

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# T6M72, JT6M72-AS

## T6M72, JT6M72-AS CMOS Single-Chip LSI for LCD Calculator

The T6M72, JT6M72-AS is CMOS single-chip microcomputer for 14-digit or 12-digit 2-memory calculator.

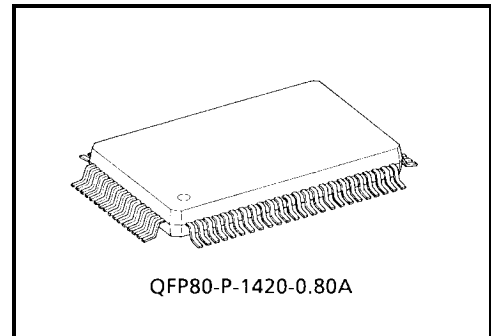
T6M72, JT6M72-AS is the complete single-chip CMOS LSI for calculator with single power supply operation.

Wide operating voltage range and low-power consumption make it suitable for 1.5 V solar battery operated.

Besides T6M72, JT6M72-AS can be selectable with a pin-programmable to function of Power timer and Memory hold. With the following features.

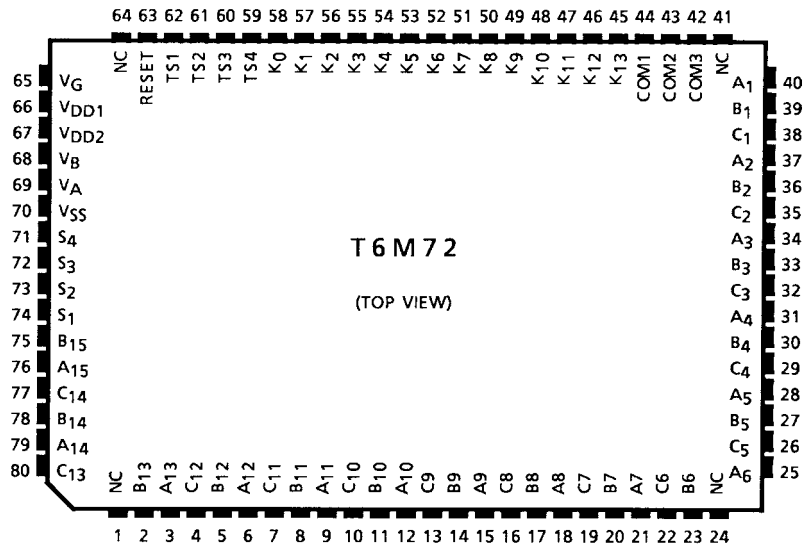
### Features

- 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 mark-down 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.



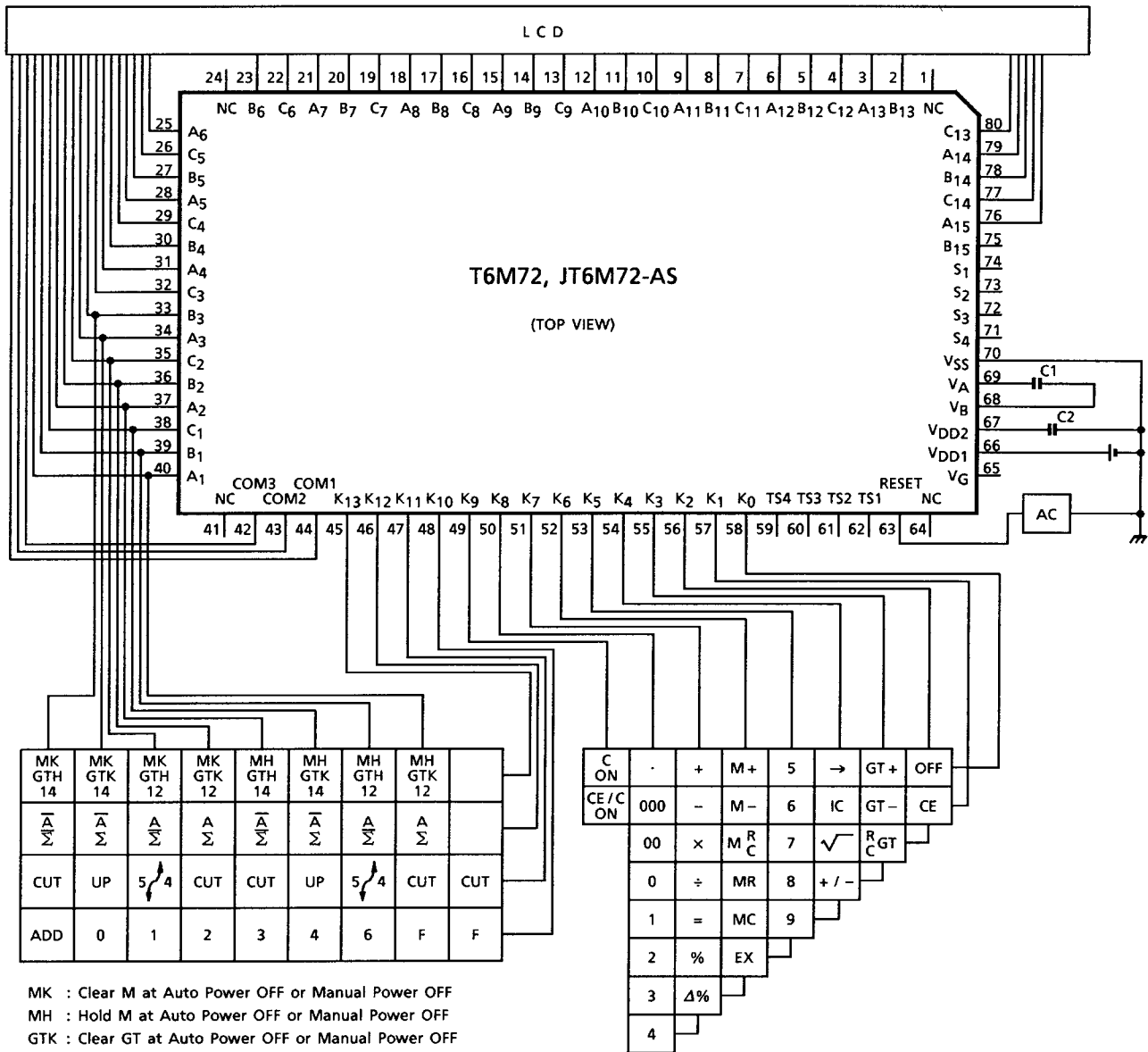
Weight: 1.52 g (typ.)

