TOSHIBA CMOS Digital Integrated Circuit   Silicon Monolithic

JT6M57-AS

JT6M57-AS CMOS Single-Chip LSI for LCD Calculator

The JT6M57-AS is a single-chip microcomputer for 12-digit or 10-digit 2-memory calculator. JT6M57-AS can drive the liquid crystal display (LCD). Single power supply operation, wide operating voltage range and low-power consumption make it suitable for 1.5 V solar battery operated calculator. Besides JT6M57-AS can selectable with a pin-programmable to function of Power timer and Memory hold.
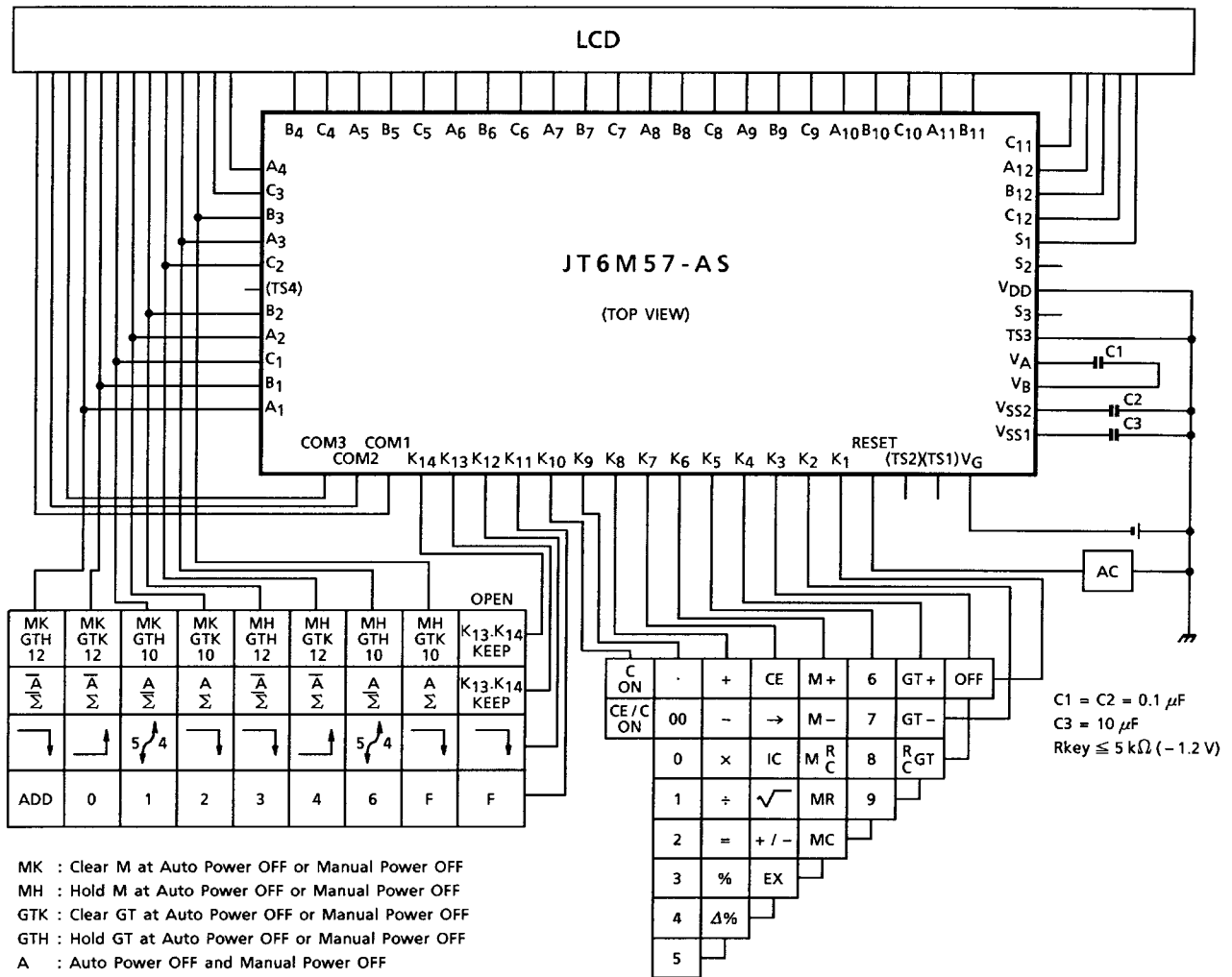
Features

