TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

T6M81A,JT6M81A-AS

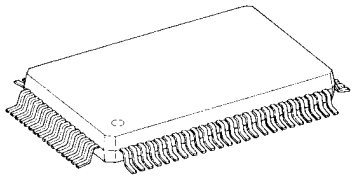
T6M81A, JT6M81A-AS CMOS Single-Chip LSI for LCD Calculator

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.



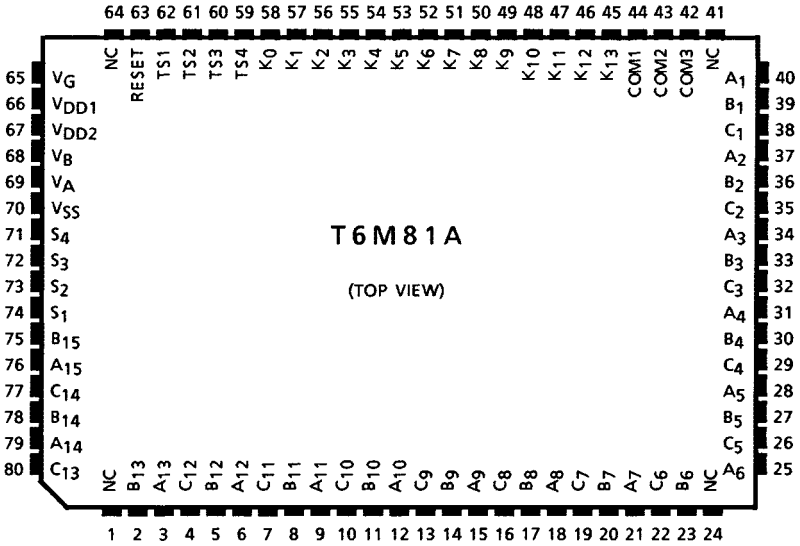
QFP80-P-1420-0.80A

Weight: 1.52 g (typ.)

Features

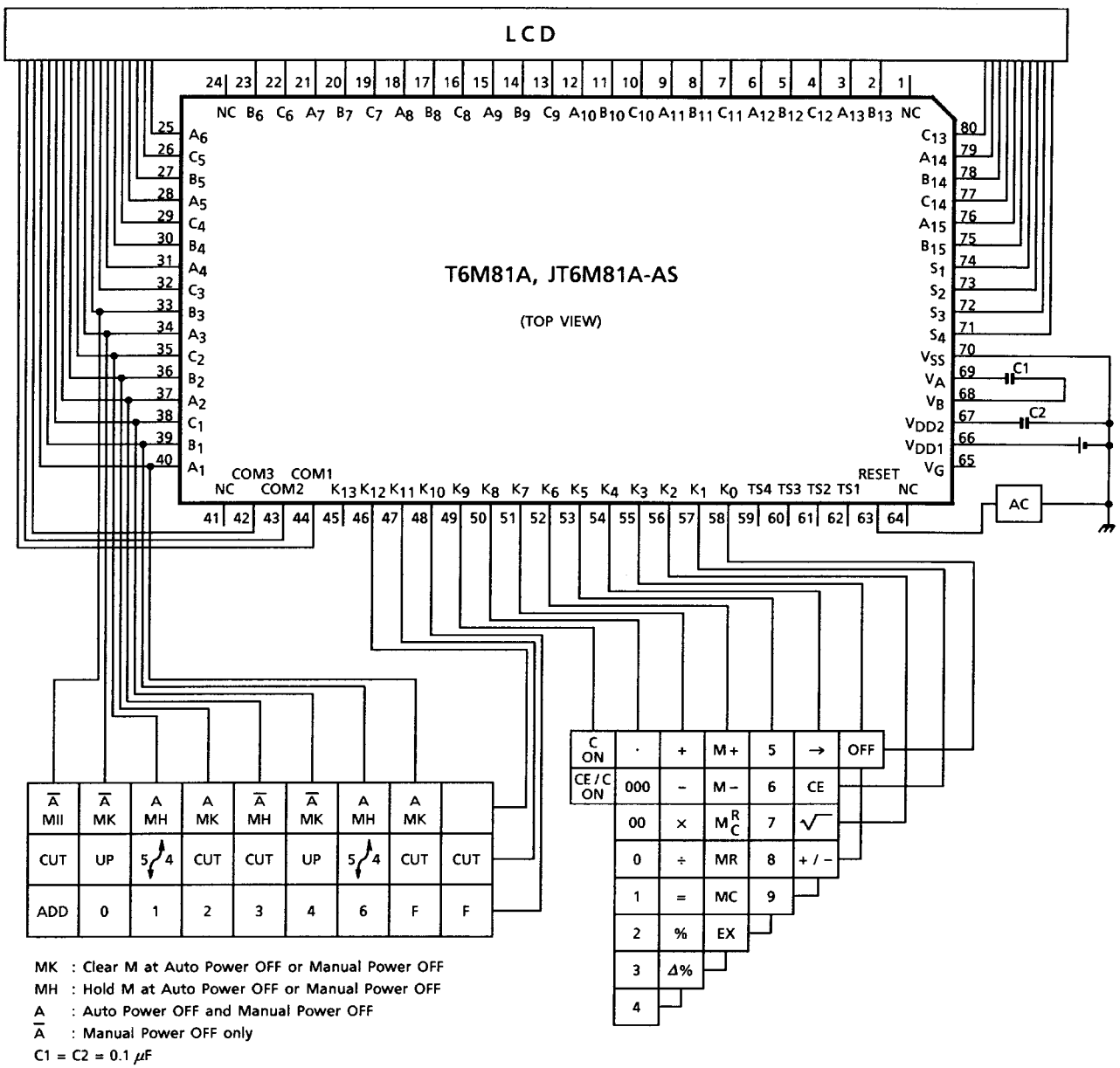
- Display: 16 digits of data, 1 digit of sign, error symbol, memory load symbol.
- Algebraic mode.
- Standard 4 functions (+, −, ×, ÷)
- Automatic percentage operation with add-on, discount.
- Automatic delta percentage, mark-up and mark-down operations.
- Square root.
- Constant calculation.
- Chain 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 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.