## Pin Assignment (top view)



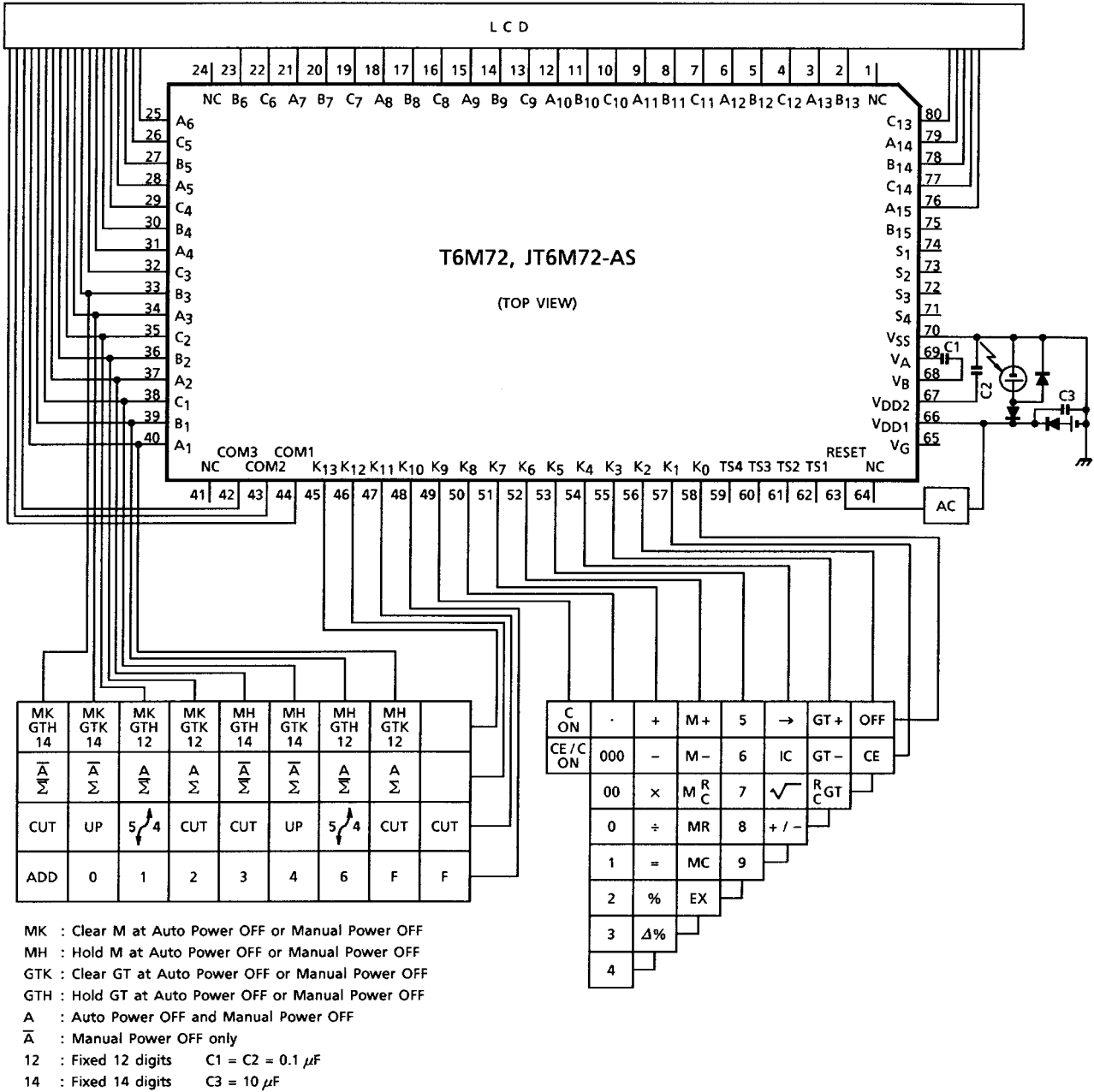
## System Block Diagram

### Battery Type

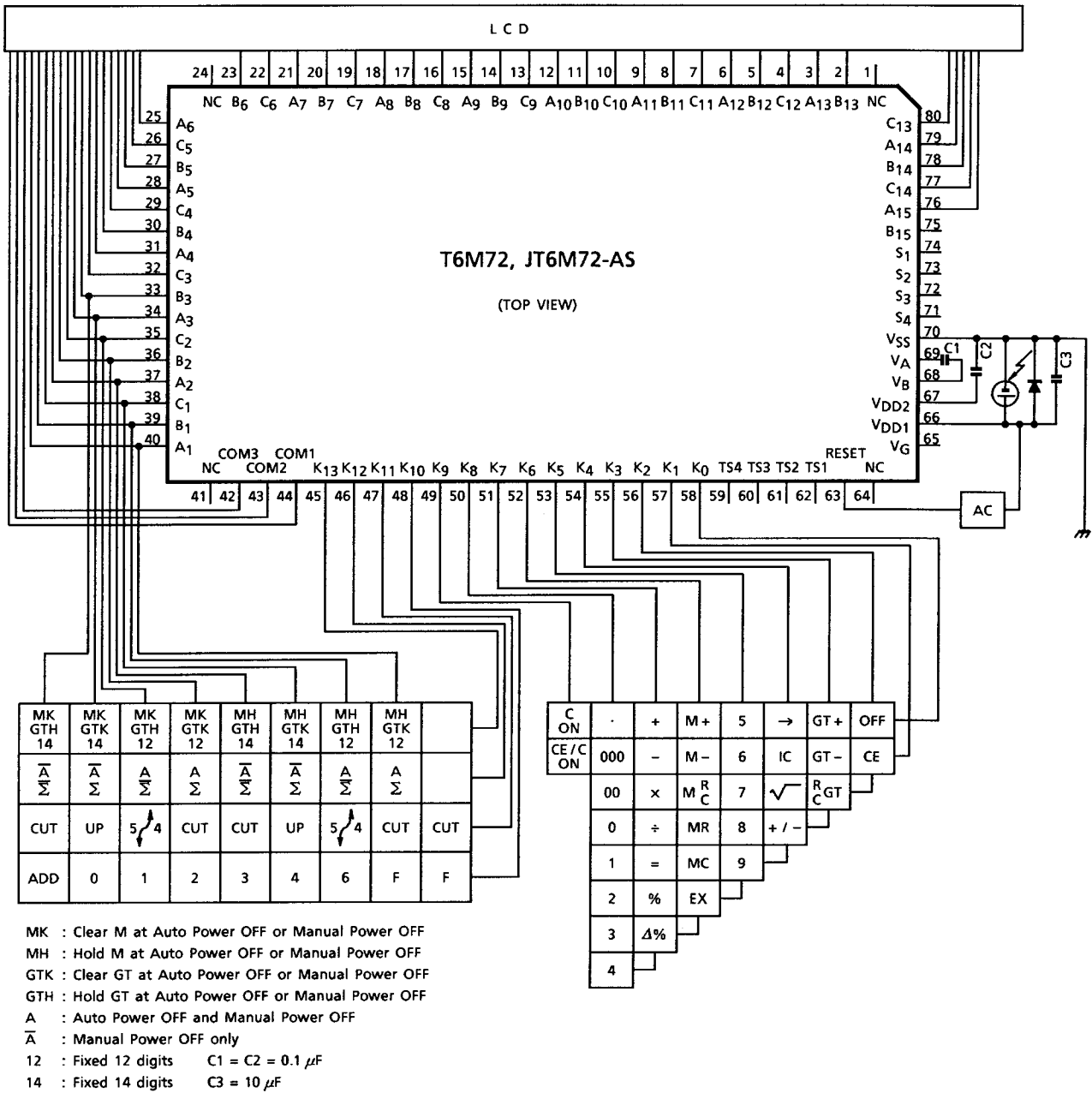


- MK : Clear M at Auto Power OFF or Manual Power OFF
- MH : Hold M at Auto Power OFF or Manual Power OFF
- GTK : Clear GT at Auto Power OFF or Manual Power OFF
- GTH : Hold GT at Auto Power OFF or Manual Power OFF
- A : Auto Power OFF and Manual Power OFF
- $\bar{A}$  : Manual Power OFF only
- 12 : Fixed 12 digits    C<sub>1</sub> = C<sub>2</sub> = 0.1  $\mu$ F
- 14 : Fixed 14 digits

