
A_5	798	– 1752
C_4	638	– 1752
B_4	478	– 1752
A_4	318	– 1752
C_3	158	– 1752
B_3	– 2	– 1752
A_3	– 162	– 1752
C_2	– 322	– 1752
B_2	– 482	– 1752
C_2	– 642	– 1752
C_1	– 802	– 1752
B_1	– 962	– 1752
A_1	– 1122	– 1752

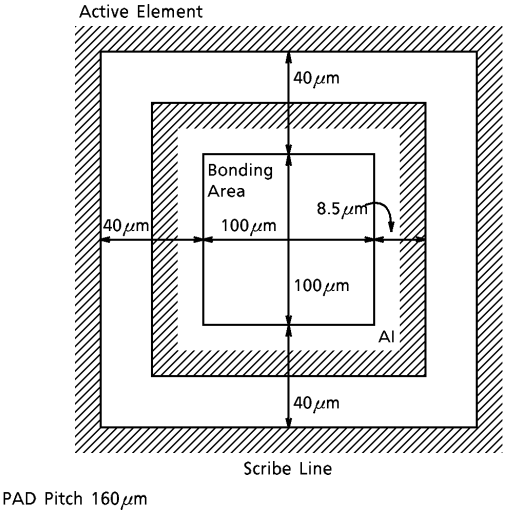
*( ) Do not connect.