Operational Features

- 12 digits or 10 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 minus.
- Key roll over function (2 keys).
- 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.
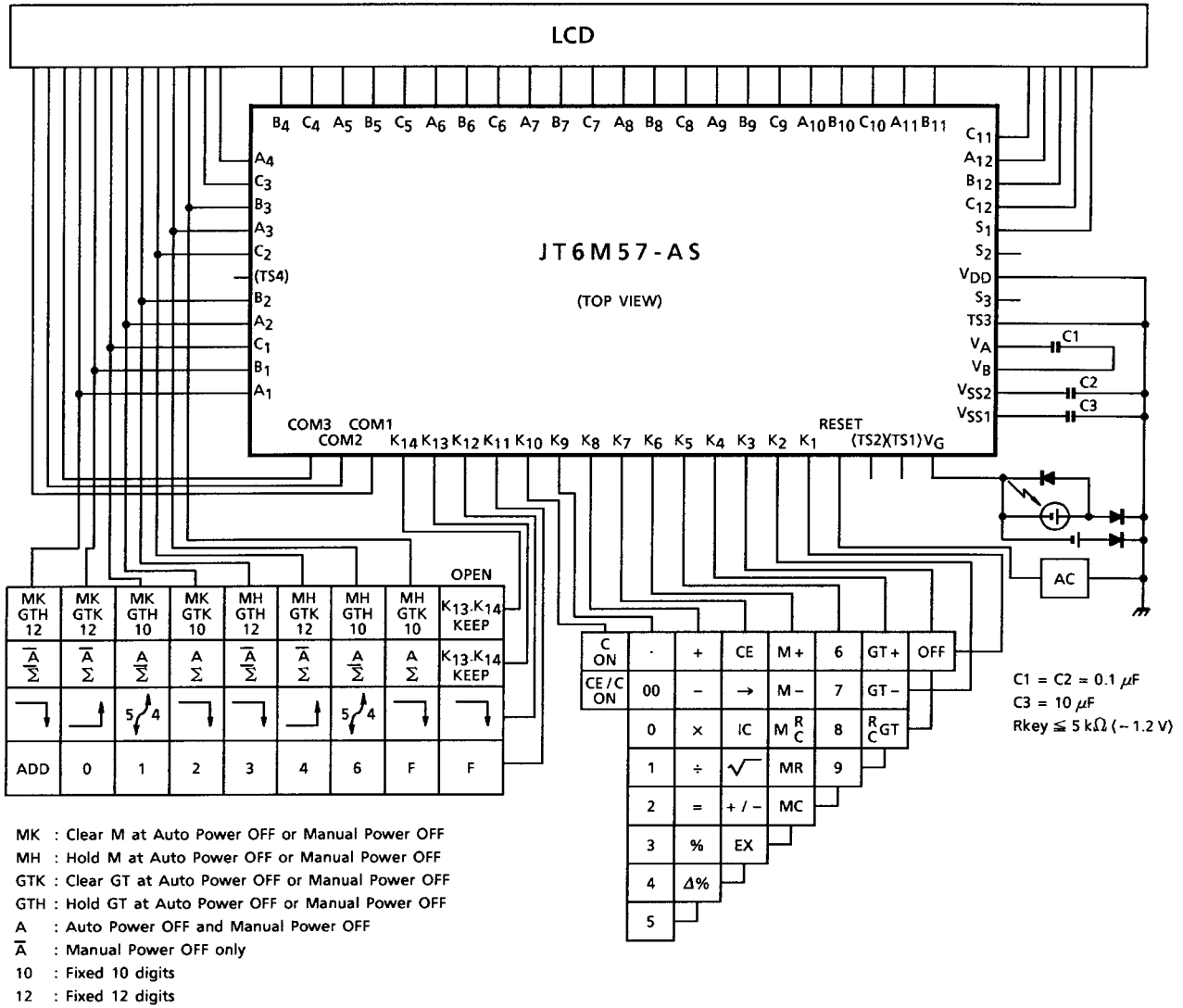
Electrical Features

- Complementary output buffer for direct driving of liquid crystal display (F. E. M LCD).
- Oscillator/clock generator internal to chip.
- Keyboard encoding internal to chip.
- Keyboard denouncing internal to chip.
- Automatic power on clear.
- Wide supply voltage range (−1.2~−2.0 V).
- Very low power consumption (3.3 μW typ.).

