# TOSHIBA

T6M81A,JT6M81A-AS

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

T6M81A, JT6M81A-AS

T6M81A, JT6M81A-AS CMOS SINGLE-CHIP LSI FOR LCD CALCULATOR

The T6M81A, JT6M81A-AS is a CMOS single-chip microcomputer for 16-digit 1-memory calculator. T6M81A, JT6M81A-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 T6M81A, JT6M81A-AS can selectable with a pin-programmable to function of Power timer and Memory hold. With the following features.
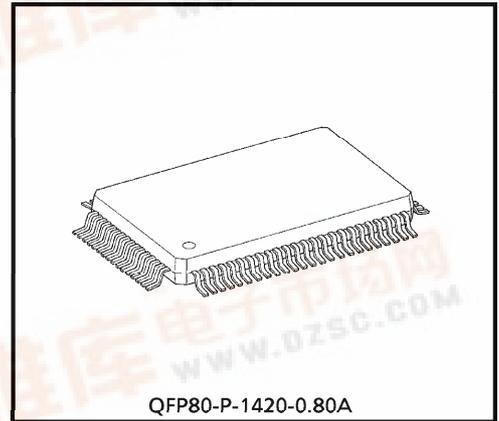
QFP80-P-1420-0.80A

Weight : 1.52 g (Typ.)

FEATURES

- Display : 16 digits of data, 1 digit of sign, error symbol, memory load symbol.

- Algebraic mode.

- Standard 4 functions (+ , − , × , ÷)

- 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 contents indicator, turned on with non-zero in the 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
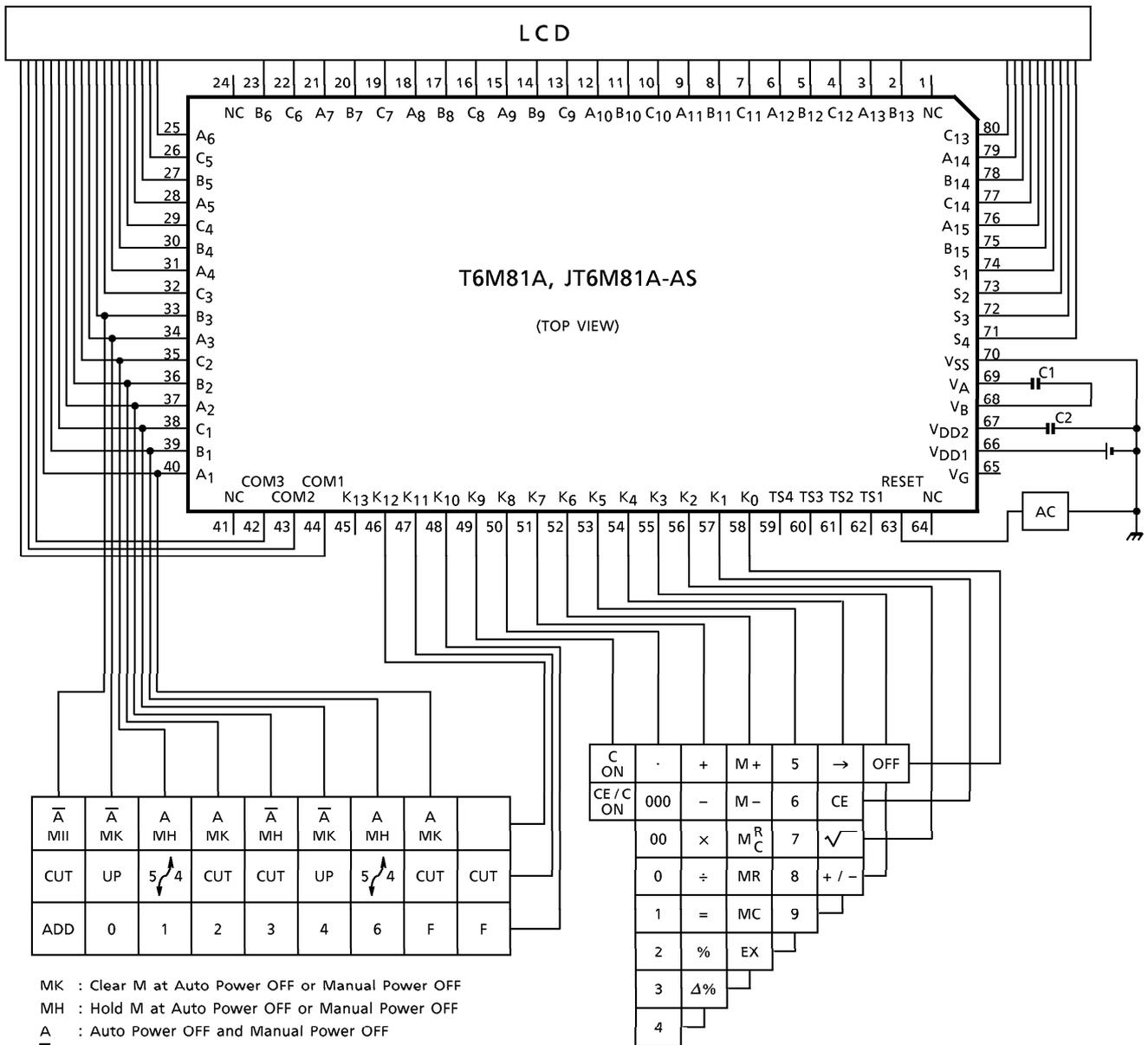
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
C1 = C2 = 0.1 μF