CHIP LAYOUT



Chip size : 3.79×3.84 (mm)
Chip thickness : 440±30 (μm)
Substrate : V_{SS}

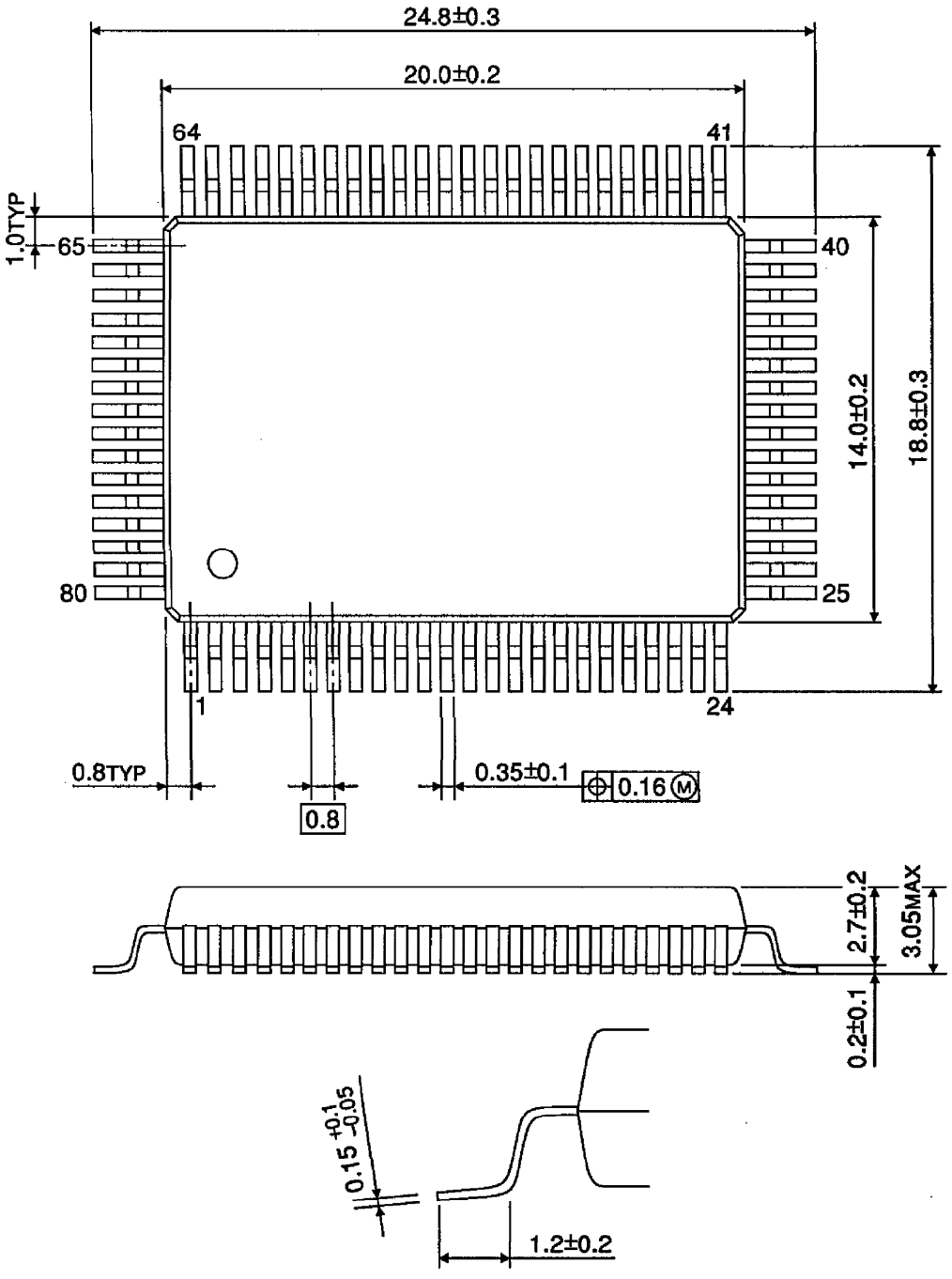
PAD LAYOUT



PAD Pitch 160μm

OUTLINE DRAWING

QFP80-P-1420-0.80A Unit : mm



Weight : 1.52g (Typ.)

GENERAL SPECIFICATION FOR CALCULATOR LSI BARE CHIP

1. Purpose

   This is to specify the quality standard for the integrated circuit produced by TOSHIBA CORPORATION (hereinafter referred as to VENDOR) to be delivered to PURCHASER.

2. Definition

   This specification applies only to the calculator LSI bare chip produced by VENDOR and purchased by PURCHASER and defined the general specification items.

3. Priority of specifications

   When the discrepancies or questions happen to the specifications and instructions provided by VENDOR, the priority shall be ranked as follows.

   1) Individual specification for the calculator LSI bare chip.
      (Both PURCHASER and VENDOR are confirmed by the special sheets.)
   2) General specifications for the calculator LSI bare chip.
   3) Other related specifications and standards.

4. Characteristics

   To be shown in the individual specification sheets.
   The individual specification shall consist of the following 4 items in principle.

   1) Rated specifications.
   2) Electrical characteristics.
   3) Pin configuration & mechanical dimensions.
   4) Others.

5. Inspection of product for delivery

   5.1 Inspection lot

   a) Inspection lot shall consist of products produced by same material under same design, through same production process, and same facilities and assured same quality by same quality assurance method, and lot number shall be put on all trays to be able to trace the lot history.

   b) The quantity of products per Inspection lot shall consist of all the same VENDOR's lot number.

5.2 Sampling plan

Statistical sampling and inspection shall be in accordance with MIL-STD-105D single sampling plans for normal inspections, general inspection level Ⅱ.

The acceptable quality level (AQL) shall be specified in following table :

TEST ITEM	AQL (%)
Electrical	2.5
Visual	4.0

5.3 Electrical criteria

Criteria of Electrical Characteristics are prescribed in Attachment-1.

5.4 Visual criteria

Visual Criteria are prescribed in Attachment-2.

6. Incoming inspection

6.1 General

a) PURCHASER's incoming inspection should be done within 15 days after PURCHASER receives the quantity of products in principle.

b) PURCHASER shall report the results of incoming inspection to VENDOR and provide VENDOR with detailed data in failure rate and items regarding VENDOR's lot number respectively, if VENDOR demands the report from PURCHASER.

6.2 Inspection procedure

PURCHASER should do his incoming inspection according to the following procedure.

a) First : Visual inspection should be done.

b) Next : Electrical and other inspection should be done under condition with bare chip before going into PURCHASER's process.

7. Treatment for defective lot and products

Regarding the defective lot and defective products which are found through PURCHASER's incoming inspection, PURCHASER can be returned to VENDOR with detailed description on failures concerned.
However, if VENDOR cannot receive the defective items within 30 days after PURCHASER's incoming inspection, VENDOR should be able to make no reference to the defective problem.

