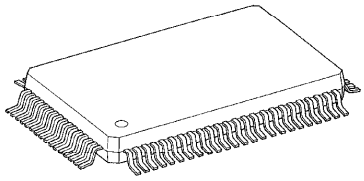
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

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.)

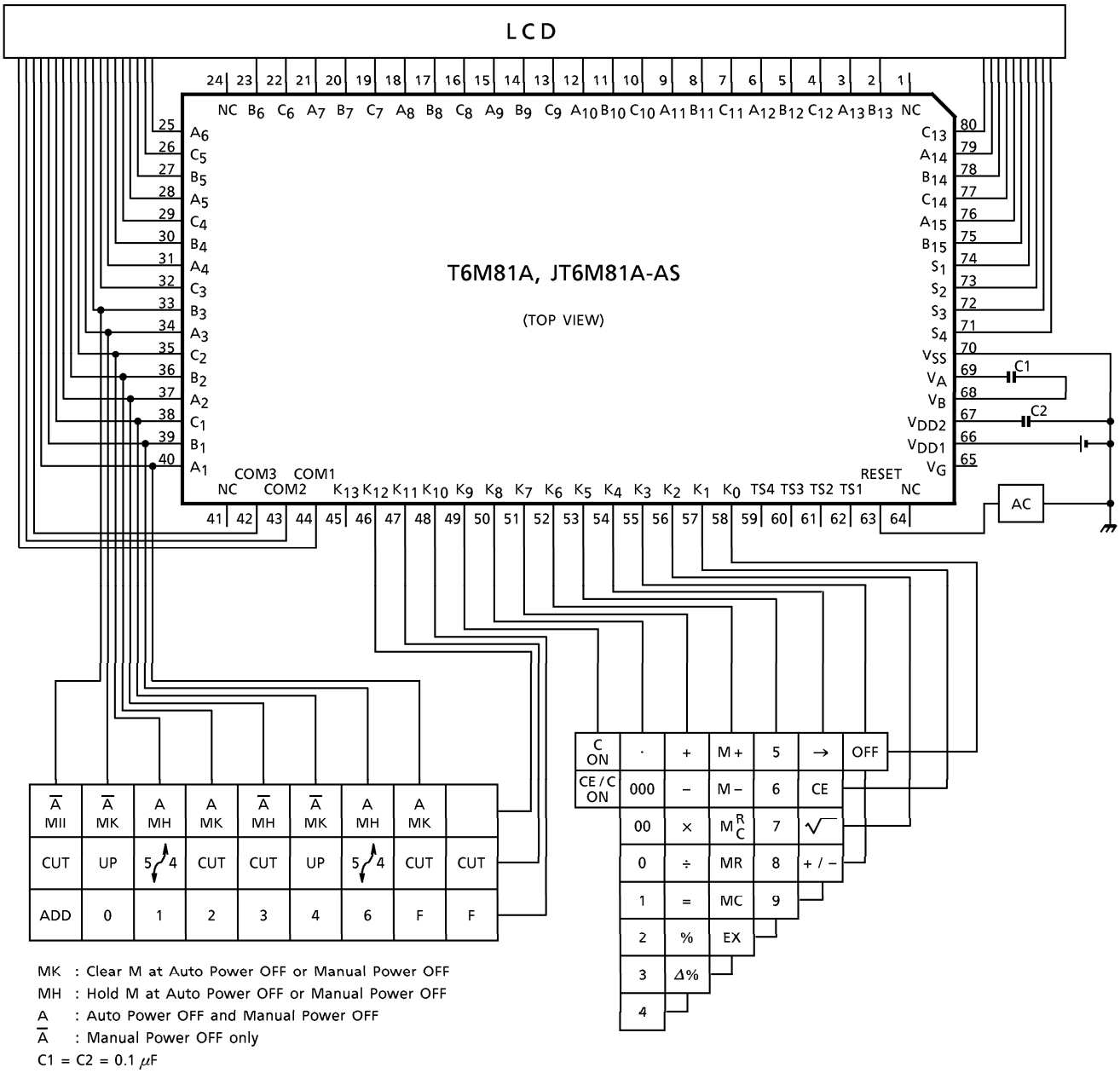
FEATURES

- 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.