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
10 : Fixed 10 digits
12 : Fixed 12 digits

C1 = C2 = 0.1 μF
C3 = 10 μF
Rkey $\leq$ 5 kΩ ($-$1.2 V)

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
$\bar{A}$: Manual Power OFF only
10 : Fixed 10 digits
12 : Fixed 12 digits

$C1 = C2 = 0.1\ \mu F$
$C3 = 10\ \mu F$
$Rkey \leqq 5\ k\Omega\ (\sim 1.2\ V)$

Solar Type

LCD

JT6M57-AS

(TOP VIEW)

Pins (top): B_4 C_4 A_5 B_5 C_5 A_6 B_6 C_6 A_7 B_7 C_7 A_8 B_8 C_8 A_9 B_9 C_9 A_{10} B_{10} C_{10} A_{11} B_{11}

Pins (left): A_4 C_3 B_3 A_3 C_2 (TS4) B_2 A_2 C_1 B_1 A_1

Pins (right): C_{11} A_{12} B_{12} C_{12} S_1 S_2 V_{DD} S_3 $TS3$ V_A V_B V_{SS2} V_{SS1}

Pins (bottom): COM3 COM1 COM2 K_{14} K_{13} K_{12} K_{11} K_{10} K_9 K_8 K_7 K_6 K_5 K_4 K_3 K_2 K_1 RESET (TS2)(TS1)V_G

C1 = C2 = 0.1 μF
C3 = 10 μF
Rkey $\leq$ 5 kΩ ($-$1.2 V)

AC

MK GTH 12	MK GTK 12	MK GTH 10	MK GTK 10	MH GTH 12	MH GTK 12	MH GTH 10	MH GTK 10	OPEN $K_{13} \cdot K_{14}$ KEEP
$\overline{A}$ $\overline{\Sigma}$	$\overline{A}$ Σ	A $\overline{\Sigma}$	A Σ	$\overline{A}$ $\overline{\Sigma}$	$\overline{A}$ Σ	A $\overline{\Sigma}$	A Σ	$K_{13} \cdot K_{14}$ KEEP
⌐	⌐	5/4	⌐	⌐	⌐	5/4	⌐	⌐
ADD	0	1	2	3	4	6	F	F

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
10   : Fixed 10 digits
12   : Fixed 12 digits

C ON	·	+	CE	M +	6	GT +	OFF
CE / C ON	00	−	→	M −	7	GT −	
	0	×	IC	M $\frac{R}{C}$	8	$\frac{R}{C}$ GT	
	1	÷	$\sqrt{\ }$	MR	9		
	2	=	+ / −	MC			
	3	%	EX				
	4	Δ%					
	5						