## Dual Type

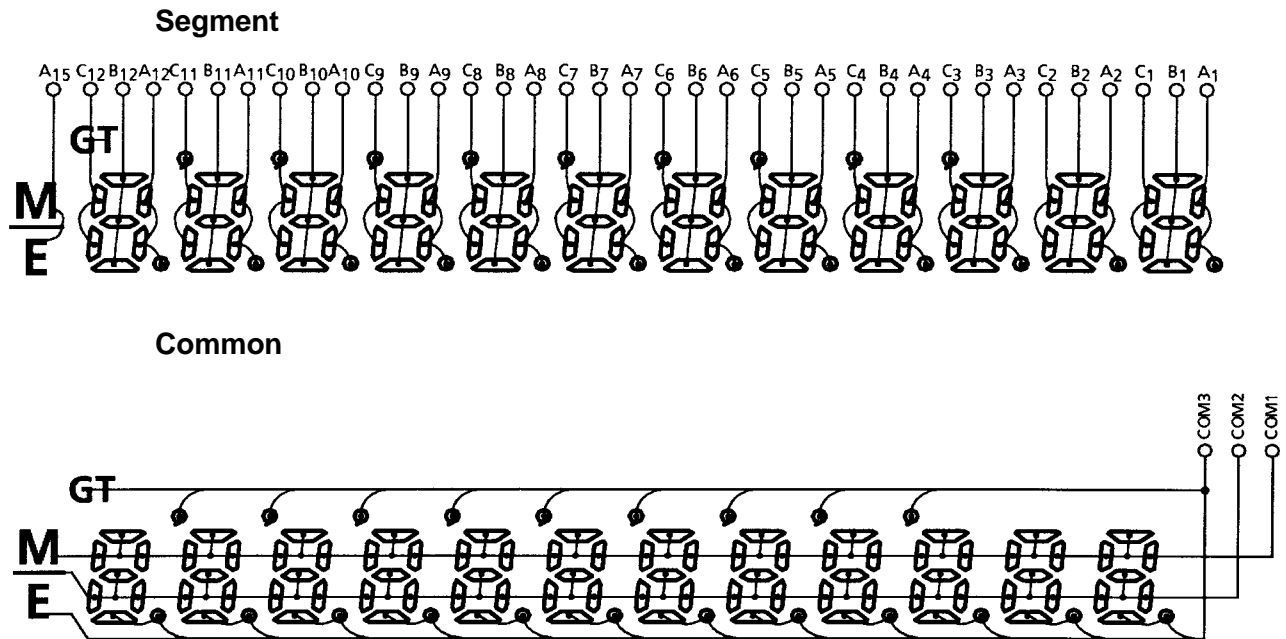


## Solar Type

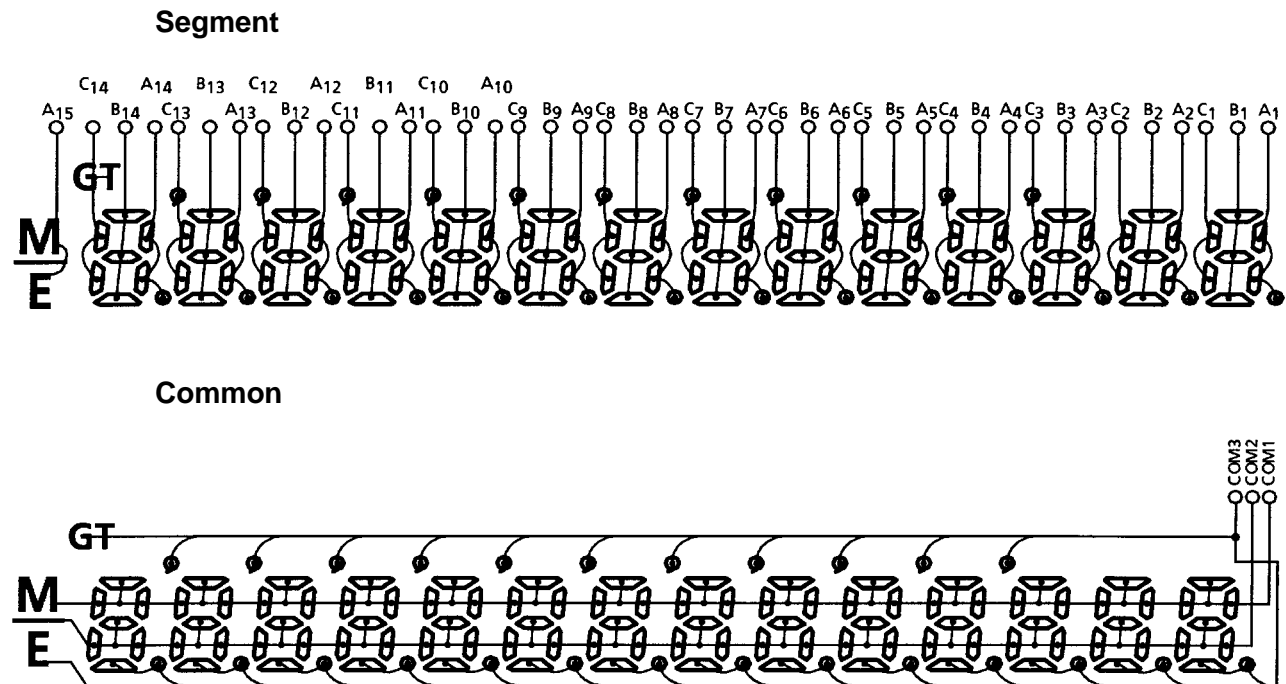


## Connection of LCD

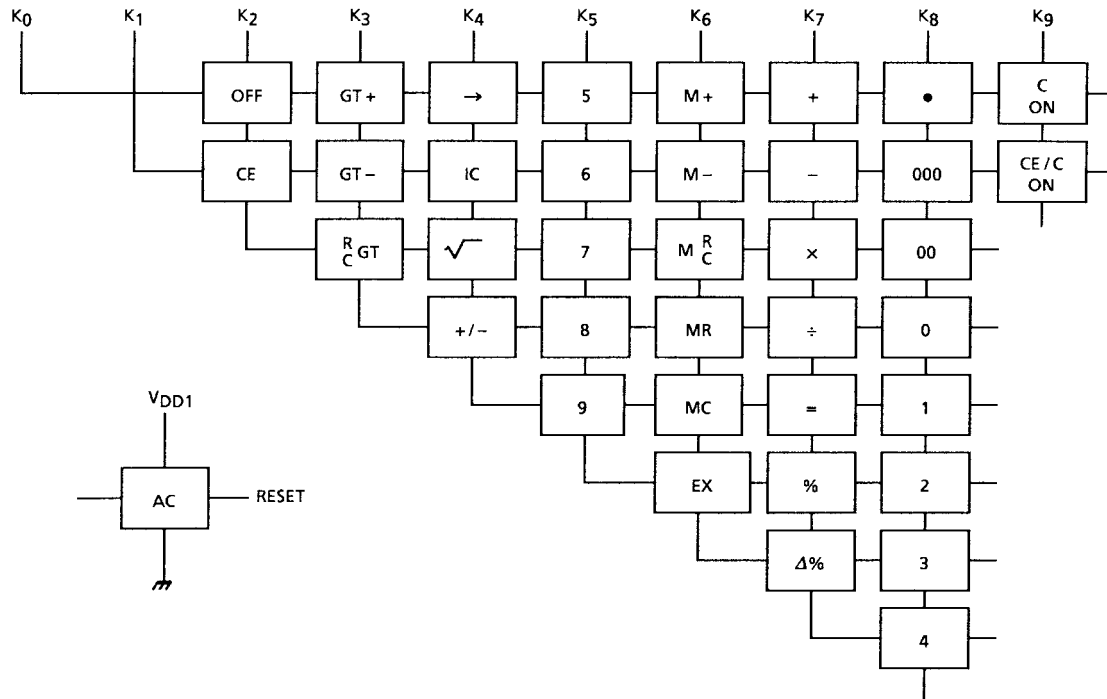
- (1) Select of 12 digits



