TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

T6M23A,JT6M23A-AS

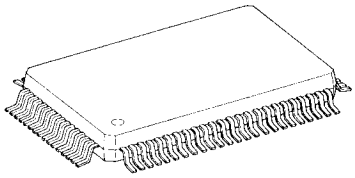
T6M23A, JT6M23A-AS CMOS Single-Chip LSI for LCD Calculator

The T6M23A, JT6M23A-AS is CMOS single-chip microcomputer for 14-digit capacity or 12-degit capacity 2-memory calculator.

T6M23A, JT6M23A-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 T6M23A, JT6M23A-AS can selectable with a pin-programmable to function of Power timer and Memory hold. With the following features.



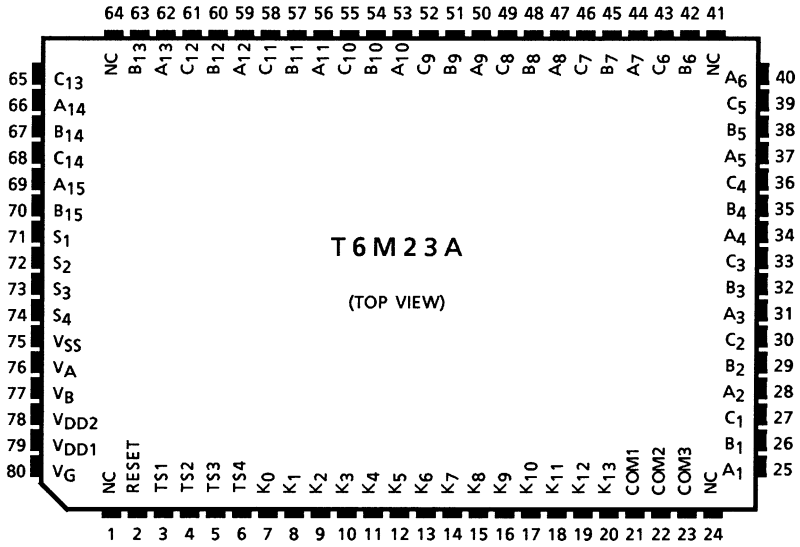
QFP80-P-1420-0.80A

Weight: 1.52 g (typ.)