Dual Type

T6M81A, JT6M81A-AS

(TOP VIEW)

MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
C1 = C2 = 0.1 μF
C3 = 10 μF

Solar Type

T6M81A, JT6M81A-AS

(TOP VIEW)

$\overline{A}$ MII	$\overline{A}$ MK	A MH	A MK	$\overline{A}$ MH	$\overline{A}$ MK	A MH	A MK	
CUT	UP	5↗4	CUT	CUT	UP	5↗4	CUT	CUT
ADD	0	1	2	3	4	6	F	F

C ON	·	+	M+	5	→	OFF
CE / C ON	000	−	M−	6	CE	
	00	×	M$_C^R$	7	√	
	0	÷	MR	8	+ / −	
	1	=	MC	9		
	2	%	EX			
	3	Δ%				
	4					

MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
A   : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
C1 = C2 = 0.1 μF
C3 = 10 μF
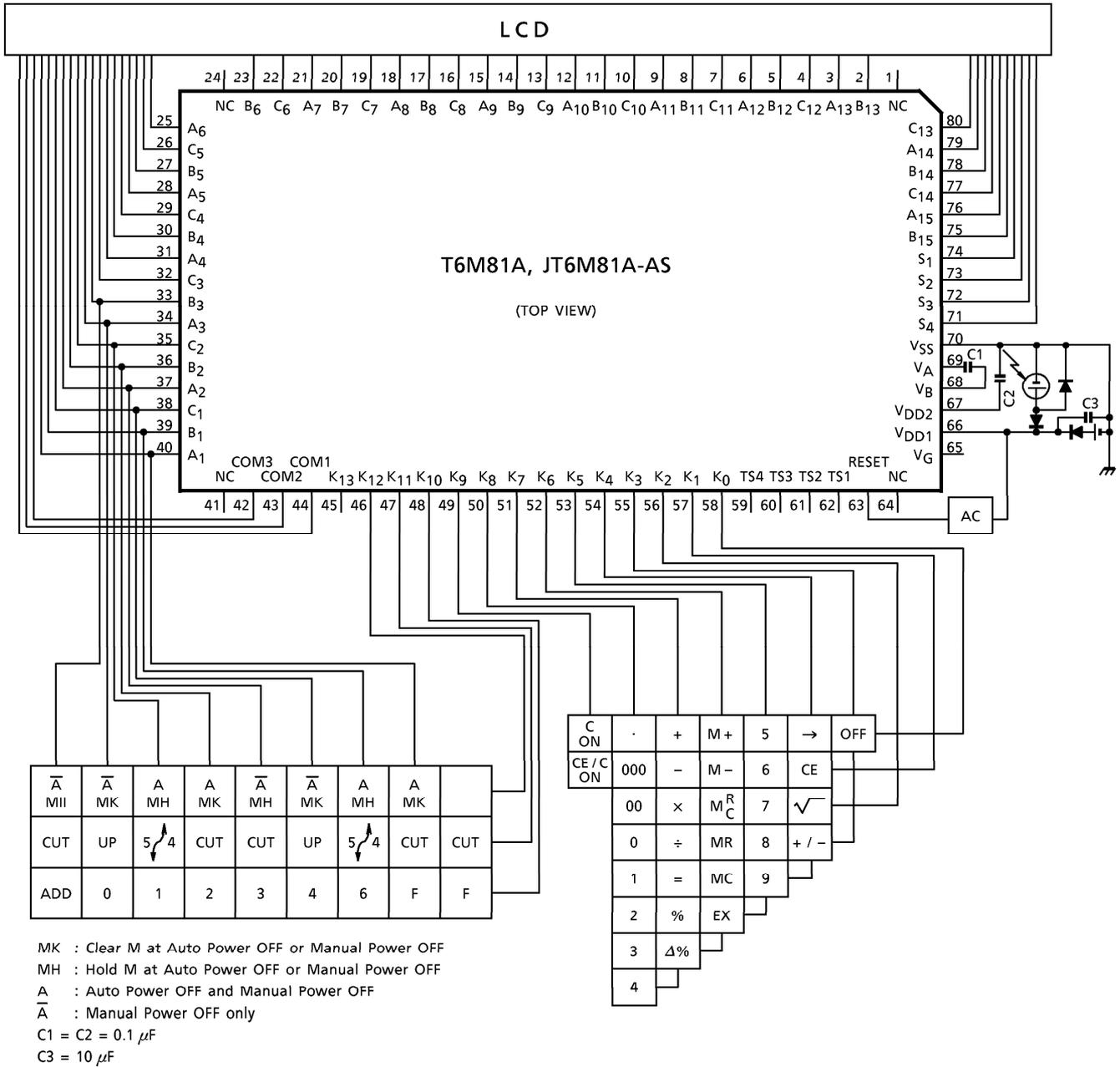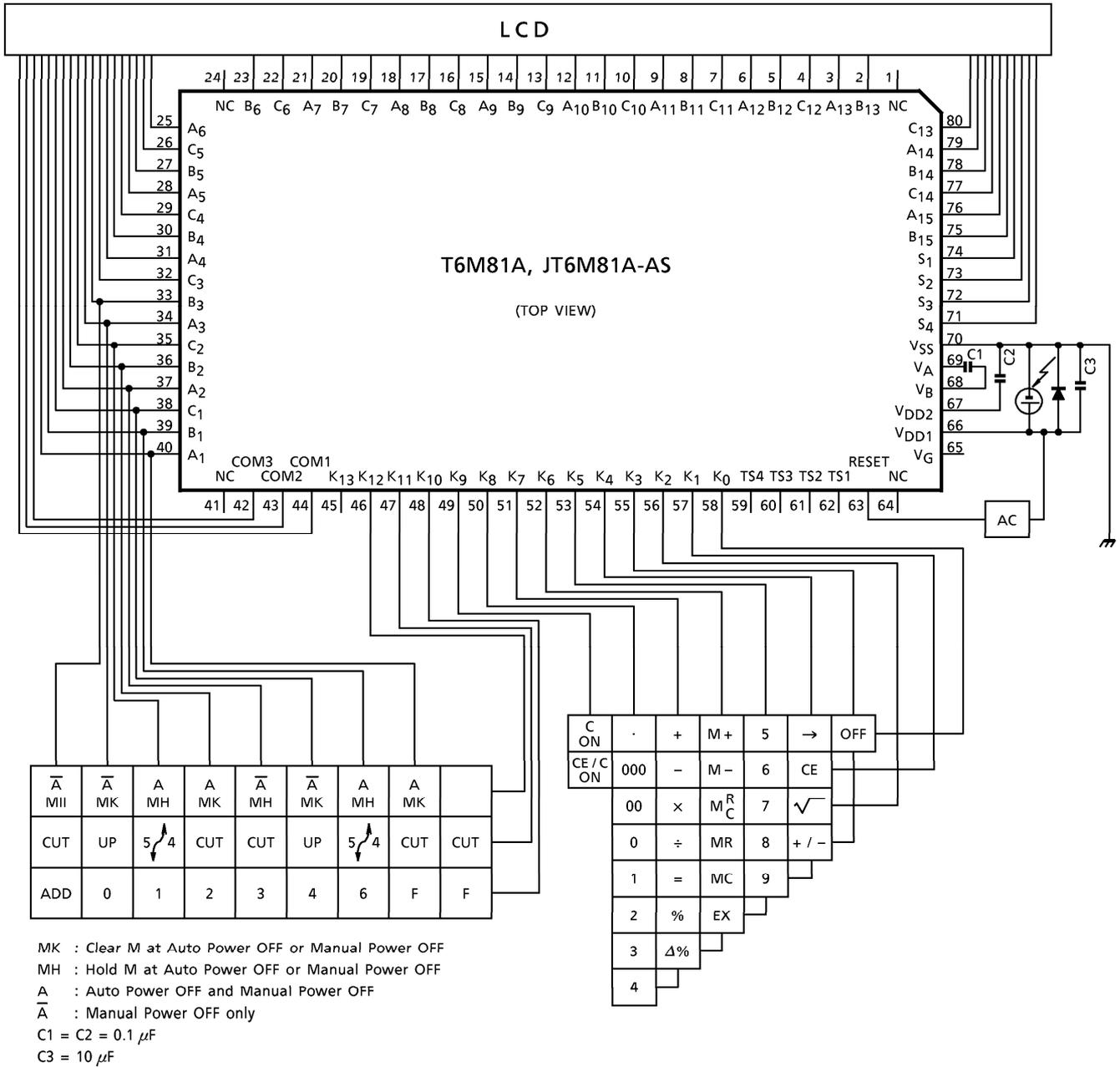
CONNECTION OF LCD