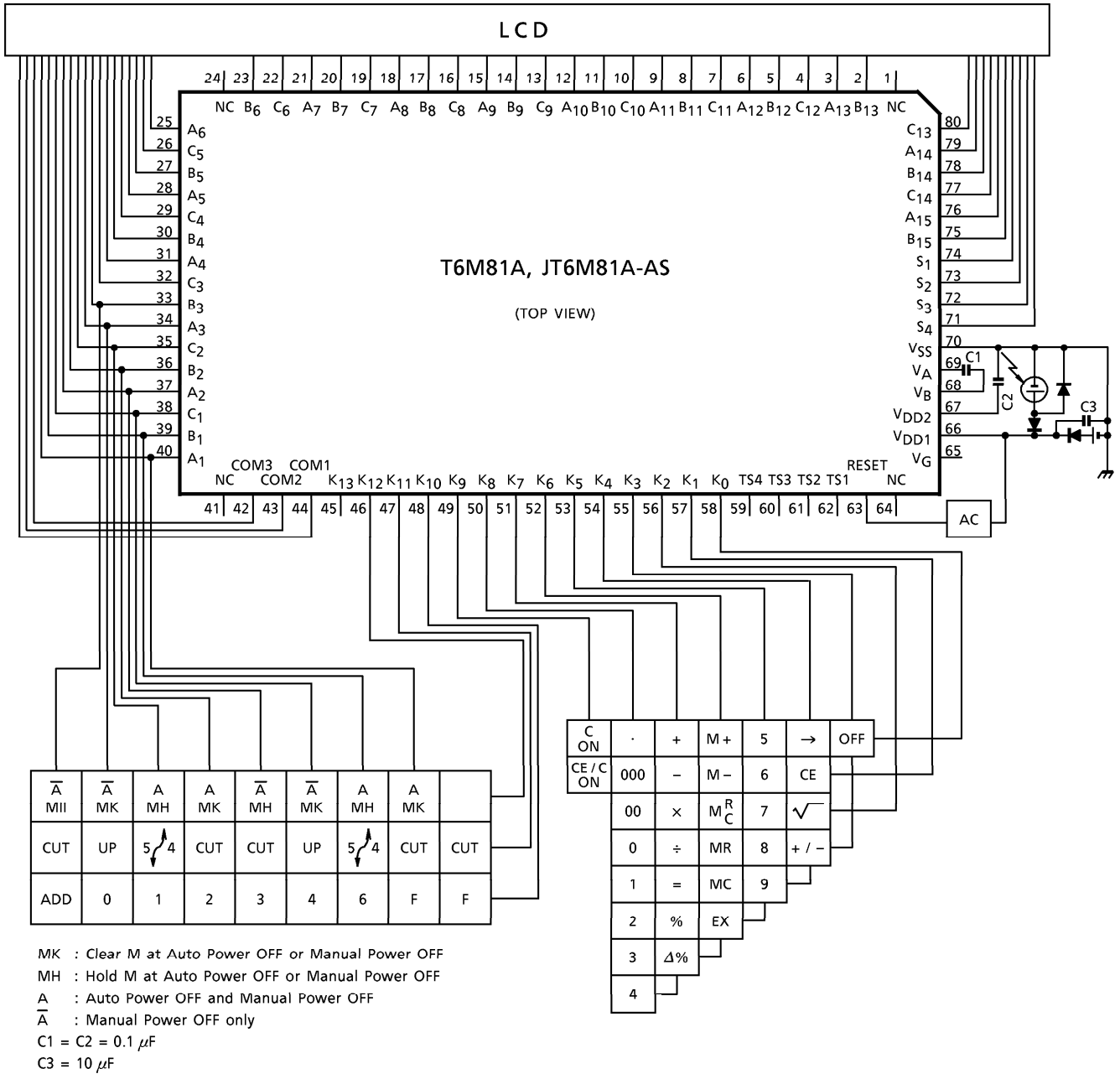
SYSTEM BLOCK DIAGRAM

Battery Type



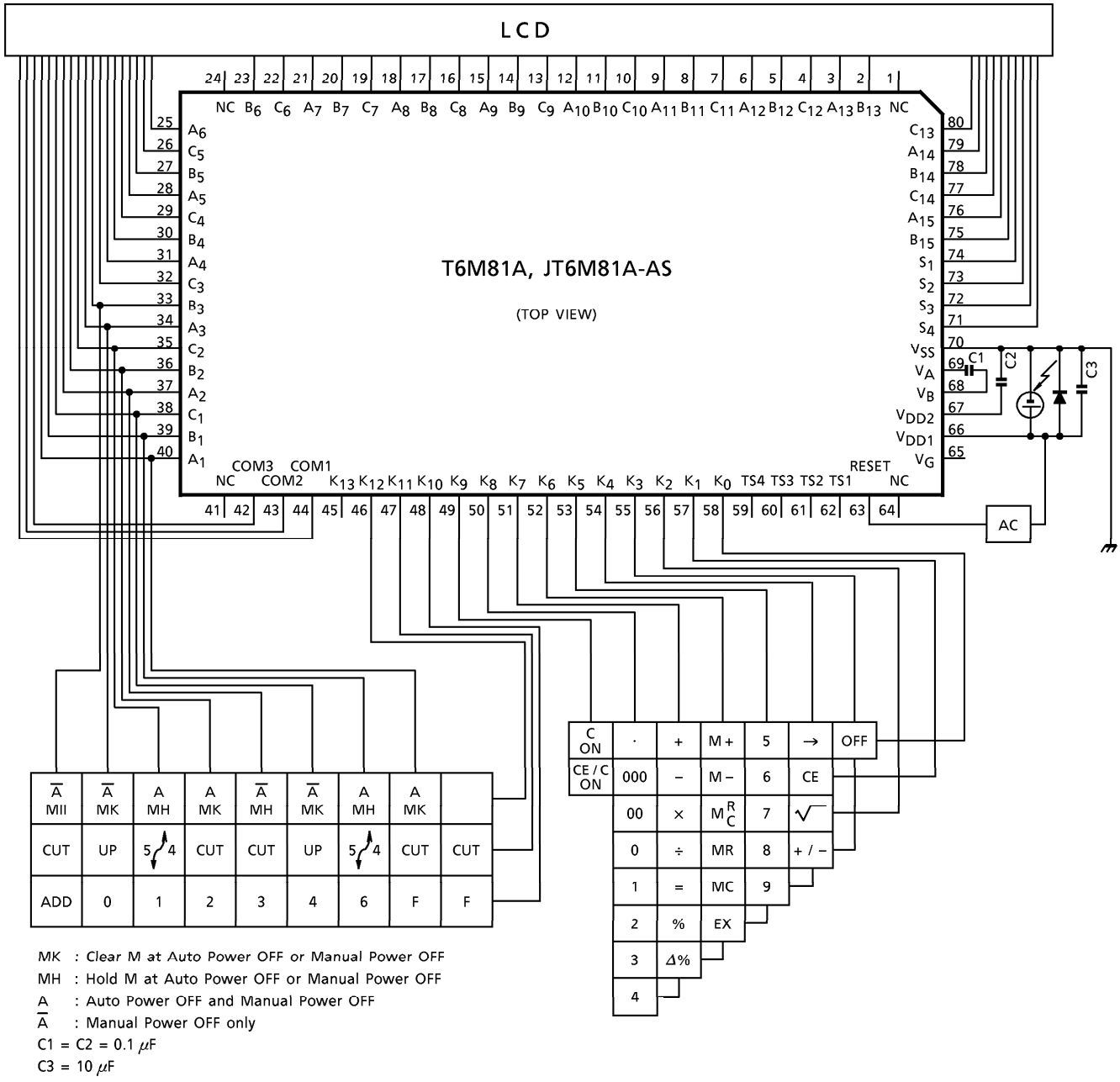
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\overline{A}$: Manual Power OFF only
C1 = C2 = 0.1 μF