8. Packing and labeling

a) Dice shall be placed in die tray with the top metalization facting up in order.

b) In principle, a pile consists of 5 trays and several piles are packed in a package. These piles and packages are indicated with printed labels as shown below.

Date	
Name	
Lot No.	
Net	
TOSHIBA MADE IN JAPAN	

c) PURCHASER shall return these packing materials to VENDOR on VENDOR's demand.

9. Storage criteria

Solid state chips, unlike packaged devices, are non-hermetic devices normally fragile and small in physical size, and therefore, require special handling considerations as follows :

9.1 Chips must be stored under proper conditions to insure that they are not subjected to a moist and / or contaminated atmosphere that alter their electrical, physical, or mechanical characteristics.
After the shipping container is opened, the chips must be stored under the following conditions :

A. Storage temperature, 40°C max.
B. Relative humidity, 50% max.
C. Clean, dust-free environment.

9.2 The user must exercise proper care when handling chips or wafers to prevent even the slightest physical damage to the chip.

9.3 During mounting and lead bounding of chips the user must use proper assembly techniques to obtain proper electrical, thermal, and mechanical performance.

9.4 After the chip has been mounted and bounded, any necessary procedure must be followed by the user to insure that these non-hermetic chips are not subjected to moist or contaminated atmosphere which might cause the development of electrical conductive paths across the relatively small insulating surfaces.
In addition, proper consideration must be given to the protection of these devices from other harmful environments which could conceivably adversely affect their proper performance.

10. Handling criteria

The user should find the following suggested precautions helpful in handling chips.
In any event, because of the extremely small size and fragile nature of chips, care should be taken in handling these devices.

10.1 Grounding

a) Bonders, pellet pickup tools, table tops, trim and form tools, sealing equipment, and other equipment used in chip handling should be properly grounded.

b) Operator should be properly grounded.

10.2 In-process handling

a) Assemblies or subassemblies of chips should be transported and stored in conductive carriers.

b) All external leads of the assemblies or subassemblies should be shorted together.

VISUAL INSPECTION CRITERIA

1. Visual inspection magnification shall be 40 × in principle.
2. Defects defined :

2.1 Thickness

See the technical data sheet.

2.2 Chip and crack

A die shall be rejected if :

a) Any crack of chip extends greater than 35μm in length into the inside of the scribble line. (see Fig.1)

2.3 Metallization

A die shall be rejected if :

a) More than 25% of the designed area of the metallization is missing at any bonding pad.

b) There is a short or break which affects electrical characteristics in any lead pattern. (see Fig.2)

2.4 Glass protection coat

A die shall be rejected if :

a) It exhibits glass protection coat which covers more than 25% of any active bonding pad.

2.5 Attached foreign material

A die shall be rejected if :

a) A die is covered by stains or attached foreign material which size is more than 5 times as large as a bonding pad area.

b) It exhibits residual ink, stains or attached foreign material which covers more than 20% of any active bonding pad. (see Fig.3)

2.6 Others

A die shall be rejected if :

a) There have no evident probed impression on the bonding pads.

b) A inked die, defective die, is intermized.