Pin Assignment (top view)

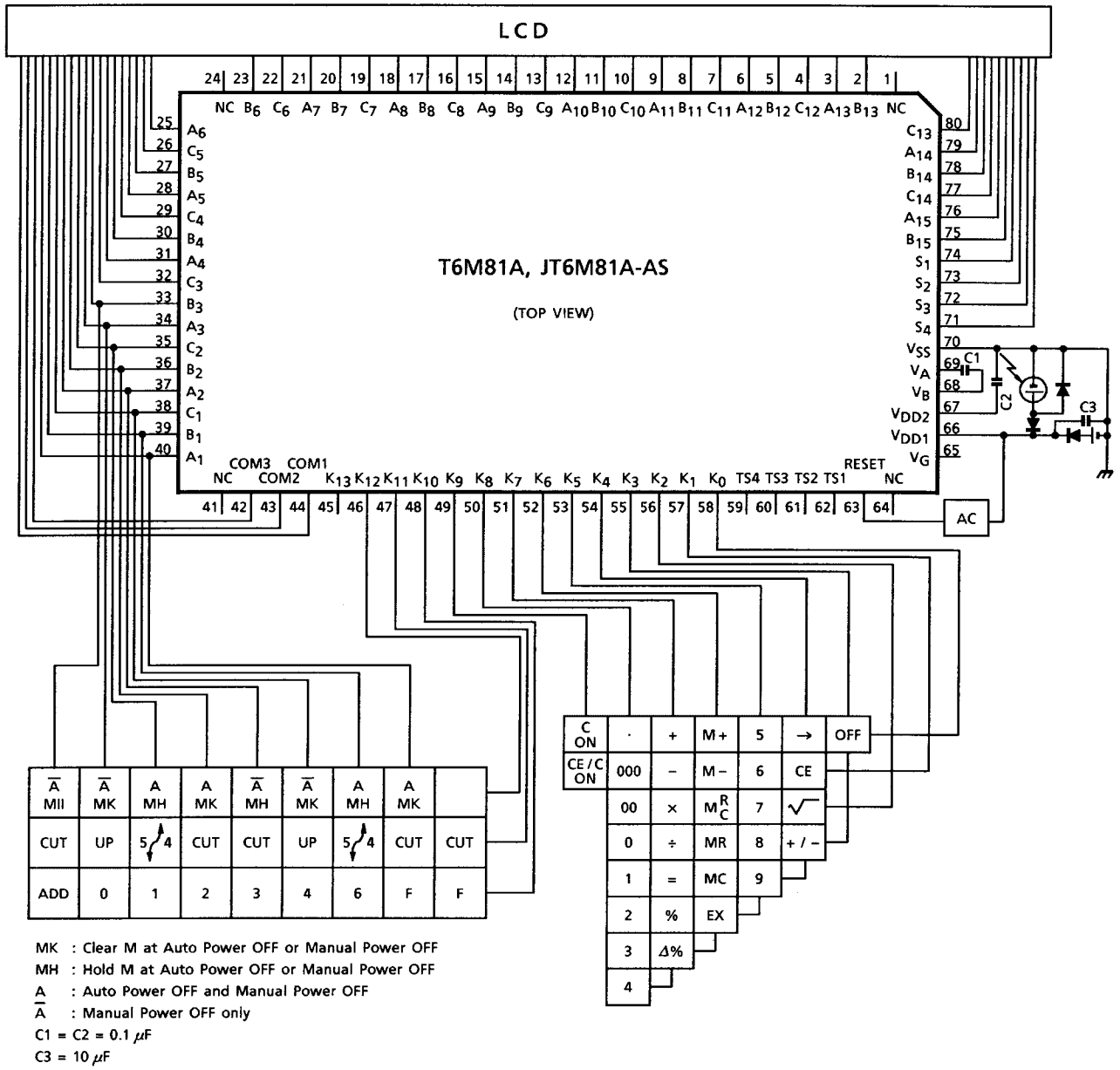


System Block Diagram

Battery Type

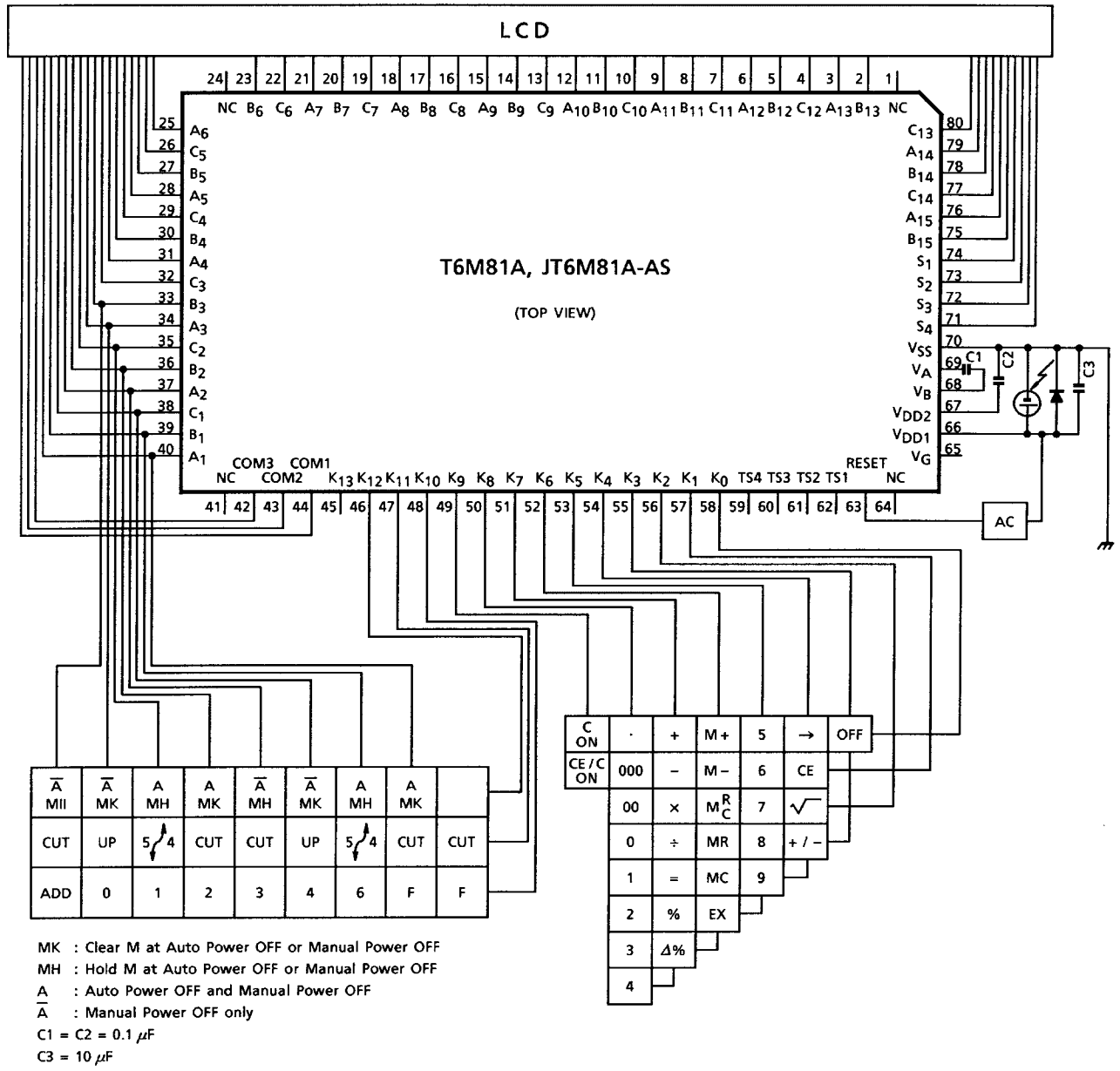


Dual Type



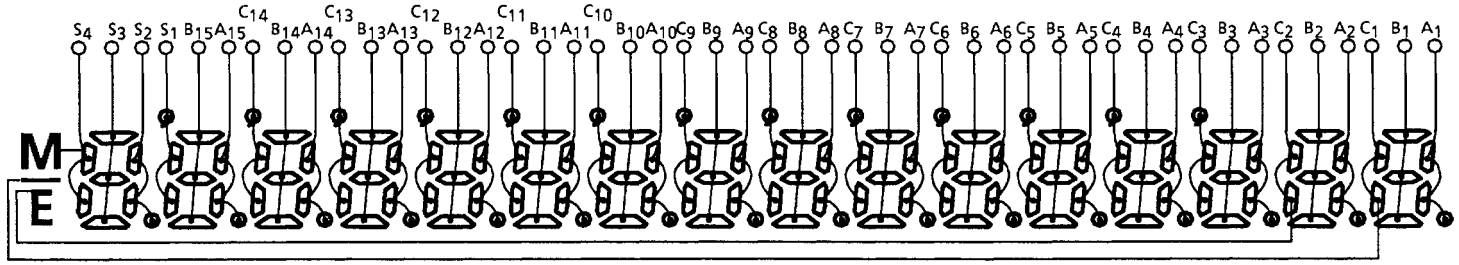