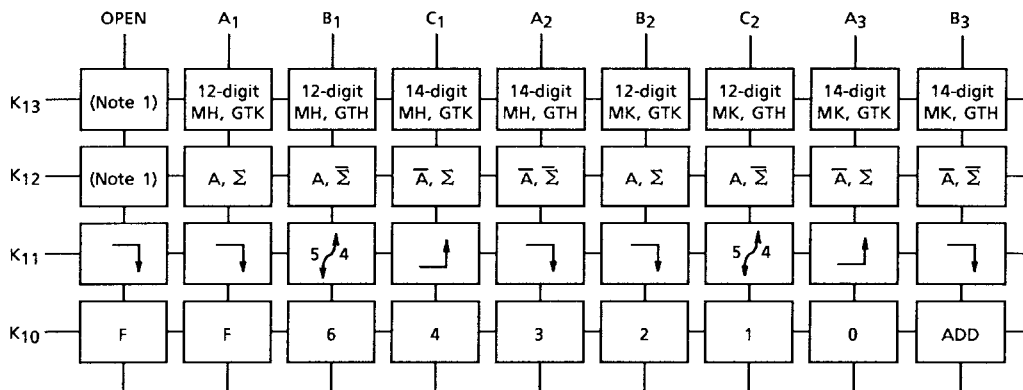
- (2) Select of 14 digits



**Key Connection**



**Touch Key**



**Lock Key**

K13: 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.