SEGMENT
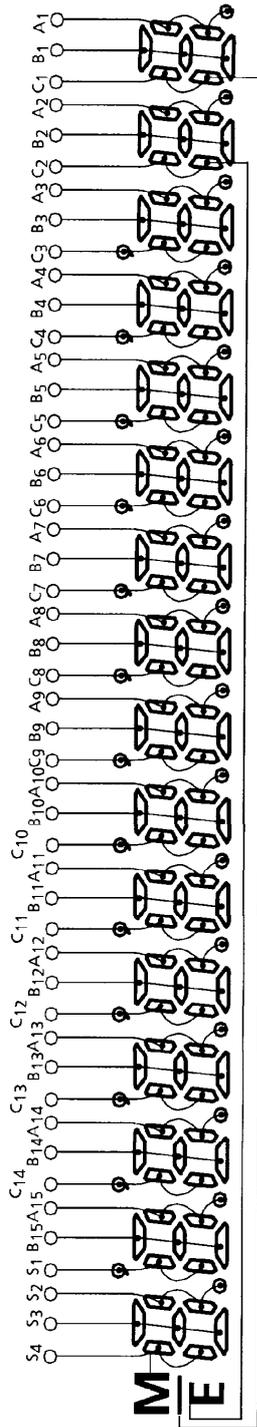
COMMON
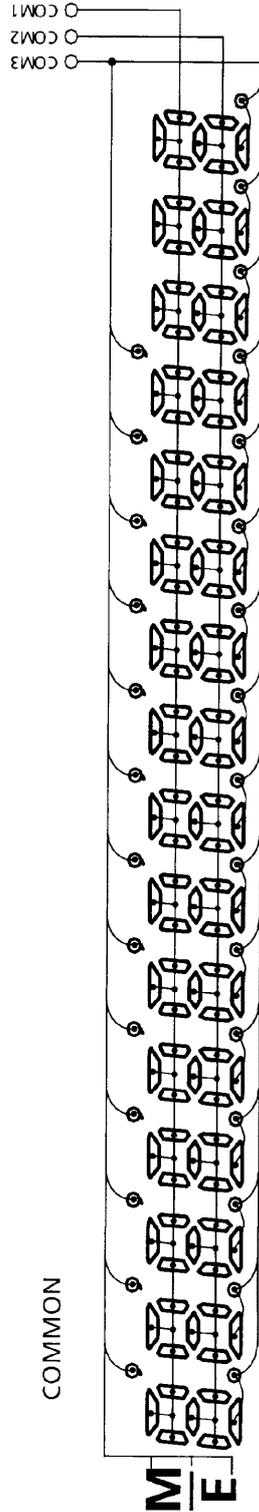
KEY CONNECTION