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
$\bar{A}$: Manual Power OFF only
C1 = C2 = 0.1 μF
C3 = 10 μF

Solar Type

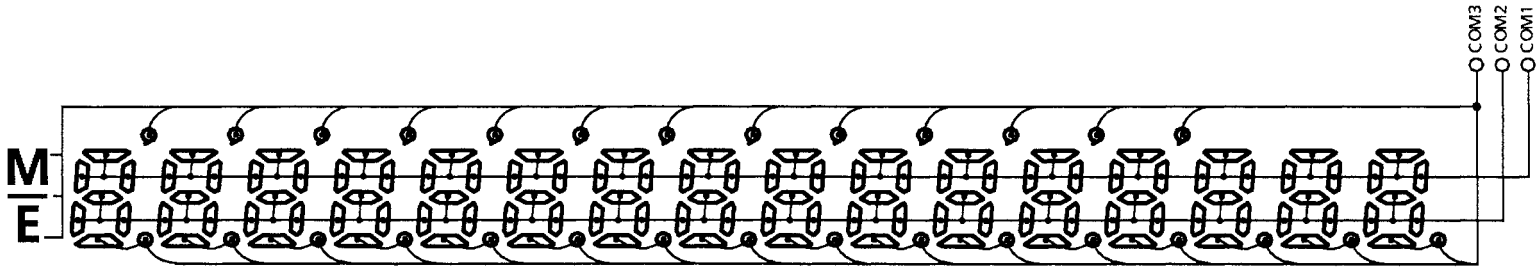

LCD
T6M81A, JT6M81A-AS
(TOP VIEW)
AC
C1
C2
C3
RESET
MK : Clear M at Auto Power OFF or Manual Power OFF
MH : Hold M at Auto Power OFF or Manual Power OFF
A : Auto Power OFF and Manual Power OFF
Ā : Manual Power OFF only
C1 = C2 = 0.1 μF
C3 = 10 μF