K12: Selectable with auto power OFF mode and total switch.

K11: Rounding switches.

K10: Selectable with fixed point or floating mode.

Note 1: K12 or K13 line is no choose then keep condition.

K12 or K13 line is no choose at the system power on then initial condition is 12-digit  $\bar{A}$ ,  $\bar{\Sigma}$  mode selected.

## Specification of Calculator

### Speed of Calculation

Numeral	.....	22.4~38.5 ms
Function	{ 1 $\boxed{+}$ ..... 45.5 ms 1 $\boxed{+}$ 2 $\boxed{+}$ ..... 80.7 ms	
Addition and Subtract	{ 1 2 3 $\boxed{+}$ 1 $\boxed{=}$ ..... 106.2 ms 9999999999999 $\boxed{-}$ 0.000000000001 $\boxed{=}$ ..... 135.4 ms	
Multiply	{ 1 2 3 $\boxed{\times}$ 2 $\boxed{=}$ ..... 125.9 ms 1 $\boxed{\times}$ 9999999999999 $\boxed{=}$ ..... 291.9 ms	
Device	{ 1 2 3 $\boxed{\div}$ 3 $\boxed{=}$ ..... 171.2 ms 9999999999999 $\boxed{\div}$ 1 $\boxed{=}$ ..... 334.8 ms	
Memory calculation	{ 2 $\boxed{M+}$ ..... 90.5 ms 9999999999999 $\boxed{\div}$ 1 $\boxed{M+}$ ..... 329.1 ms	
Square root	{ 9999999999999 $\boxed{\sqrt{\quad}}$ ..... 132.6 ms 2 $\boxed{\sqrt{\quad}}$ ..... 131.7 ms	

### Operation Example

#### 1. Fixed point calculations

(1)	Key	Display	Fixed point Place	(2)	Key	Display	Fixed point Place
	$\boxed{C}$	0.	DP = 3 (5 / 4)		$\boxed{C}$	0.	DP = 0 ( $\uparrow$ )
	2	2.			1	1.	
	$\boxed{\div}$	2.			$\boxed{\cdot}$	1.	
	3	3.			2	1.2	
	$\boxed{=}$	0.667			3	1.23	
	2	2.			$\boxed{+}$	1.23	
	$\boxed{\cdot}$	2.			1	1.	
	3	2.3			$\boxed{\cdot}$	1.	
	$\boxed{+}$	2.3			1	1.1	
	4	4.			$\boxed{=}$	3.	
	$\boxed{M+}$	6.300			9	9.	
	1	1.			$\boxed{\sqrt{\quad}}$	3.	
	$\boxed{\cdot}$	1.			$\boxed{\times}$	3.	
	2	1.2			1	1.	
	$\boxed{M+}$	1.200			$\boxed{\cdot}$	1.	
	$\boxed{MR}$	7.5	DP = 4		1	1.1	DP = F
					$\boxed{=}$	3.3	



## 2. Adding Point Mode Calculations

Key	Display	Key	Display	Key	Display
$\boxed{C}$	0.	$\boxed{M+}$	0.02M	$\boxed{=}$	33.27M -
1	1.	3	3.M	2	2.M
23	123	$\boxed{\cdot}$	3.M	$\boxed{+}$	0.02M
$\boxed{+}$	1.23	123	3.123M	9	9.M
3	3.	$\boxed{M+}$	3.12M	$\boxed{\cdot}$	9.M
$\boxed{=}$	1.26	$\boxed{MR}$	3.14M	$\boxed{\sqrt{\quad}}$	3.M
3	3.	$\boxed{C}$	0.M	$\boxed{=}$	3.02M
2	32.	1	1.M		
$\boxed{\times}$	32.	23	123M		
3	3.	$\boxed{-}$	1.23M		
$\boxed{\cdot}$	3.	3	3.M		
000	3.000	4	34.M		
$\boxed{=}$	96.00	$\boxed{\cdot}$	34.M		
2	2.	5	34.5M		

## 3. Constant Calculations

### (1) Multiplication

Key	Display	Constant
k	k	
$\boxed{\times}$	k	
a	a	
$\boxed{=}$	k·a	k×
b	b	k×
$\boxed{=}$	k·b	k×

### (2) Division

Key	Display	Constant
a	a	
$\boxed{\div}$	a	
k	k	
$\boxed{=}$	a / k	÷ k
b	b	÷ k
$\boxed{=}$	b / k	÷ k

### (3) Addition

Key	Display	Constant
a	a	
$\boxed{+}$	a	
k	k	
$\boxed{=}$	a + k	+ k
b	b	+ k
$\boxed{=}$	b + k	+ k

### (4) Subtraction

Key	Display	Constant
a	a	
$\boxed{-}$	a	
k	k	
$\boxed{=}$	a - k	- k
b	b	- k
$\boxed{=}$	b - k	- k

(5) Percentage

Key	Display	Constant
k	k	
$\times$	k	
a	a	
$\%$	$k \cdot a / 100$	$k \times$
b	b	$k \times$
$\%$	$k \cdot b / 100$	$k \times$

(6) Percentage

Key	Display	Constant
a	a	
$\div$	a	
k	k	
$\%$	$100 \cdot a / k$	$\div k$
b	b	$\div k$
$\%$	$100 \cdot b / k$	$\div k$

(7) Add-on

Key	Display	Constant
k	k	
$+$	k	
a	a	
$\%$	$k \cdot (1 + a / 100)$	$k +$
b	b	$k +$
$\%$	$k \cdot (1 + b / 100)$	$k +$