Dual Type



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



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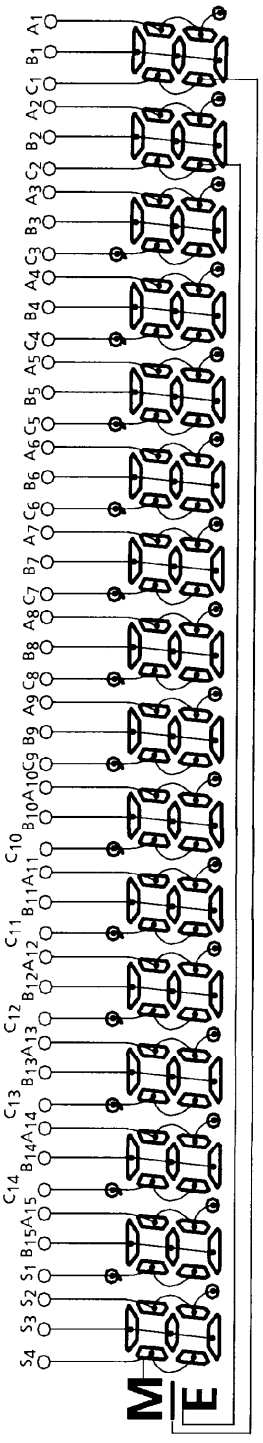
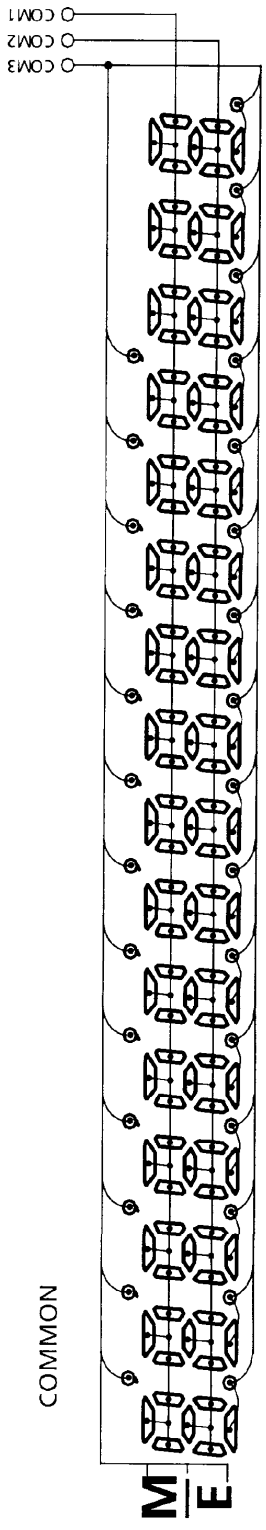
C3 = 10 μF