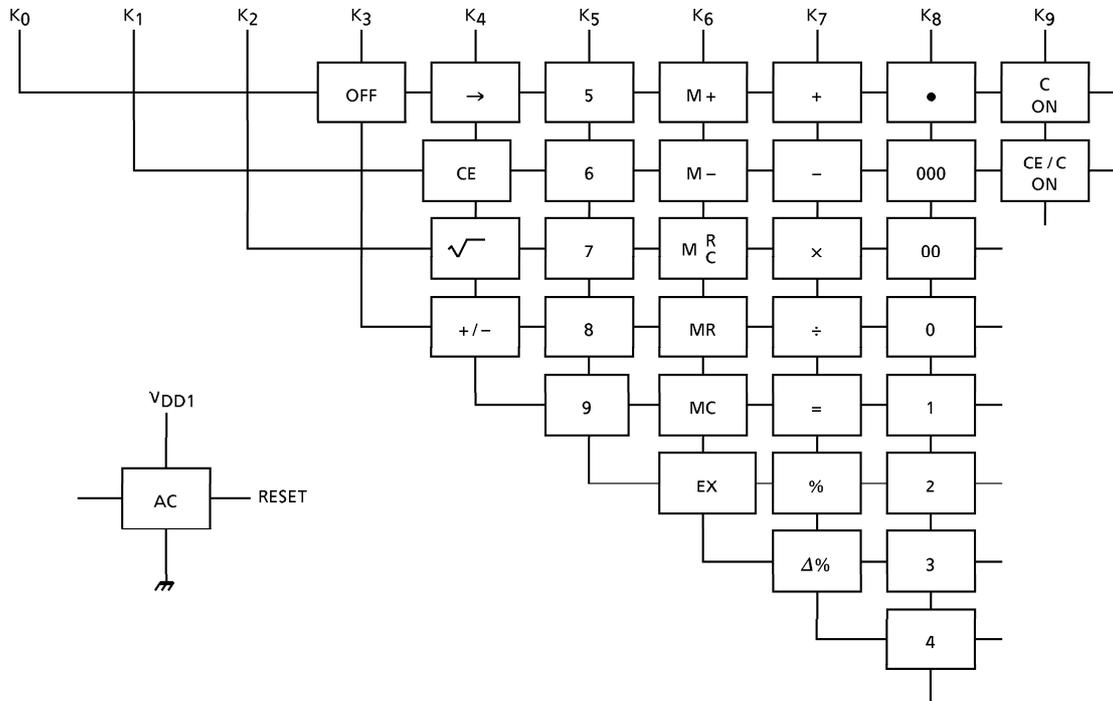
Touch Key
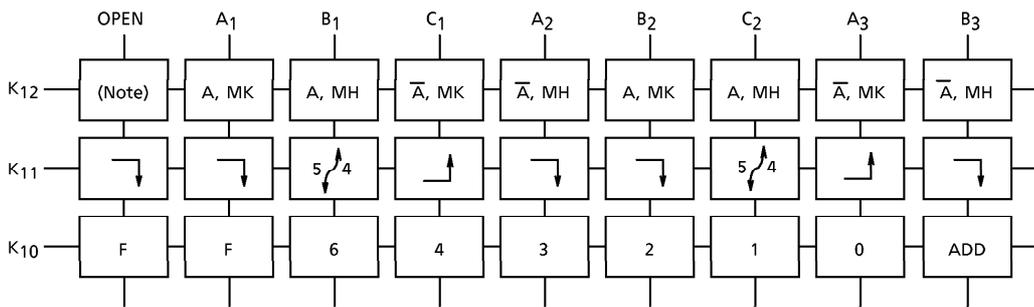
Lock Key