(8) Discount

Key	Display	Constant
k	k	
$-$	k	
a	a	
$\%$	$k \cdot (1 - a / 100)$	$k -$
b	b	$k -$
$\%$	$k \cdot (1 - b / 100)$	$k -$

## 4. $\Delta\%$ Calculations

(1)

Key	Display
a	a
$+$	a
b	b
$\Delta\%$	$100 \cdot (a + b) / b$

(2)

Key	Display
a	a
$-$	a
b	b
$\Delta\%$	$100 \cdot (a - b) / b$

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

(1) Mark-up

Key	Display
a	a
$\div$	a
b	b
$\Delta\%$	$a / (1 - b / 100)$
$\Delta\%$	$ a / (1 - b / 100) $

(2) Mark-down

Key	Display
a	a
$\div$	a
b	b
$+/-$	-b
$\Delta\%$	$a / (1 + b / 100)$
$\Delta\%$	$a / (1 + b / 100) - a$

**6. Add-On, Discount Calculations**

Add-on

	Key	Display
(1)	a	a
	$\boxed{\times}$	a
	b	b
	$\boxed{\%}$	$a \cdot b / 100$
	$\boxed{+}$	$a \cdot b / 100$
	$\boxed{=}$	$a (1 + b / 100)$
(3)	a	a
	$\boxed{+}$	a
	b	b
	$\boxed{\%}$	$a (1 + b / 100)$
(5)	a	a
	$\boxed{\times}$	a
	b	b
	$\boxed{\Delta\%}$	$a \cdot (1 + b / 100)$

Discount

	Key	Display
(2)	a	a
	$\boxed{\times}$	a
	b	b
	$\boxed{\%}$	$a \cdot b / 100$
	$\boxed{-}$	$a \cdot b / 100$
	$\boxed{=}$	$a (1 - b / 100)$
(4)	a	a
	$\boxed{-}$	a
	b	b
	$\boxed{\%}$	$a (1 - b / 100)$
(6)	a	a
	$\boxed{\times}$	a
	b	b
	$\boxed{+/-}$	-b
	$\boxed{\Delta\%}$	$a (1 - b / 100)$

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

Key	Display	Item Counter
a	a	0
$\boxed{+}$	a	1
b	b	1
$\boxed{+}$	a + b	2
c	c	2
$\boxed{+}$	a + b + c	3
d	d	3
$\boxed{+}$	a + b + c + d	4

Key	Display	Item Counter
$\boxed{-}$	a + b + c + d	2
d	d	2
$\boxed{+}$	a + b + c	3
e	e	3
$\boxed{=}$	a + b + c + e	4
$\boxed{\div}$	a + b + c + e	4
$\boxed{IC}$	4	4
$\boxed{=}$	$(a + b + c + e) / 4$	5

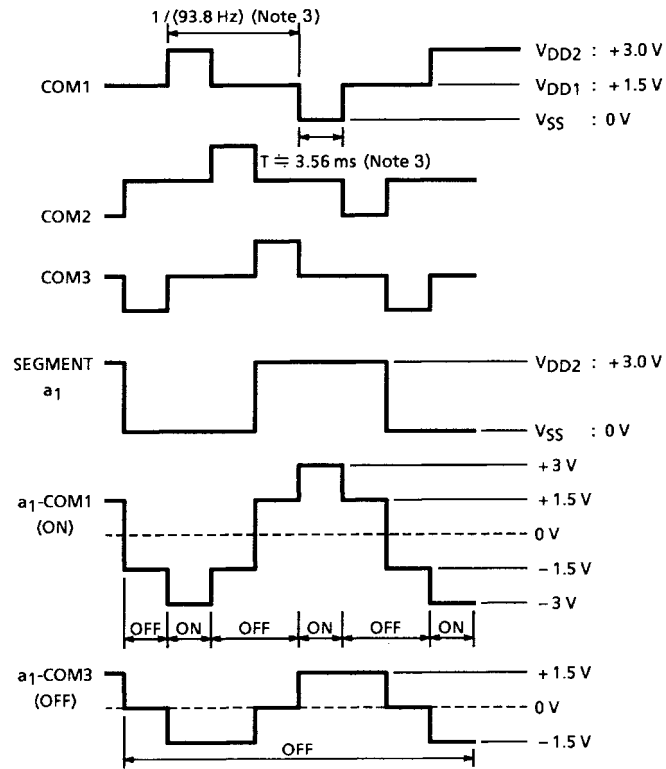
## Maximum Ratings

Characteristics	Symbol	Rating	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 ( $V_{DD1} = 1.5 \pm 0.2$ V, $V_{DD2} = 3.0 \pm 0.4$ V, $V_{SS} = 0$ V, $T_a = 25^\circ\text{C}$ )