Connection of LCD

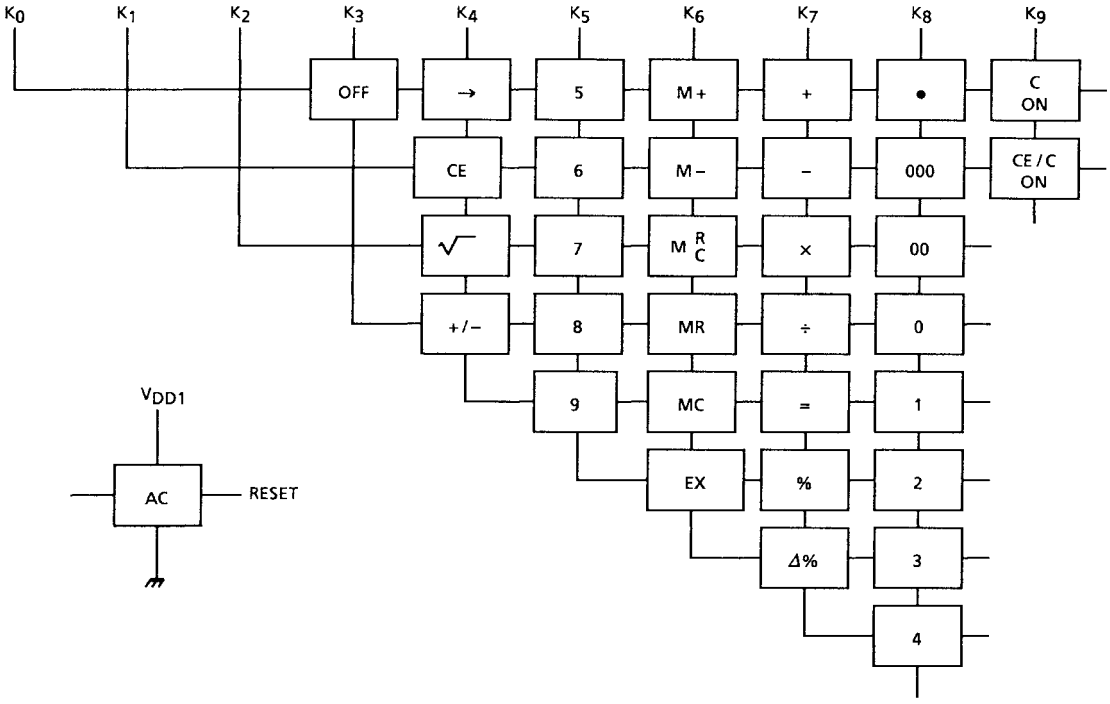
Segment



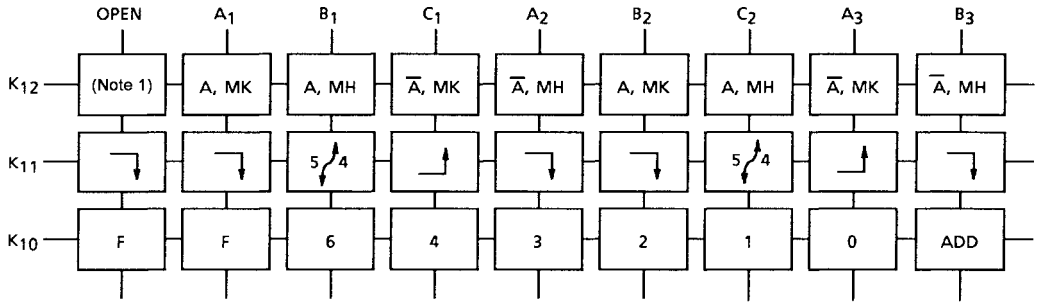
Common



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 1: 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.