Connection of LCD

Select of 10 Digits

Segment
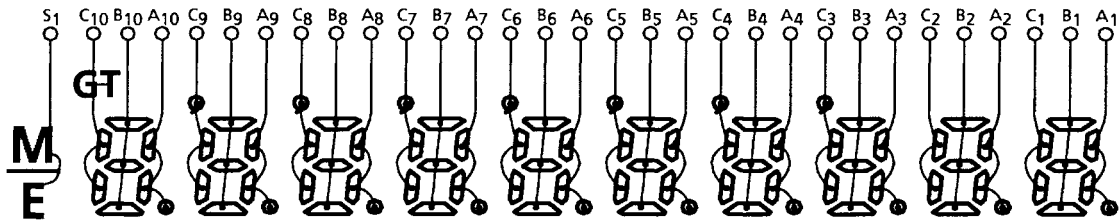
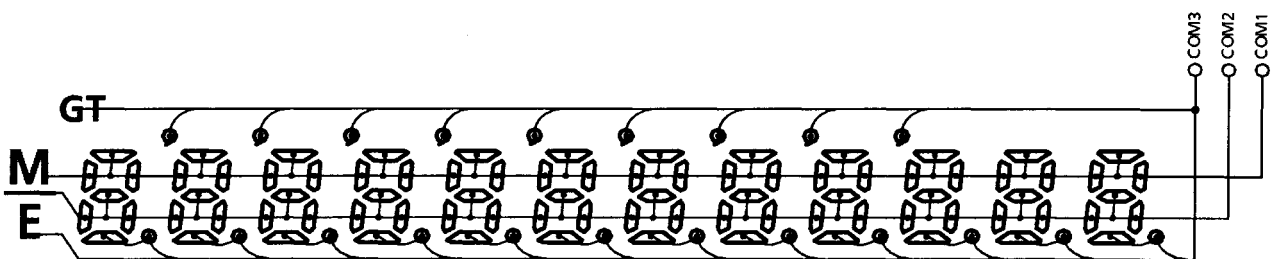**Common**
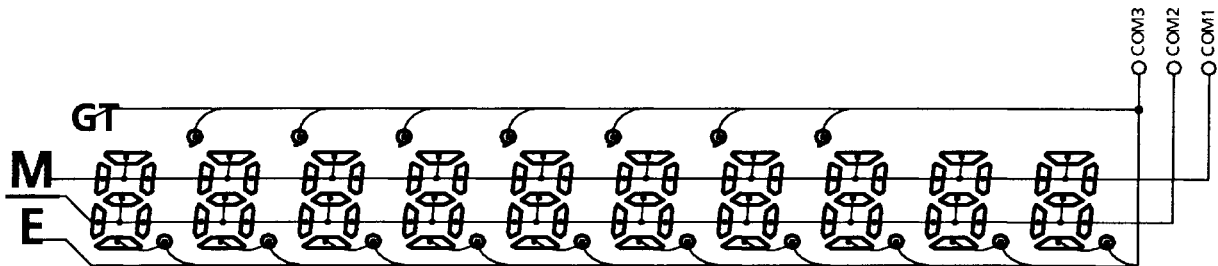
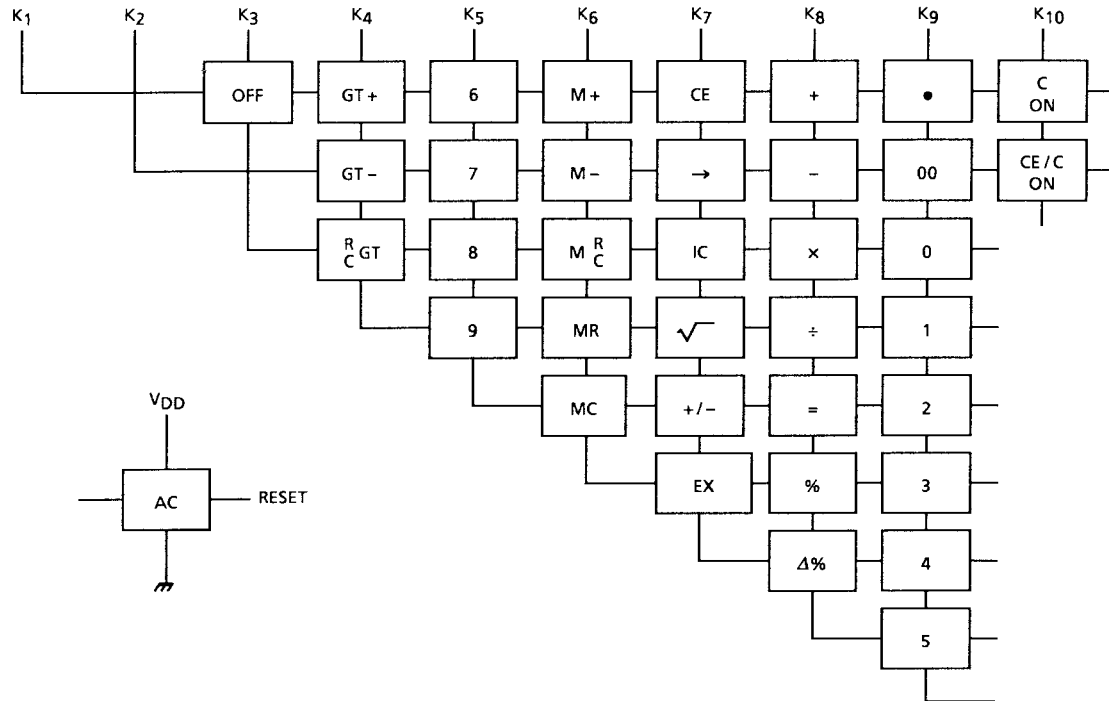### Select of 12 Digits
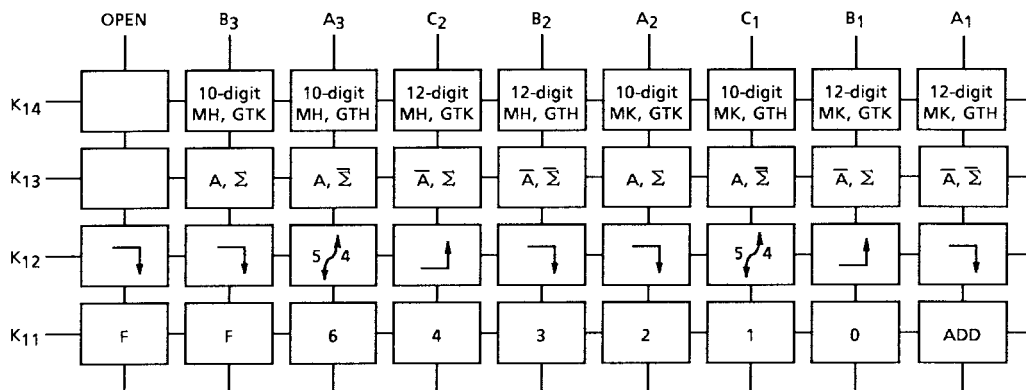
Segment
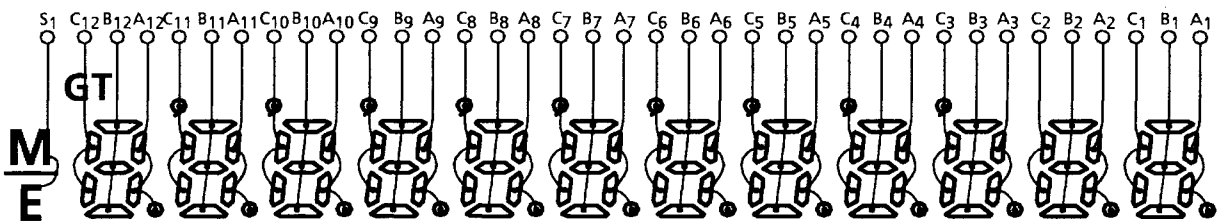
Common