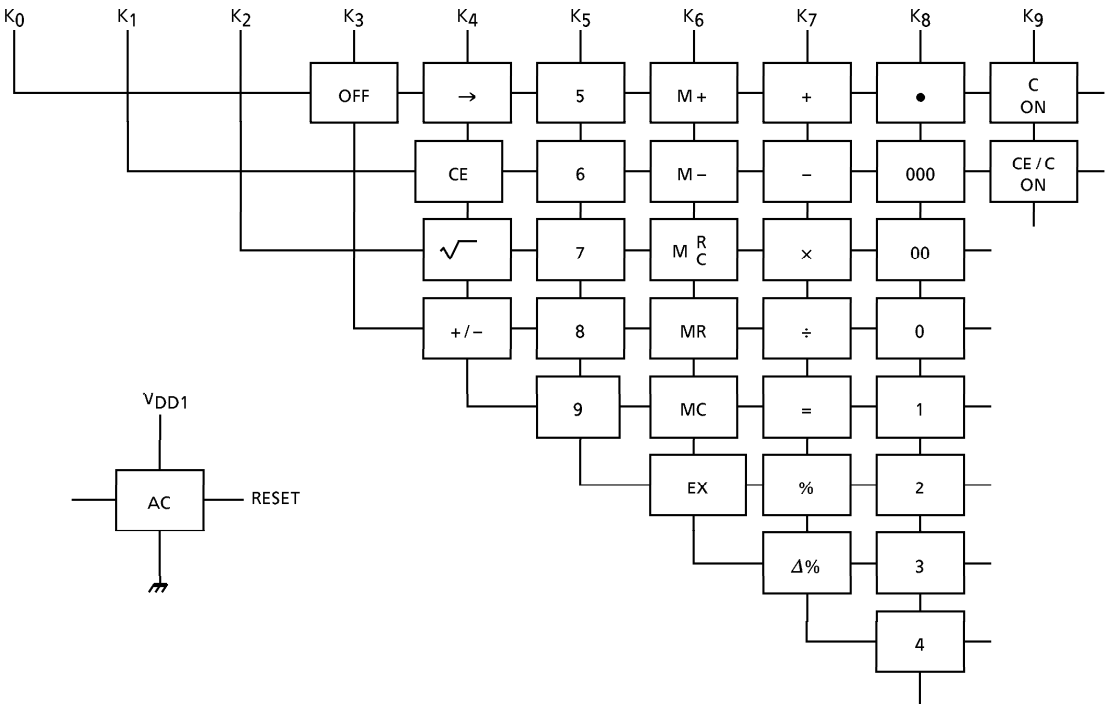
CONNECTION OF LCD



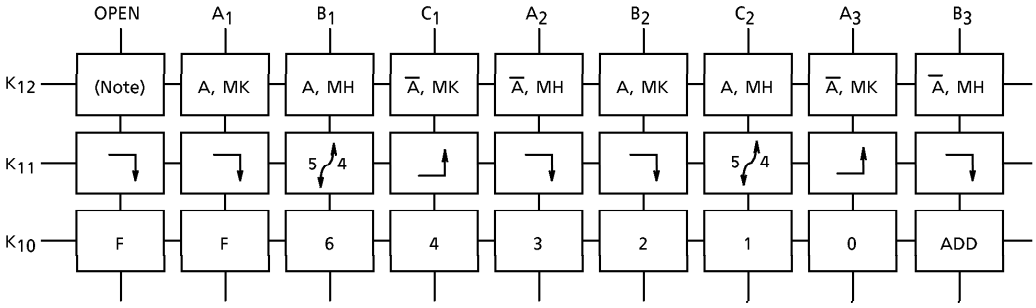


T6M81A, JT6M81A-AS—06

KEY CONNECTION



Touch Key



Lock Key

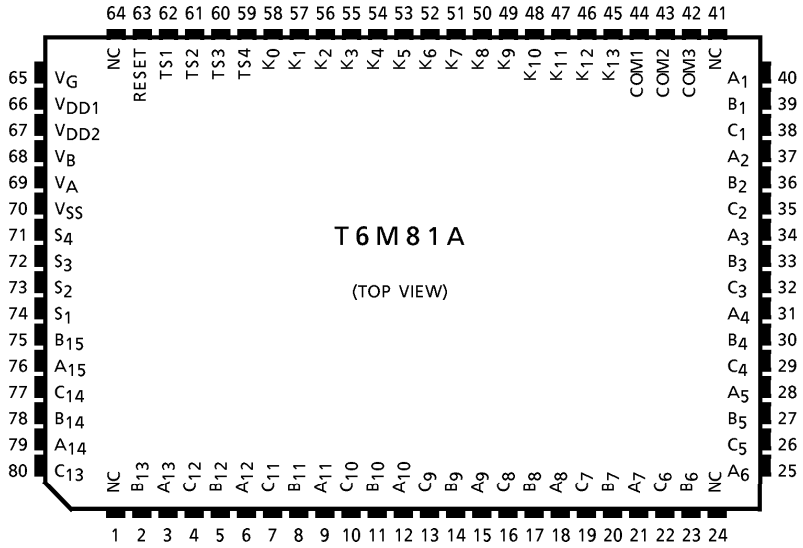
K_{12} .... Selectable with Auto Power OFF mode and Total switch.
MH (Memory Hold) , MK (Memory Kill)