K_{12} .... Selectable with Auto Power OFF mode and Total switch.
MH (Memory Hold), MK (Memory Kill)
K_{11} .... Rounding switches
K_{10} .... Selectable with Fixed point or Floating mode.

(Note) : K_{12} line is No choose then keep condition.
K_{12} line is No choose at the system power on then initial condition is $\overline{A}$, MH
Mode selected.

PIN ASSIGNMENT
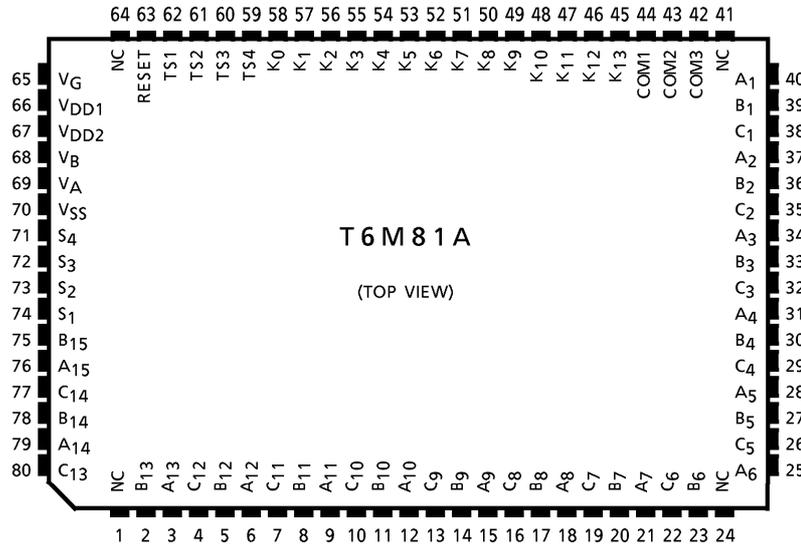
SPECIFICATION OF CALCULATOR

Speed of calculation

Numeral	....	27.8~40.9 ms

Function		
	1 $\boxed{+}$	42.7 ms
	1 $\boxed{+}$ 2 $\boxed{+}$	83.9 ms

Addition and subtract		
	1 2 3 $\boxed{+}$ 1 $\boxed{=}$	82.8 ms
	9999999999999999 $\boxed{-}$ 0.000000000000001 $\boxed{=}$	106.4 ms

| Multiply		
	1 2 3 $\boxed{\times}$ 2 $\boxed{=}$	110.8 ms
	1 $\boxed{\times}$ 9999999999999999 $\boxed{=}$	309.9 ms

Device		
	1 2 3 $\boxed{\div}$ 3 $\boxed{=}$	165.1 ms
	9999999999999999 $\boxed{\div}$ 1 $\boxed{=}$	348.4 ms

Memory calculation		
	2 $\boxed{M+}$	93.8 ms
	9999999999999999 $\boxed{\div}$ 1 $\boxed{M+}$	388.1 ms

Square root		
	9999999999999999 $\boxed{\sqrt{}}$	259.7 ms
	2 $\boxed{\sqrt{}}$	170.2 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

Key	Display	Constant
a	a	
+	a	
k	k	
=	a + k	+ k
b	b	+ k
=	b + k	+ k

④ Subtraction

Key	Display	Constant
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					Discount		
	Key	Display				Key	Display
①	a	a			②	a	a
	$\times$	a				$\times$	a
	b	b				b	b
	%	a·b / 100				%	a·b / 100
	+	a·b / 100				−	a·b / 100
	=	a (1 + b / 100)				=	a (1 − b / 100)
③	a	a			④	a	a
	+	a				−	a
	b	b				b	b
	%	a (1 + b / 100)				%	a (1 − b / 100)
⑤	a	a			⑥	a	a
	$\times$	a				$\times$	a
	b	b				b	b
	Δ%	a·(1 + b / 100)				+/−	− b
						Δ%	a (1 − b / 100)