Key Connection

Touch Key

Lock Key

K_{14}: 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_{13}: Selectable with auto power OFF mode and total switch.

K_{12}: Rounding switches.

K_{11}: Selectable with fixed point or floating mode.

Specification of Calculator

Speed of Caluculation (standard oscillating frequency fϕ = 48 kHz)

Numeral . . . . 11.8~17.7 ms

Function
$\begin{cases} 1\boxed{+} \dots \dots \dots \dots \dots \dots \dots \dots \quad 25.6 \text{ ms} \\ 1\boxed{+}2\boxed{+} \dots \dots \dots \dots \dots \dots \quad 95.2 \text{ ms} \end{cases}$

Addition and Subtract
$\begin{cases} 1\ 2\ 3\boxed{+}1\boxed{=} \dots \dots \dots \dots \dots \quad 89.1 \text{ ms} \\ 9999999999\boxed{-}0.000000001\boxed{=} \dots \dots \quad 111.8 \text{ ms} \end{cases}$

Multiply
$\begin{cases} 1\ 2\ 3\boxed{\times}2\boxed{=} \dots \dots \dots \dots \quad 109.6 \text{ ms} \\ 1\boxed{\times}9999999999\boxed{=} \dots \dots \dots \quad 207.7 \text{ ms} \end{cases}$

Device
$\begin{cases} 1\ 2\ 3\boxed{\div}3\boxed{=} \dots \dots \dots \dots \quad 147.9 \text{ ms} \\ 9999999999\boxed{\div}1\boxed{=} \dots \dots \dots \quad 249.0 \text{ ms} \end{cases}$