3. Limit samples should be fized, if necessary.

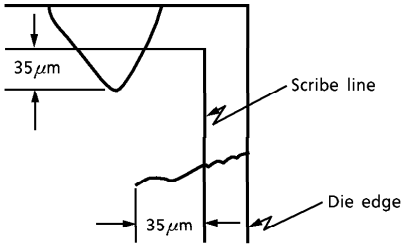


Fig.1

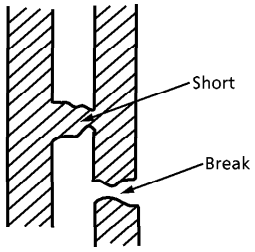


Fig.2 Lead pattern

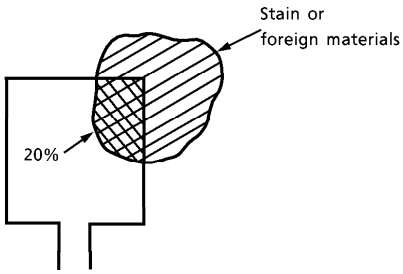
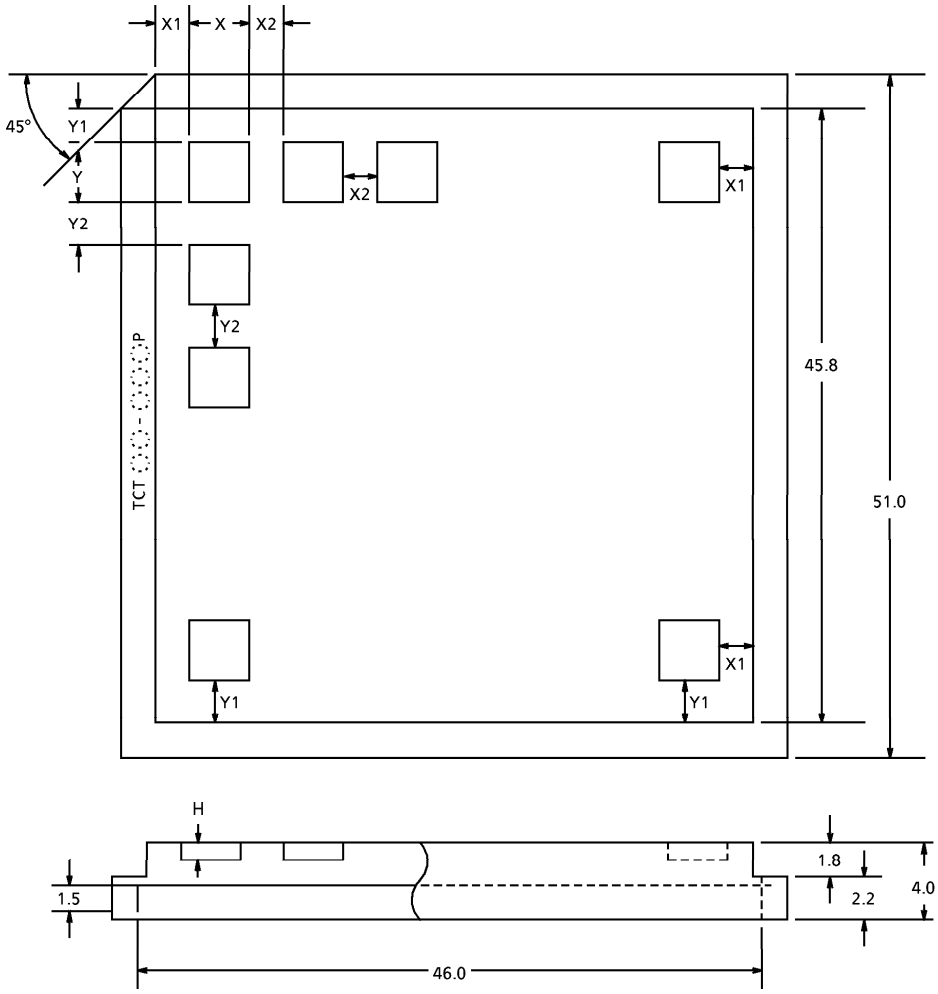