MAXIMUM RATINGS

CHARACTERISTICS	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD1}	$-0.3 \sim 2.0$	V
Input Voltage	V_{IN}	$-0.3 \sim V_{DD1} + 0.3$	V
Operating Temperature	T_{opr}	$0 \sim 40$	°C
Storage Temperature	T_{stg}	$-55 \sim 125$	°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 CIR-CUIT	PIN NAME	TEST CONDITION	MIN	TYP.	MAX	UNIT
Operating Voltage	V_{DD1}	—	—	—	1.2	1.5	2.0	V
"1" Input Voltage	$V_{IH(1)}$	—	$K_2 \sim K_9$ RESET	—	$V_{DD1} - 0.4$	—	V_{DD1}	V
"1" Input Voltage	$V_{IH(2)}$	—	$K_{10} \sim K_{13}$	—	$V_{DD2} - 0.4$	—	V_{DD2}	V
"0" Input Voltage	V_{IL}	—	$K_2 \sim K_{13}$ 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	$V_{OH(2)}$	—	$K_1 \sim K_9$	—	$V_{DD1} - 0.2$	—	V_{DD1}	V
"0" Output Voltage	$V_{OL(2)}$	—	$K_1 \sim K_{13}$	—	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
	$R_{KEYH(2)}$	—	$K_0 \sim K_9$	$V_{OUT} = V_{DD1} - 0.5$ V	—	—	14	kΩ
	$R_{KEYH(3)}$	—	$K_{10} \sim K_{13}$	$V_{OUT} = 0$ V	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
	$R_{KEYL(3)}$	—	$K_0 \sim K_9$ (1)	$V_{OUT} = 0.5$ V	—	—	50	kΩ
	$R_{KEYL(4)}$	—	$K_0 \sim K_9$ (2)	$V_{OUT} = V_{DD1}$	72	—	170	kΩ
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

CHARACTERISTICS	SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	I_{DDWAIT}	—	—	$V_{DD1} = 1.5\,V$	—	—	3.3	μA
	I_{DDOP}	—	—	$V_{DD1} = 1.2\,V$	—	—	8.9	μA
	I_{DDOFF}	—	—	$V_{DD1} = 1.5\,V$	—	—	2.0	μA
Power Off Timer Times	T	—	—	$V_{DD1} = 1.5\,V$	429	600	1001	s

WAVEFORMS FOR DISPLAY
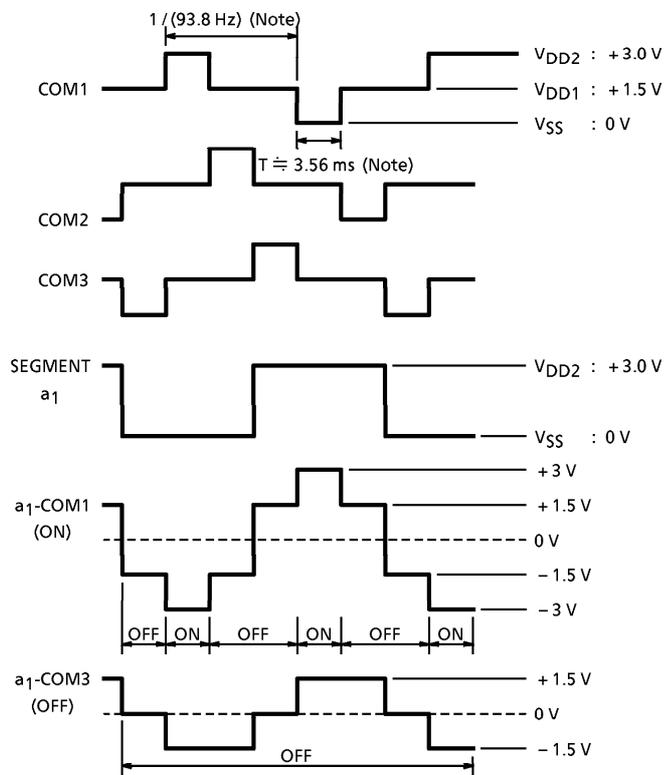
PAD LOCATION TABLE

(μm)