Features

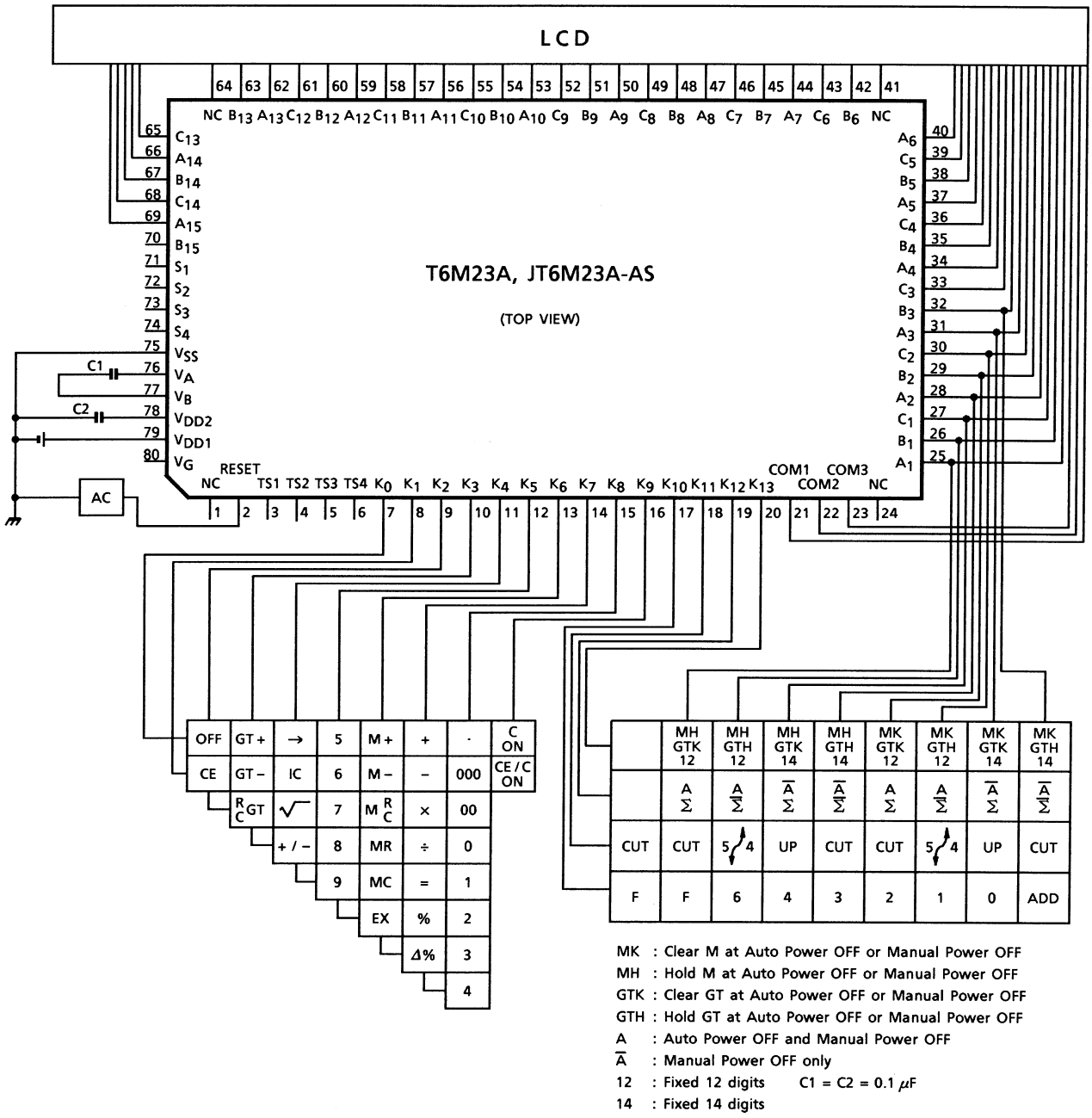
- Display: 14 digits or 12 digits (selectable with a pin-programmable) of data, 2 digits of sign, error symbol, memory load symbol.
- Algebraic mode.
- Standard 4 functions (+, −, ×, ÷)
- Memory and grand total (GT) memory calculation.
- Accumulating GT memory register with count up (down) item counter.
- Automatic percentage operation with add-on, discount.
- Automatic delta percentage, mark-up and 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.

Pin Assignment (top view)