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 [+]	42.7 ms
	1 [+] 2 [+]	83.9 ms
Addition and subtract	1 2 3 [+] 1 [=]	82.8 ms
	9999999999999999 [−] 0.000000000000001 [=]	106.4 ms
Multiply	1 2 3 [×] 2 [=]	110.8 ms
	1 [×] 9999999999999999 [=]	309.9 ms
Device	1 2 3 [÷] 3 [=]	165.1 ms
	9999999999999999 [÷] 1 [=]	348.4 ms
Memory calculation	2 [M+]	93.8 ms
	9999999999999999 [÷] 1 [M+]	388.1 ms
Square root	9999999999999999 [√]	259.7 ms
	2 [√]	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

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)

MAXIMUM RATINGS

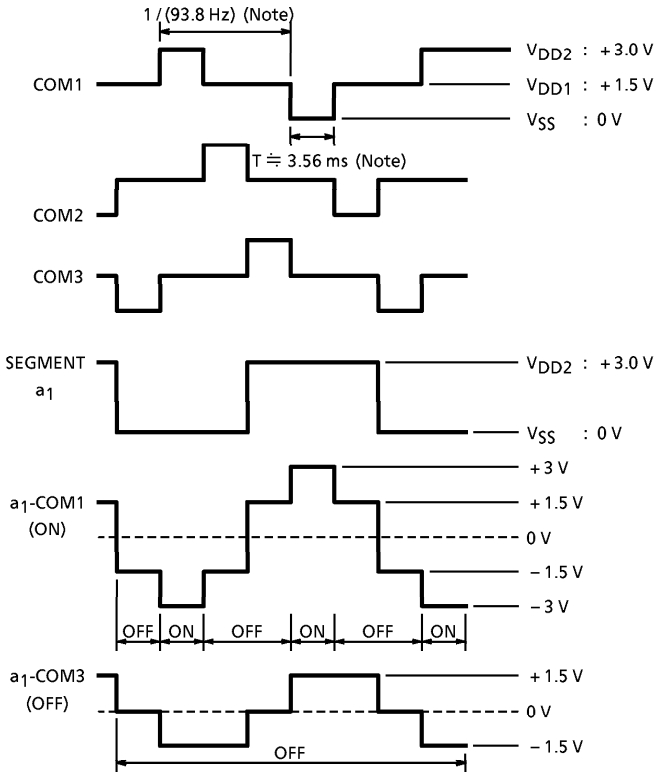
CHARACTERISTICS	SYMBOL	RATING	UNIT
Supply Voltage	V_{DD1}	−0.3~2.0	V
Input Voltage	V_{IN}	−0.3~V_{DD1} + 0.3	V
Operating Temperature	T_{opr}	0~40	°C
Storage Temperature	T_{stg}	−55~125	°C

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 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} − 0.5 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	kΩ
	R_{KEYH} (3)	—	K_{10}~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~K_9 (1)	V_{OUT} = 0.5 V	—	—	50	kΩ
	R_{KEYL} (4)	—	K_0~K_9 (2)	V_{OUT} = V_{DD1}	72	—	170	kΩ
Oscillating (WAIT)	f_{ϕ}WAIT	—	—	V_{DD1} = 1.5 V	5.4	9.0	15.5	kHz
Frequency (OPERATE)	f_{ϕ}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



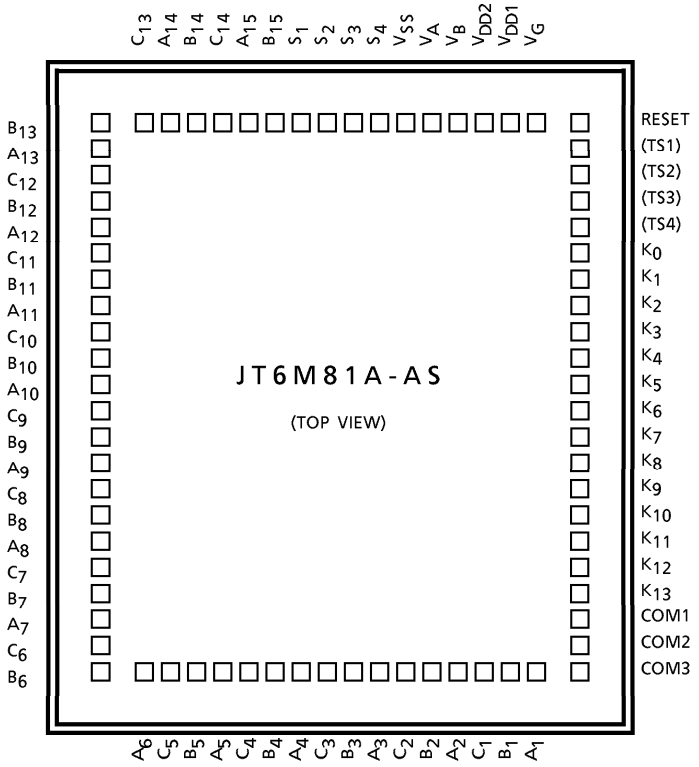
PAD LOCATION TABLE (μm)