| NAME	X POINT	Y POINT	NAME	X POINT	Y POINT
B_6	-1757	-1680	RESET	1757	1680
C_6	-1757	-1520	(TS1)	1757	1520
A_7	-1757	-1360	(TS2)	1757	1360
B_7	-1757	-1200	(TS3)	1757	1200
C_7	-1757	-1040	(TS4)	1757	1040
A_8	-1757	-880	K_0	1757	880
B_8	-1757	-720	K_1	1757	720
C_8	-1757	-560	K_2	1757	560
A_9	-1757	-400	K_3	1757	400
B_9	-1757	-240	K_4	1757	240
C_9	-1757	-80	K_5	1757	80
A_{10}	-1757	80	K_6	1757	-80
B_{10}	-1757	240	K_7	1757	-240
C_{10}	-1757	400	K_8	1757	-400
A_{11}	-1757	560	K_9	1757	-560
B_{11}	-1757	720	K_{10}	1757	-720
C_{11}	-1757	880	K_{11}	1757	-880
A_{12}	-1757	1040	K_{12}	1757	-1040
B_{12}	-1757	1200	K_{13}	1757	-1200
C_{12}	-1757	1360	COM1	1757	-1360
A_{13}	-1757	1520	COM2	1757	-1520
B_{13}	-1757	1680	COM3	1757	-1680
C_{13}	-1089	1753	A_1	1122	-1752
A_{14}	-929	1753	B_1	962	-1752
B_{14}	-769	1753	C_1	802	-1752
C_{14}	-609	1753	A_2	642	-1752
A_{15}	-449	1753	B_2	482	-1752
B_{15}	-289	1753	C_2	322	-1752
S_1	-129	1753	A_3	162	-1752
S_2	31	1753	B_3	2	-1752
S_3	191	1753	C_3	-158	-1752
S_4	351	1753	A_4	-318	-1752
V_{SS}	511	1753	B_4	-478	-1752
V_A	671	1753	C_4	-638	-1752
V_B	831	1753	A_5	-798	-1752
V_{DD2}	991	1753	B_5	-958	-1752
V_{DD1}	1151	1753	C_5	-1118	-1752
V_G	1388	1753	A_6	-1278	-1752

(Note) : ( ) Do not connect.

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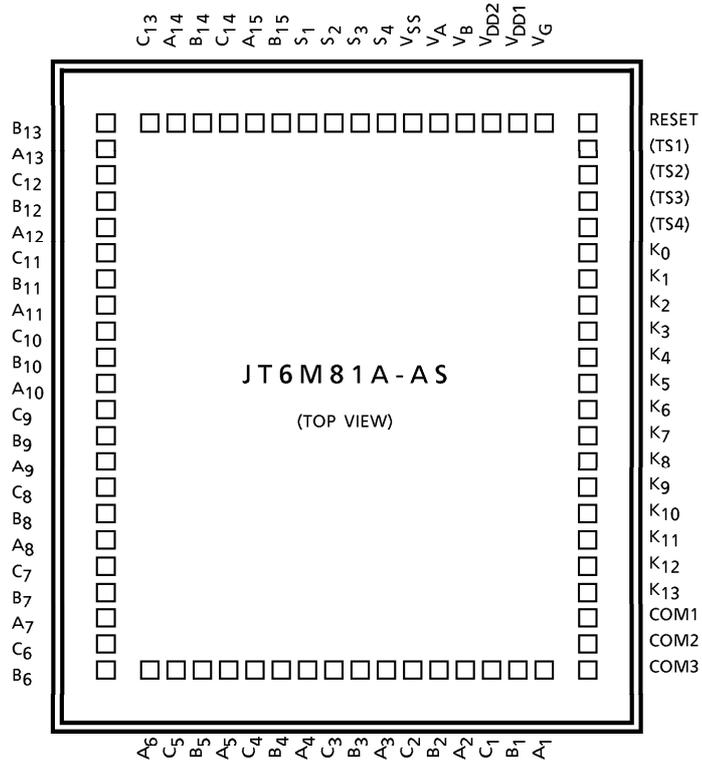
Chip size   : 3.79 × 3.84 (mm)
Chip thickness : 440 ± 30 (μm)
Substrate   : V_{SS}

PAD LAYOUT

PAD Pitch 160 μm
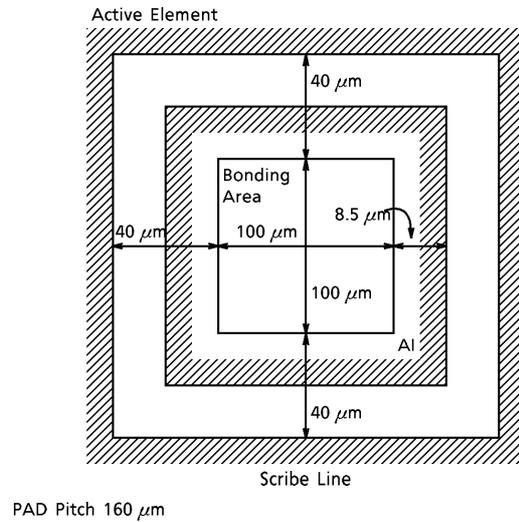
PACKAGE DIMENSIONS

QFP80-P-1420-0.80A

Unit : mm

Weight : 1.52 g (Typ.)