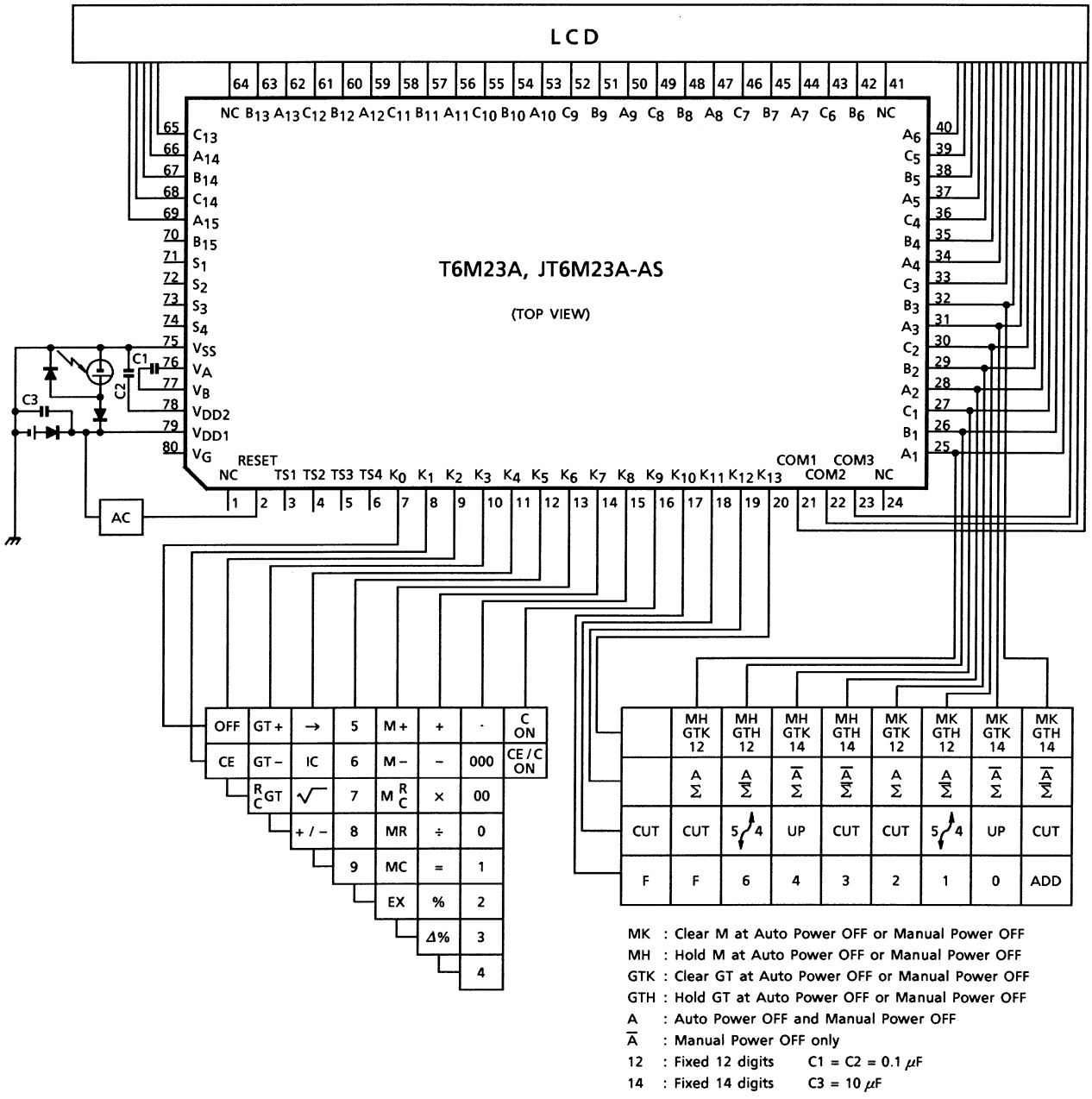
System Block Diagram

Battery Type



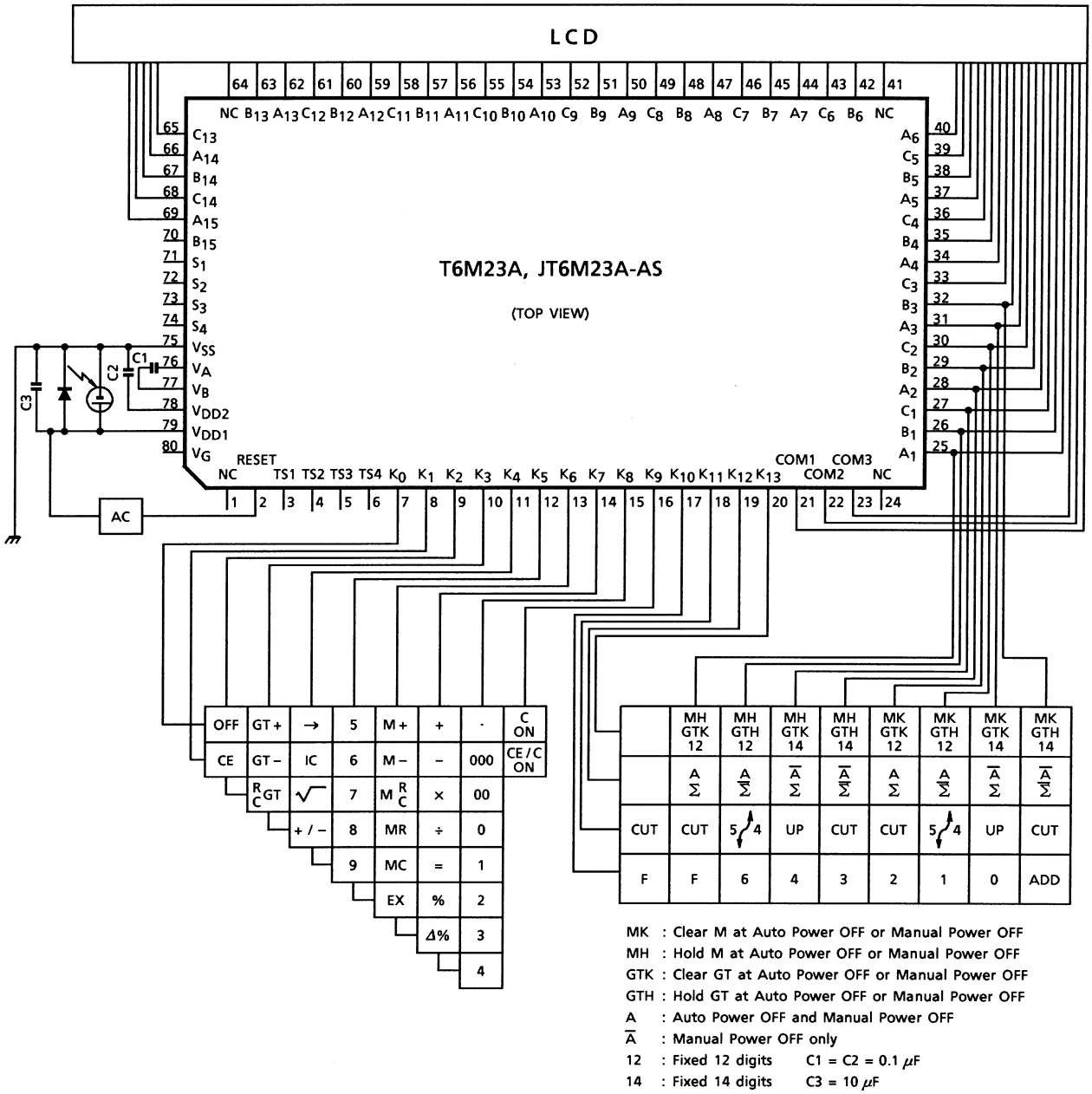
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
GTK : Clear GT at Auto Power OFF or Manual Power OFF
GTH : Hold GT at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
12 : Fixed 12 digits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

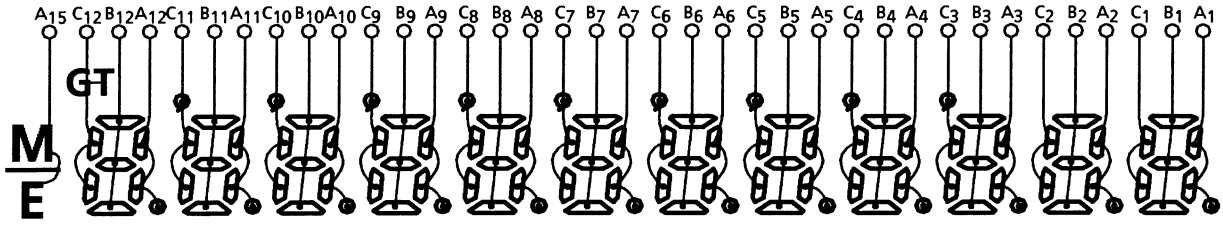


MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
GTK : Clear GT at Auto Power OFF or Manual Power OFF
GTH : Hold GT at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
12 : Fixed 12 digits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