Memory calculation
$\begin{cases} 2\ \boxed{M+} \dots \dots \dots \dots \dots \dots \quad 143.3 \text{ ms} \\ 9999999999\boxed{\div}1\boxed{M+} \dots \dots \dots \quad 296.2 \text{ ms} \end{cases}$

Square root
$\begin{cases} 9999999999\boxed{\sqrt{\ }} \dots \dots \dots \dots \quad 167.7 \text{ ms} \\ 2\boxed{\sqrt{\ }} \dots \dots \dots \dots \dots \dots \quad 125.0 \text{ ms} \end{cases}$

Keys for Calculator

$\boxed{0\quad 0}$, $\boxed{0}$~$\boxed{9}$: Number

$\boxed{\cdot}$

$\boxed{+/-}$: Changer Sign

$\boxed{+}$ $\boxed{-}$ $\boxed{\times}$ $\boxed{\div}$: Function
$\boxed{=}$ $\boxed{\sqrt{\ }}$ $\boxed{\%}$ $\boxed{\Delta\%}$

$\boxed{M+}$ $\boxed{M-}$ $\boxed{GT+}$ $\boxed{GT-}$: Memory
$\boxed{MC}$ $\boxed{MR}$ $\boxed{M^R_C}$ $\boxed{^R_C GT}$

$\boxed{EX}$: Exchange

$\boxed{\rightarrow}$: Shift

$\boxed{IC}$: Item Counter

$\boxed{CE}$ $\boxed{^{CE/C}_{(ON)}}$ $\boxed{^{C}_{(ON)}}$: Clear

$\boxed{OFF}$: OFF

$\boxed{AC}$: SYSTEM RESET

Operation Example

1. Fixed Point Calculation

(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	
RM	7.5	

(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 Calculation

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	RM	3.14M	√	3.M
3	3.	C	0.M	=	3.02M
2	32.	1	1.M		
×	32.	23	123.M		
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 Calculation

(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% Calculation

(1)
Key	Display
a	a
$\boxed{+}$	a
b	b
$\boxed{Δ\%}$	$100 \cdot (a + b) / b$

(2)
Key	Display
a	a
$\boxed{-}$	a
b	b
$\boxed{Δ\%}$	$100 \cdot (a - b) / b$

5. Mark-Up, Mark-Down Calculation

(1) Mark-up
Key	Display
a	a
$\boxed{÷}$	a
b	b
$\boxed{Δ\%}$	$a / (1 - b / 100)$
$\boxed{Δ\%}$	$\lvert a / (1 - b / 100) - a \rvert$

(2) Mark-down
Key	Display
a	a
$\boxed{÷}$	a
b	b
$\boxed{+/-}$	$-b$
$\boxed{Δ\%}$	$a / (1 + b / 100)$
$\boxed{Δ\%}$	$\lvert a / (1 + b / 100) - a \rvert$

6. Add-On, Discount Calculation

Add-on

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

(3)
Key	Display
a	a
$\boxed{+}$	a
b	b
$\boxed{\%}$	$a (1 + b / 100)$

(5)
Key	Display
a	a
$\boxed{\times}$	a
b	b
$\boxed{Δ\%}$	$a (1 + b / 100)$

Discount

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

(4)
Key	Display
a	a
$\boxed{-}$	a
b	b
$\boxed{\%}$	$a (1 - b / 100)$

(6)
Key	Display
a	a
$\boxed{\times}$	a
b	b
$\boxed{+/-}$	$-b$
$\boxed{Δ\%}$	$a (1 - b / 100)$

7. Average Operation Use of the Item Counter

Key	Display	Item Counter	Key	Display	Item Counter
A	A	0	−	A + B + C + D	2
+	A	1	D	D	2
B	B	1	+	A + B + C	3
+	A + B	2	E	E	3
C	C	2	=	A + B + C + E	4
+	A + B + C	3	÷	A + B + C + E	4
D	D	3	IC	4	4
+	A + B + C + D	4	=	(A + B + C + E) / 4	5

Maximum Ratings

Characteristics	Symbol	Rating	Unit
Supply voltage	V_G	+0.3~−2.0	V
Input voltage	V_{IN}	+0.3~V_G −0.3	V
Operating temperature	T_{opr}	0~40	°C
Storage temperature	T_{stg}	−55~125	°C