Fig.3

OUTSIDE DIMENSIONS OF CHIP TRAY



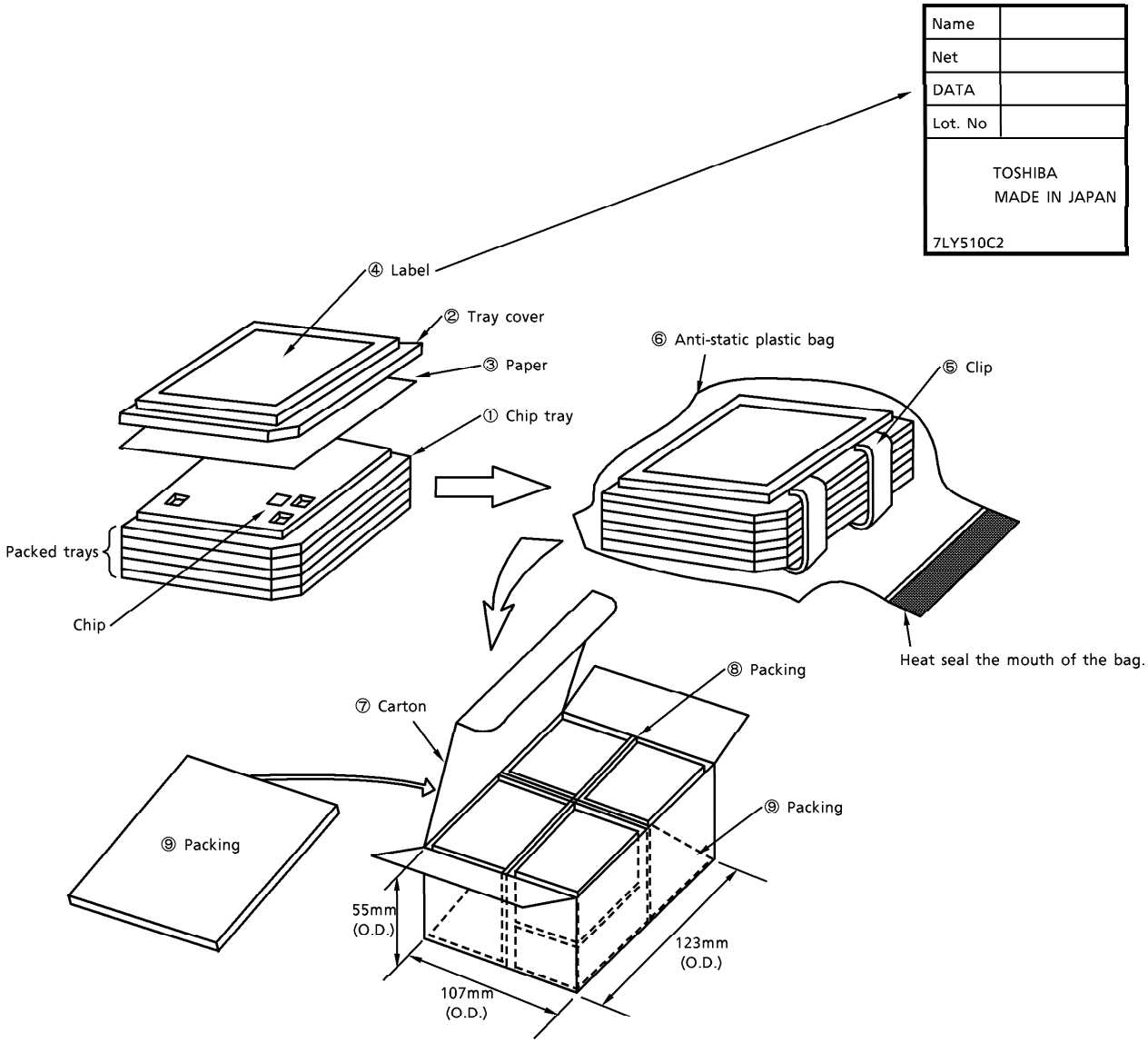
Unit : mm

CHIP NAME	TRAY NAME	X	Y	(H)	No. OF POCKETS	X1	X2	Y1	Y2
JT6M23A-AS	TCT45-060P	4.50	4.50	0.60	7×7 (49)	2.050	1.700	2.050	1.700

Tray material :

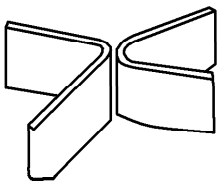
Carbon-containing polypropylene

PACKING METHOD-1



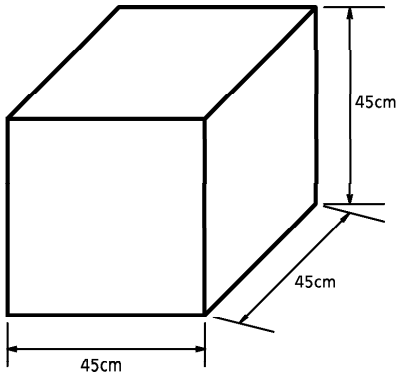
Place eight bags of chip trays in each carton box ⑦. Lay one sheet of packing ⑨ (7UF44F) before closing the lid of the cart box. (See the diagram above.)

Prepare packing ⑧ by cutting 7UF44F into halves and folding each in half as shown below ; use them as inner partitions.



PACKING METHOD-2

Shipping box



- Inner box : Containing 20 boxes
- Weight : Approx. 15kg (including packing material)
- Material : Corrugated cardboard
- IC contents : 36×5×8×20=28.8kpcs.