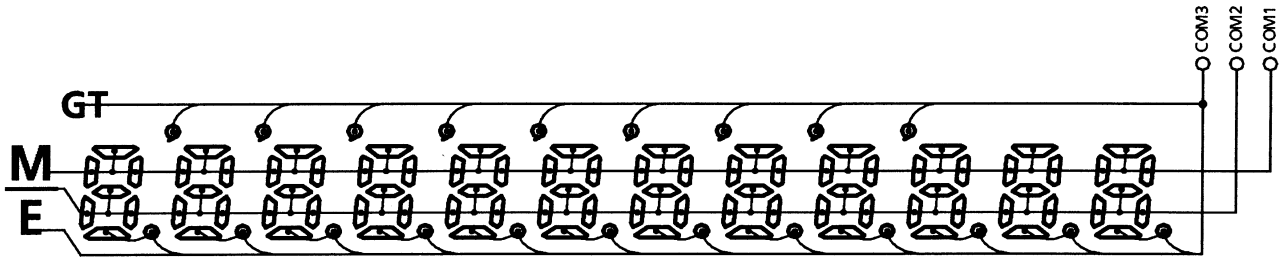
Connection of LCD

(1) Select of 12 digits

Segment

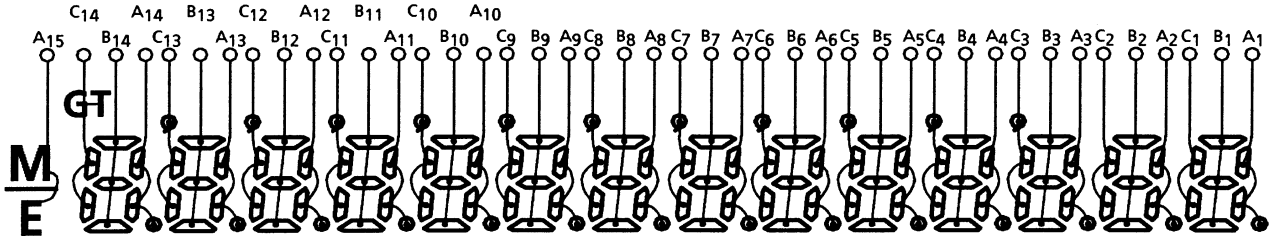


Common

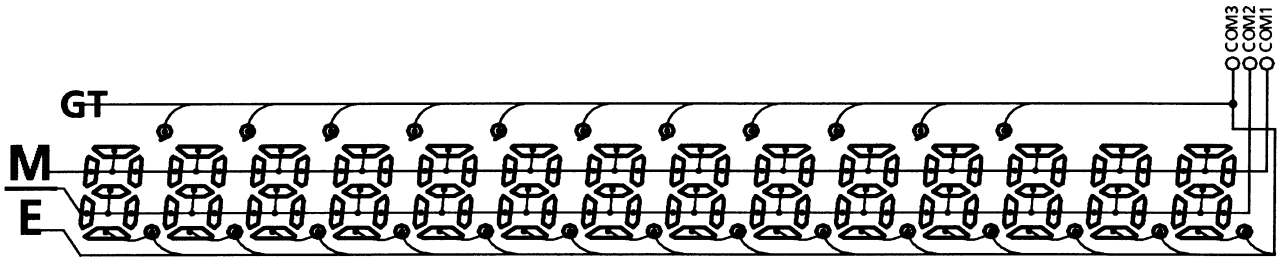


(2) Select of 14 digits

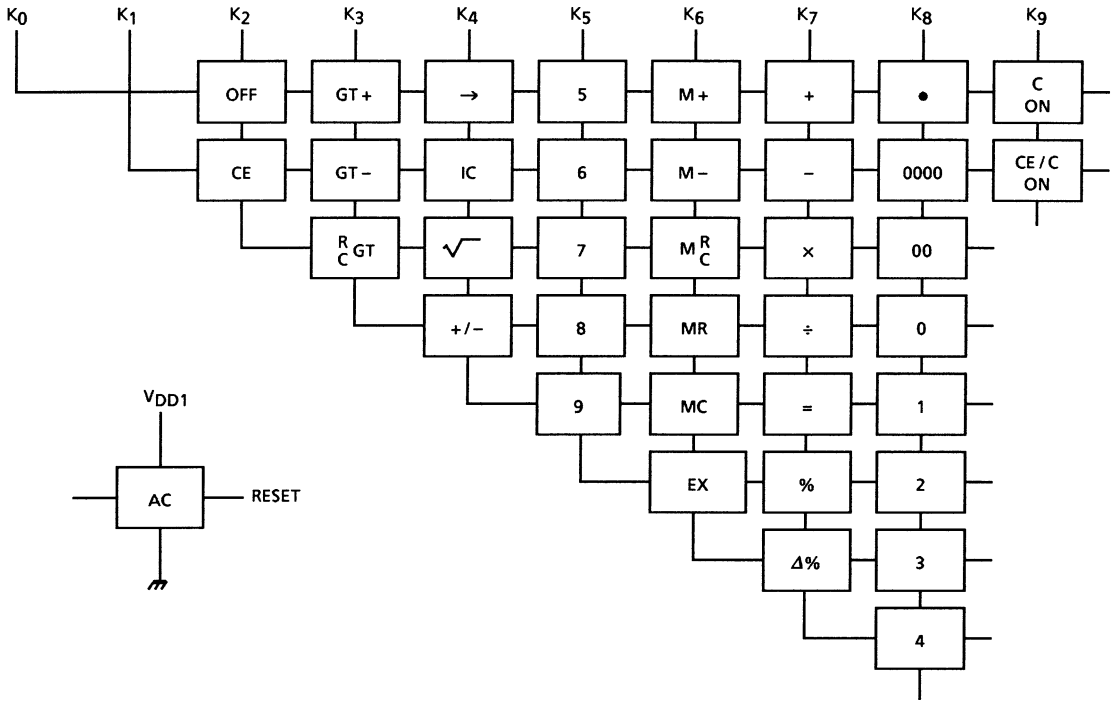
Segment



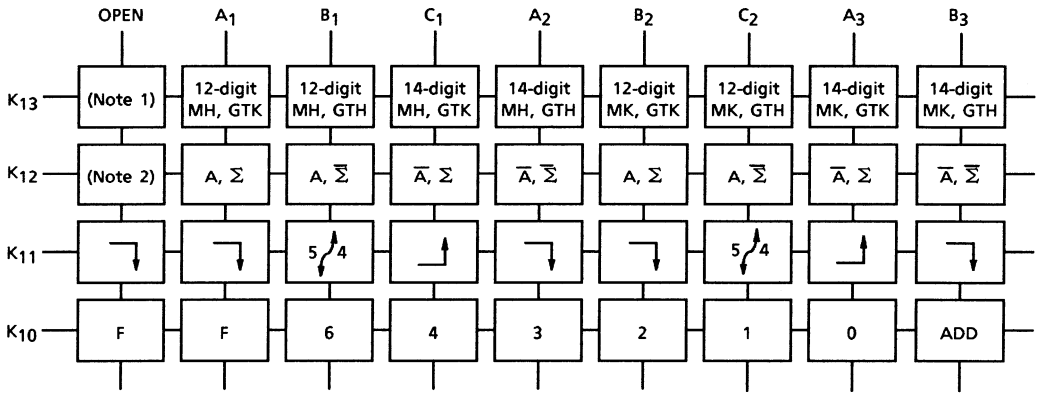
Common



Key Connection



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-digit $\overline{A}$, $\overline{\Sigma}$ mode selected.

Specification of Calculator

Speed of Calculation

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

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

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% 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
−	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