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)

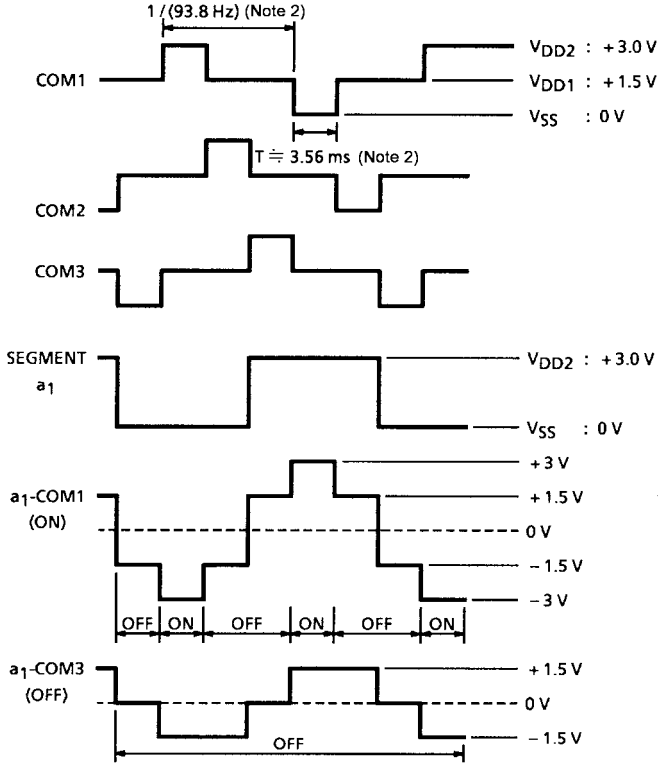
Maximum Ratings

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 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	I_{DDWAIT}	—	—	V_{DD1} = 1.5 V	—	—	3.3	μA
	I_{DDOP}	—	—	V_{DD1} = 1.2 V	—	—	8.9	
	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



Pad Location Table

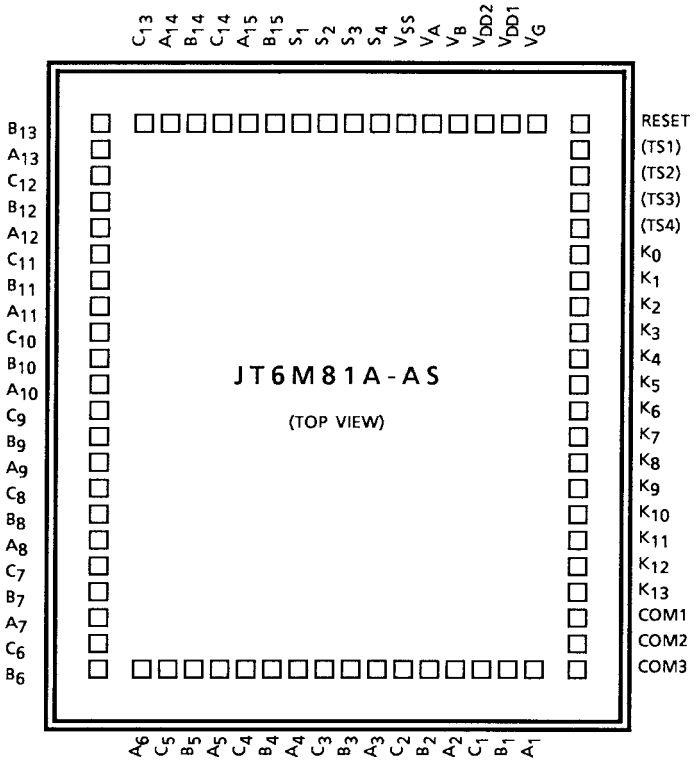
(μm)

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 2: ( ) Do not connect.