Characteristics	Symbol	Test Circuit	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 <sub>2</sub> ~K <sub>9</sub> RESET	—	$V_{DD1} - 0.4$	—	$V_{DD1}$	V	
"1" input voltage	$V_{IH}$ (2)	—	K <sub>10</sub> ~K <sub>13</sub>	—	$V_{DD2} - 0.4$	—	$V_{DD2}$	V	
"0" input voltage	$V_{IL}$	—	K <sub>2</sub> ~K <sub>13</sub> 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 <sub>1</sub> ~K <sub>9</sub>	—	$V_{DD1} - 0.2$	—	$V_{DD1}$	V	
"0" output voltage	$V_{OL}$ (2)	—	K <sub>1</sub> ~K <sub>13</sub>	—	0	—	0.2	V	
"1" output resistance	$R_{OH}$	—	SEGMENT COM1~3	$V_{OUT} = V_{DD2} - 0.5$ V	—	—	70	k $\Omega$	
"0" output resistance	$R_{OL}$	—	SEGMENT COM1~3	$V_{OUT} = 0.5$ V	—	—	70	k $\Omega$	
Key pull up resistance	$R_{KEYH}$ (1)	—	RESET	$V_{OUT} = V_{DD1} - 0.5$ V	—	—	25	k $\Omega$	
	$R_{KEYH}$ (2)	—	K <sub>0</sub> ~K <sub>9</sub>	$V_{OUT} = V_{DD1} - 0.5$ V	—	—	14		
	$R_{KEYH}$ (3)	—	K <sub>10</sub> ~K <sub>13</sub>	$V_{OUT} = 0$ V	120	—	800		
Key pull down resistance	$R_{KEYL}$ (1)	—	RESET (1)	$V_{OUT} = V_{DD1}$	100	—	300	k $\Omega$	
	$R_{KEYL}$ (2)	—	RESET (2)	$V_{OUT} = V_{DD1}$	18	—	300		
	$R_{KEYL}$ (3)	—	K <sub>0</sub> ~K <sub>9</sub> (1)	$V_{OUT} = 0.5$ V	—	—	50		
	$R_{KEYL}$ (4)	—	K <sub>0</sub> ~K <sub>9</sub> (2)	$V_{OUT} = V_{DD1}$	72	—	170		
Oscillating (WAIT)	$f_{\phi}$ WAIT	—	—	$V_{DD1} = 1.5$ V	5.4	9.0	15.5	kHz	
Frequency (OPERATE)	$f_{\phi}$ OP	—	—	$V_{DD1} = 1.5$ V	20.0	34	61.3	kHz	
Frame frequency	$f_F$	—	SEGMENT COM1~3	$V_{DD1} = 1.5$ V	56.3	93.8	161.5	Hz	
Supply current	1 (WAIT)	$I_{DD}$ WAIT	—	—	$V_{DD1} = 1.5$ V	—	—	3.3	$\mu$ A
	2 (OPERATE)	$I_{DD}$ OP	—	—	$V_{DD1} = 1.2$ V	—	—	8.9	
	3 (OFF)	$I_{DD}$ OFF	—	—	$V_{DD1} = 1.5$ V	—	—	2.0	
Power off timer times	T	—	—	$V_{DD1} = 1.5$ V	429	600	1001	s	

**Waveforms for Display**



Note 3: At  $f\phi = 9 \text{ kHz}$

## Pad Location Table

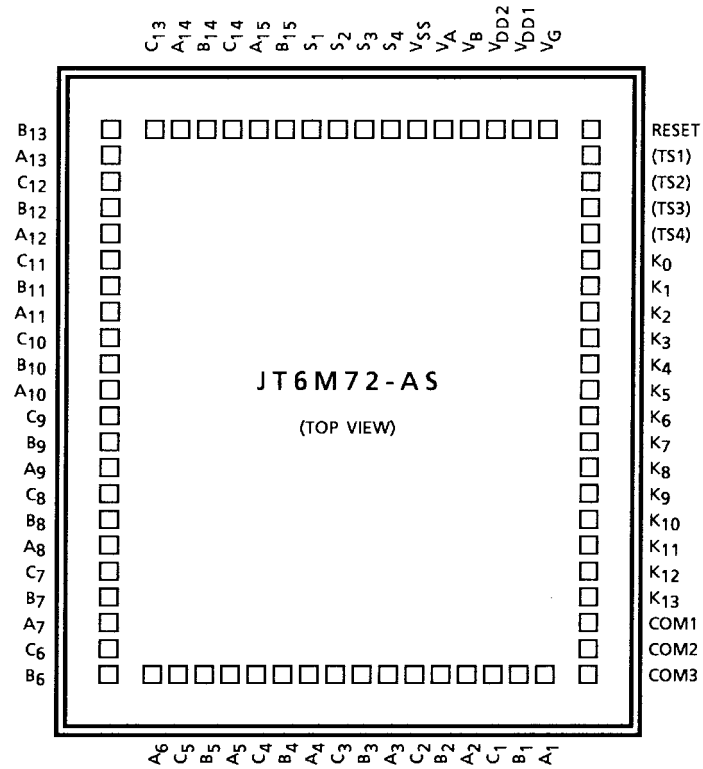
( $\mu\text{m}$ )

Name	X Point	Y Point
B <sub>6</sub>	-1757	-1680
C <sub>6</sub>	-1757	-1520
A <sub>7</sub>	-1757	-1360
B <sub>7</sub>	-1757	-1200
C <sub>7</sub>	-1757	-1040
A <sub>8</sub>	-1757	-880
B <sub>8</sub>	-1757	-720
C <sub>8</sub>	-1757	-560
A <sub>9</sub>	-1757	-400
B <sub>9</sub>	-1757	-240
C <sub>9</sub>	-1757	-80
A <sub>10</sub>	-1757	80
B <sub>10</sub>	-1757	240
C <sub>10</sub>	-1757	400
A <sub>11</sub>	-1757	560
B <sub>11</sub>	-1757	720
C <sub>11</sub>	-1757	880
A <sub>12</sub>	-1757	1040
B <sub>12</sub>	-1757	1200
C <sub>12</sub>	-1757	1360
A <sub>13</sub>	-1757	1520
B <sub>13</sub>	-1757	1680
C <sub>13</sub>	-1089	1753
A <sub>14</sub>	-929	1753
B <sub>14</sub>	-769	1753
C <sub>14</sub>	-609	1753
A <sub>15</sub>	-449	1753
B <sub>15</sub>	-289	1753
S <sub>1</sub>	-129	1753
S <sub>2</sub>	31	1753
S <sub>3</sub>	191	1753
S <sub>4</sub>	351	1753
V <sub>SS</sub>	511	1753
V <sub>A</sub>	671	1753
V <sub>B</sub>	831	1753
V <sub>DD2</sub>	991	1753
V <sub>DD1</sub>	1151	1753
V <sub>G</sub>	1388	1753