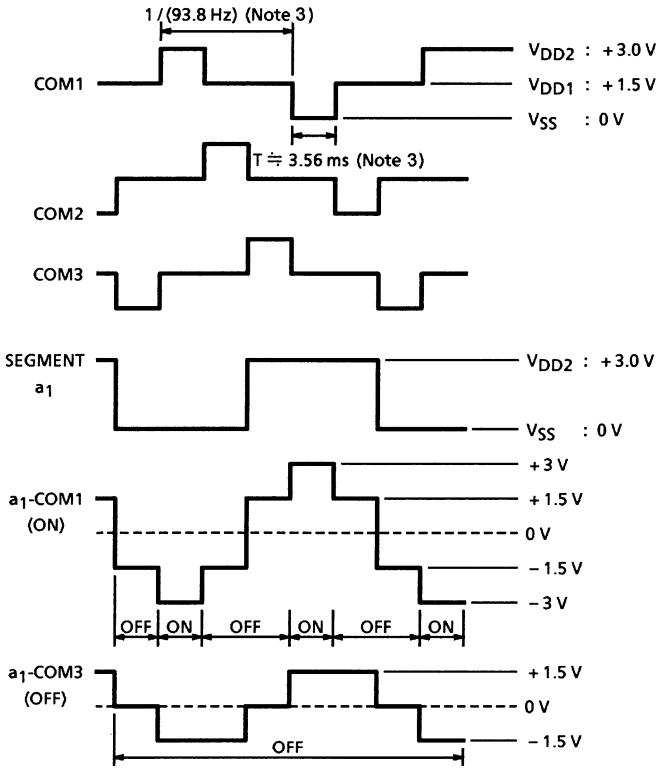
Maximum Ratings

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{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 ± 0.2 V, V_{DD2} = 3.0 ± 0.4 V, V_{SS} = 0 V, Ta = 25°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_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} − 0.5 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} = V_{DD1} − 0 5 V	—	—	25	kΩ
		$R_{KEYH\ (2)}$	—	K_0~K_9	V_{OUT} = V_{DD1} − 0 5 V	—	—	14	
		$R_{KEYH\ (3)}$	—	K_{10}~K_{13}	V_{OUT} = 0 V	120	—	800	
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	
		$R_{KEYL\ (3)}$	—	K_0~K_9 (1)	V_{OUT} = 0.5 V	—	—	50	
		$R_{KEYL\ (4)}$	—	K_0~K_9 (2)	V_{OUT} = V_{DD1}	72	—	170	
Oscillating (WAIT)		fϕWAIT	—	—	V_{DD1} = 1.5 V	5.4	9.0	15.5	kHz
Frequency (OPERATE)		fϕOP	—	—	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_{DDWAIT}	—	—	V_{DD1} = 1.5 V	—	—	3.3	μA
	2 (OPERATE)	I_{DDOP}	—	—	V_{DD1} = 1.2 V	—	—	8.9	
	3 (OFF)	I_{DDOFF}	—	—	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_ϕ = 9 kHz

Pad Location Table

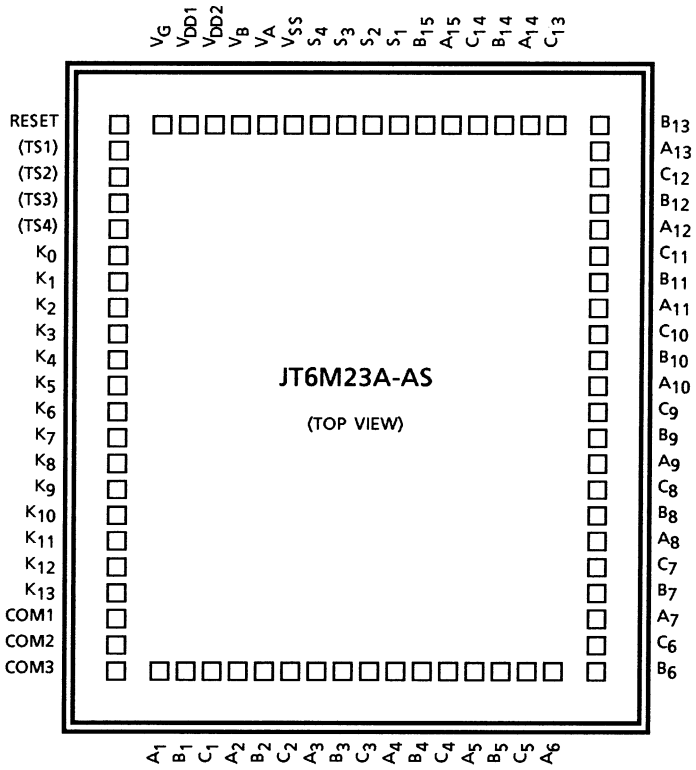
(μm)

Name	X Point	Y 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	Y 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
A_2	−642	−1752
C_1	−802	−1752
B_1	−962	−1752
A_1	−1122	−1752

Note 4: ( ) Do not connect.