NAME	X POINT	Y POINT
B_6	– 1757	– 1680
C_6	– 1757	– 1520
A_7	– 1757	– 1360
B_7	– 1757	– 1200
C_7	– 1757	– 1040
A_8	– 1757	– 880
B_8	– 1757	– 720
C_8	– 1757	– 560
A_9	– 1757	– 400
B_9	– 1757	– 240
C_9	– 1757	– 80
A_{10}	– 1757	80
B_{10}	– 1757	240
C_{10}	– 1757	400
A_{11}	– 1757	560
B_{11}	– 1757	720
C_{11}	– 1757	880
A_{12}	– 1757	1040
B_{12}	– 1757	1200
C_{12}	– 1757	1360
A_{13}	– 1757	1520
B_{13}	– 1757	1680
C_{13}	– 1089	1753
A_{14}	– 929	1753
B_{14}	– 769	1753
C_{14}	– 609	1753
A_{15}	– 449	1753
B_{15}	– 289	1753
S_1	– 129	1753
S_2	31	1753
S_3	191	1753
S_4	351	1753
V_{SS}	511	1753
V_A	671	1753
V_B	831	1753
V_{DD2}	991	1753
V_{DD1}	1151	1753
V_G	1388	1753

NAME	X POINT	Y POINT
RESET	1757	1680
(TS1)	1757	1520
(TS2)	1757	1360
(TS3)	1757	1200
(TS4)	1757	1040
K_0	1757	880
K_1	1757	720
K_2	1757	560
K_3	1757	400
K_4	1757	240
K_5	1757	80
K_6	1757	– 80
K_7	1757	– 240
K_8	1757	– 400
K_9	1757	– 560
K_{10}	1757	– 720
K_{11}	1757	– 880
K_{12}	1757	– 1040
K_{13}	1757	– 1200
COM1	1757	– 1360
COM2	1757	– 1520
COM3	1757	– 1680
A_1	1122	– 1752
B_1	962	– 1752
C_1	802	– 1752
A_2	642	– 1752
B_2	482	– 1752
C_2	322	– 1752
A_3	162	– 1752
B_3	2	– 1752
C_3	– 158	– 1752
A_4	– 318	– 1752
B_4	– 478	– 1752
C_4	– 638	– 1752
A_5	– 798	– 1752
B_5	– 958	– 1752
C_5	– 1118	– 1752
A_6	– 1278	– 1752

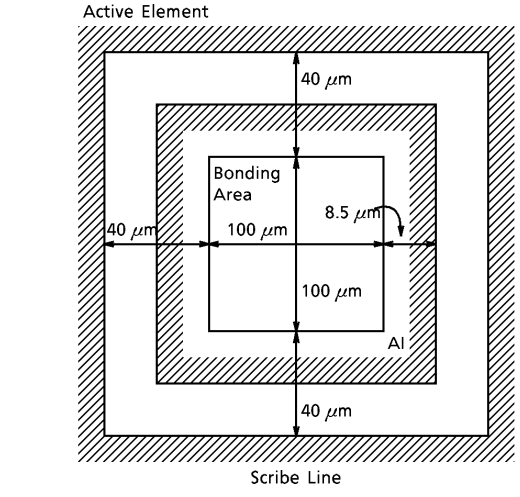
(Note) : ( ) Do not connect.