Name	X Point	Y Point
RESET	1757	1680
(TS1)	1757	1520
(TS2)	1757	1360
(TS3)	1757	1200
(TS4)	1757	1040
K <sub>0</sub>	1757	880
K <sub>1</sub>	1757	720
K <sub>2</sub>	1757	560
K <sub>3</sub>	1757	400
K <sub>4</sub>	1757	240
K <sub>5</sub>	1757	80
K <sub>6</sub>	1757	-80
K <sub>7</sub>	1757	-240
K <sub>8</sub>	1757	-400
K <sub>9</sub>	1757	-560
K <sub>10</sub>	1757	-720
K <sub>11</sub>	1757	-880
K <sub>12</sub>	1757	-1040
K <sub>13</sub>	1757	-1200
COM1	1757	-1360
COM2	1757	-1520
COM3	1757	-1680
A <sub>1</sub>	1122	-1752
B <sub>1</sub>	962	-1752
C <sub>1</sub>	802	-1752
A <sub>2</sub>	642	-1752
B <sub>2</sub>	482	-1752
C <sub>2</sub>	322	-1752
A <sub>3</sub>	162	-1752
B <sub>3</sub>	2	-1752
C <sub>3</sub>	-158	-1752
A <sub>4</sub>	-318	-1752
B <sub>4</sub>	-478	-1752
C <sub>4</sub>	-638	-1752
A <sub>5</sub>	-798	-1752
B <sub>5</sub>	-958	-1752
C <sub>5</sub>	-1118	-1752
A <sub>6</sub>	-1278	-1752

Note 4: ( ) Do not connect.

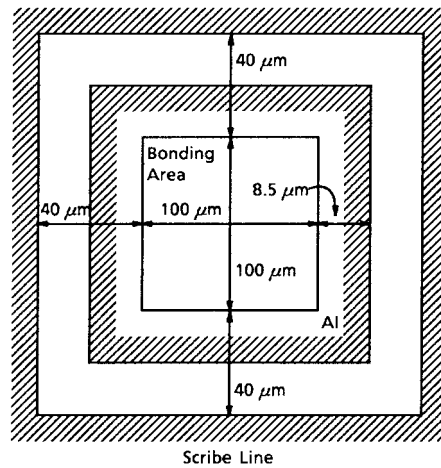
**Chip Layout**



Chip size : 3.79 × 3.84 (mm)  
 Chip thickness : 440 ± 30 (μm)  
 Substrate : V<sub>SS</sub>

**Pad Layout**

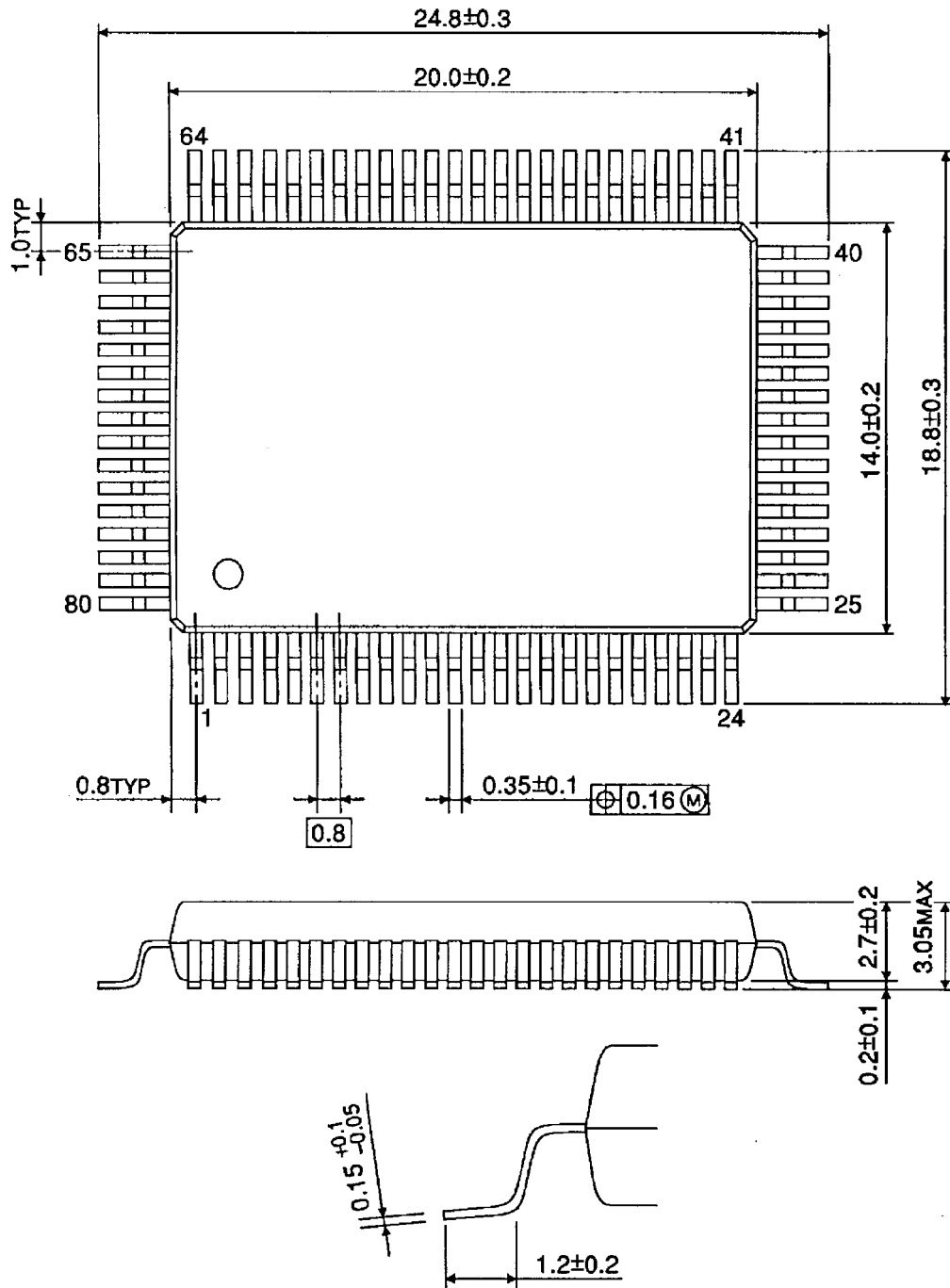
**Active Element**



**Package Dimensions**

QFP80-P-1420-0.80A

Unit : mm



Weight: 1.52 g (typ.)



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000707EBA

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