Electrical Characteristics (V_G = −1.5 V ± 0.2 V, V_{SS2} = −3.0 ± 0.4 V, V_{DD} = 0 V, Ta = 25°C)

Characteristics		Symbol	Test Circuit	Pin Name	Test Condition	Min	Typ.	Max	Unit
Operating voltage		V_G	—	—	—	−1.2	−1.5	−2.0	V
"1" input voltage		$V_{IH\,(1)}$	—	K_3~K_{10} RESET	—	V_G + 0.4	—	V_G	V
"1" input voltage		$V_{IH\,(2)}$	—	K_{11}~K_{14}	—	V_{SS2} + 0.4	—	V_{SS2}	V
"0" input voltage		V_{IL}	—	K_3~K_{14} RESET	—	0	—	−0.4	V
"1" output voltage		$V_{OH\,(1)}$	—	SEGMENT COM1~3	—	V_{SS2} + 0.2	—	V_{SS2}	V
"0" output voltage		$V_{OL\,(1)}$	—	SEGMENT COM1~3	—	0	—	−0.2	V
"M" output voltage		V_{OM}	—	COM1~3	—	V_G + 0.2	—	V_G − 0.2	V
"1" output voltage		$V_{OH\,(2)}$	—	K_1~K_{10}	—	V_G + 0.2	—	V_G	V
"0" output voltage		$V_{OL\,(2)}$	—	K_1~K_{14}	—	0	—	−0.2	V
"1" output resistance		R_{OH}	—	SEGMENT COM1~3	V_{OUT} = V_{SS2} + 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} = 0 V	156	—	364	kΩ
		$R_{KEYH\,(2)}$	—	K_1~K_{10}	V_{OUT} = 0 V	240	—	560	
Key read pull up resistance		$R_{KEYH\,(3)}$	—	K_1~K_{10}	V_{OUT} = 0 V	30	—	600	kΩ
Key pull down resistance		$R_{KEYH\,(1)}$	—	RESET K_1~K_{10}	V_{OUT} = −0.5 V	—	—	10	kΩ
		$R_{KEYH\,(2)}$	—	K_{11}~K_{14}	V_{OUT} = V_{SS2}	120	—	800	
Oscillating frequency	(WAIT)	$f\phi WAIT$	—	—	V_G = −1.5 V	5.4	9.0	12.6	kHz
	(OPERATE)	$f\phi OP$	—	—	V_G = −1.5 V	28.8	48	67.2	
Frame frequency		f_F	—	SEGMENT COM1~3	V_G = −1.5 V	56.3	93.8	131	Hz
Supply current	1 (WAIT)	I_{DDWAIT}	—	—	V_G = −1.5 V	—	2.2	3.4	μA
	2 (OPERATE)	I_{DDOP}	—	—	V_G = −1.2 V	—	7.0	11.0	
	3 (OFF)	I_{DDOFF}	—	—	V_G = −1.5 V	—	—	2.0	
Power off timer times		T	—	—	V_G = −1.5 V	429	600	1001	s

Waveforms for Display
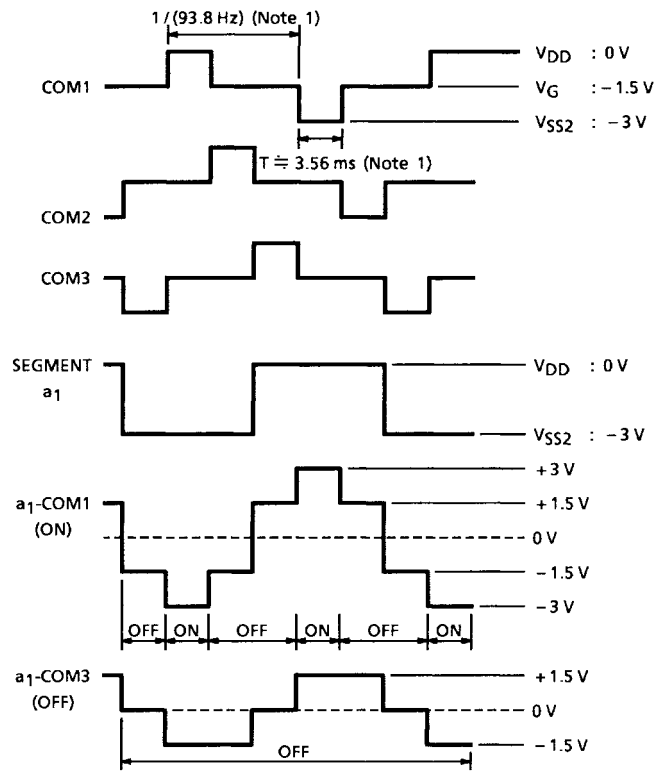
Note 1:   At fϕ = 9 kHz