CHIP LAYOUT



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

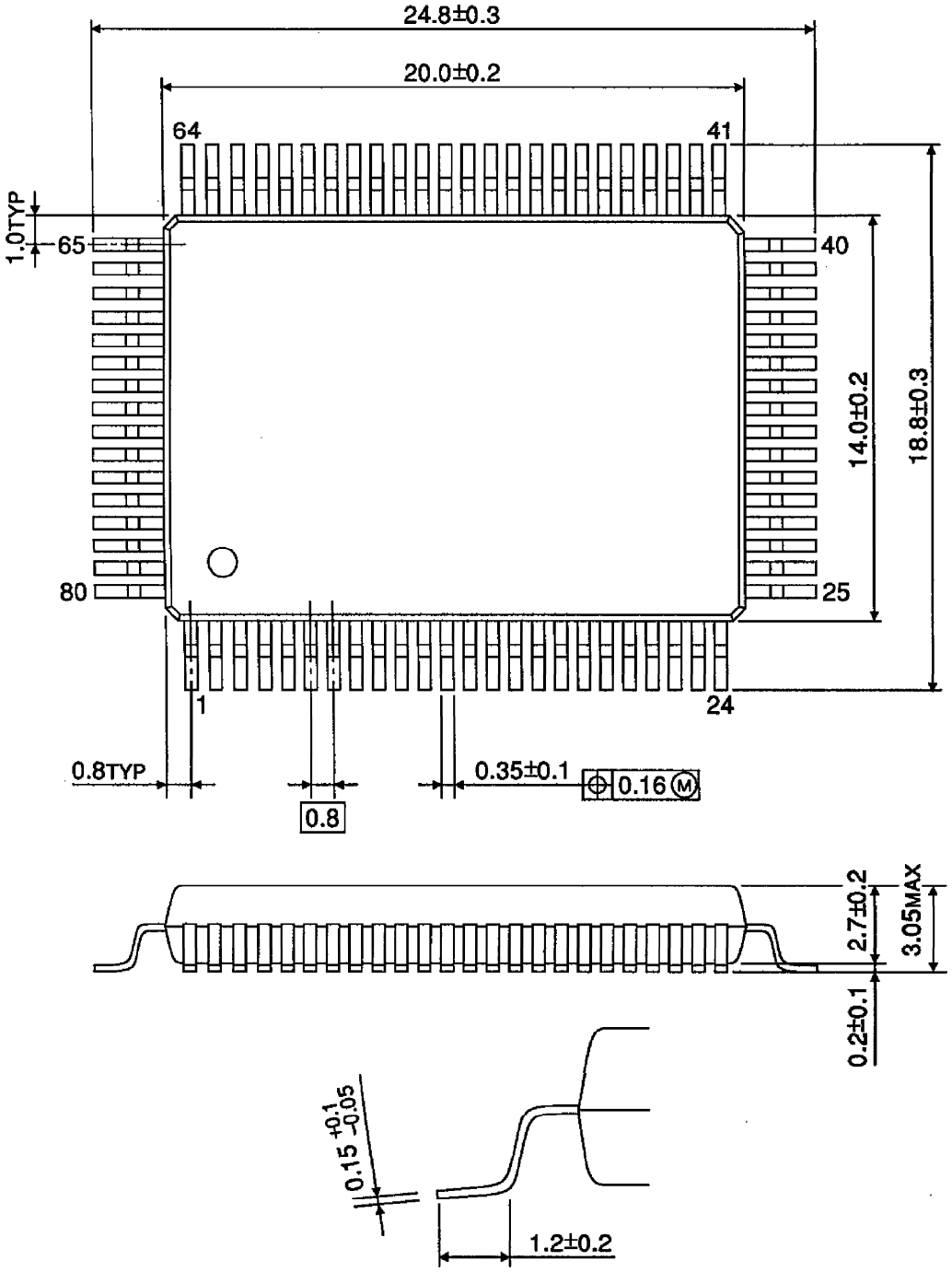
PAD LAYOUT



PAD Pitch 160 μm

PACKAGE DIMENSIONS

QFP80-P-1420-0.80A Unit : mm



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