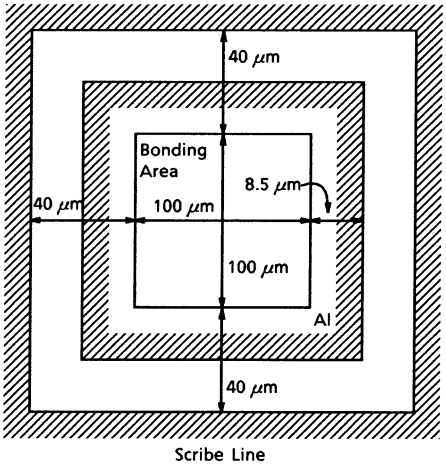
Chip Layout



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

Pad Layout

Active Element

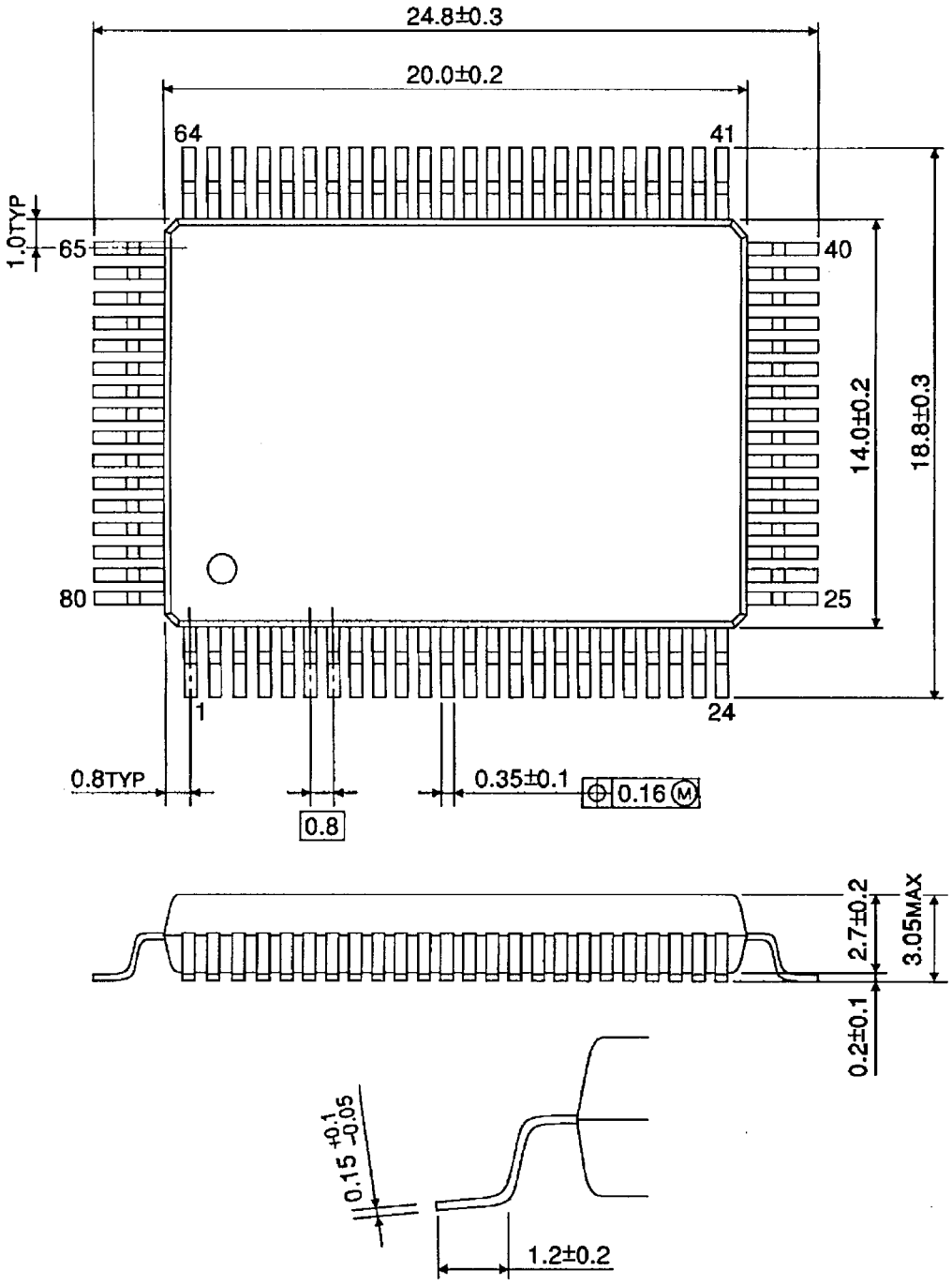


Scribe Line

PAD Pitch 160 μm

Package Dimensions

QFP80-P-1420-0.80A Unit : mm



Weight: 1.52 g (typ.)

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