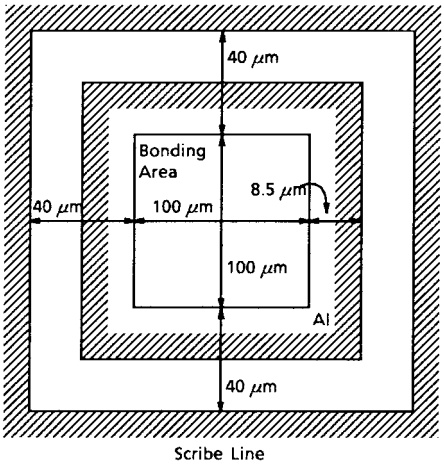
Chip Layout



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

Pad Layout

Active Element

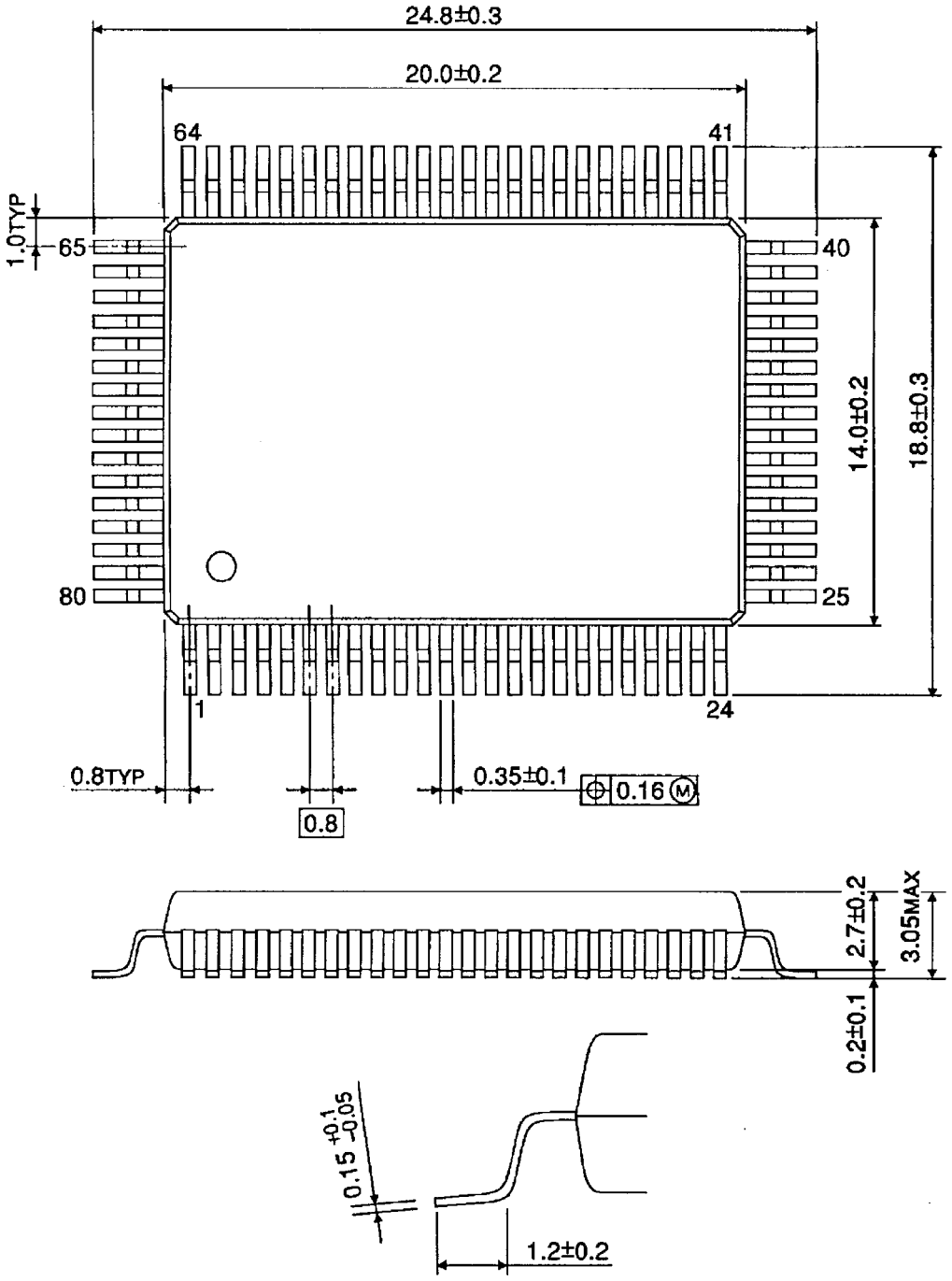


Scribe Line

PAD Pitch 160 μm

Package Dimensions

QFP80-P-1420-0.80A Unit : mm



Weight: 1.52 g (typ.)

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