Pad Location Table

(μm)

Name	X Point	Y Point		Name	X Point	Y Point
(TS1)	−1367	−1469		C3	544	1469
VG	−1160	−1469		B3	392	1469
VSS1	−971	−1469		A3	240	1469
VSS2	−775	−1469		C2	89	1469
VB	−609	−1469		(TS4)	−89	1469
VA	−424	−1469		B2	−240	1469
TS3	−252	−1469		A2	−392	1469
S3	−100	−1469		C1	−544	1469
VDD	52	−1469		B1	−696	1469
S2	203	−1469		A1	−847	1469
S1	355	−1469		COM3	−999	1469
C12	507	−1469		COM2	−1166	1469
B12	659	−1469		COM1	−1358	1469
A12	810	−1469		K14	−1408	1175
C11	980	−1469		K13	−1408	1023
B11	1162	−1469		K12	−1408	871
A11	1358	−1469		K11	−1408	720
C10	1408	−1193		K10	−1408	503
B10	1408	−1042		K9	−1408	352
A10	1408	−890		K8	−1408	200
C9	1408	−738		K7	−1408	48
B9	1408	−586		K6	−1408	−104
A9	1408	−435		K5	−1408	−255
C8	1408	−283		K4	−1408	−407
B8	1408	−131		K3	−1408	−559
A8	1408	20		K2	−1408	−710
C7	1408	172		K1	−1408	−862
B7	1408	324		RESET	−1408	−1023
A7	1408	475		(TS2)	−1408	−1175
C6	1408	627				
B6	1408	779				
A6	1408	936				
C5	1408	1119				
B5	1358	1469				
A5	1169	1469				
C4	999	1469				
B4	847	1469				
A4	696	1469				

Note 2:   (   ) Do not connect.

Chip Layout

Chip size   : 3.28 × 3.46 (mm)
Chip thickness : 440 ± 30 (μm)
Substrate   : V_{DD}
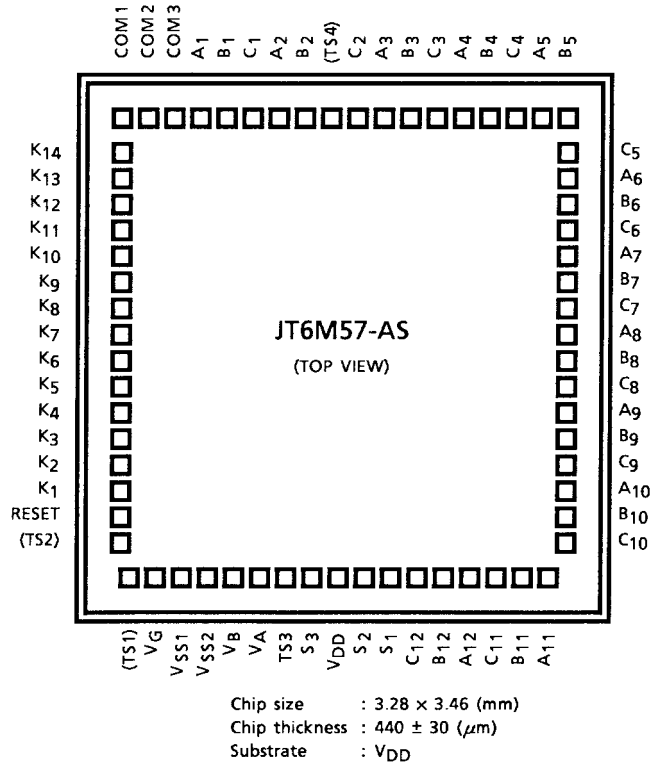
Pad Layout

Active Element

Scribe Line

PAD Pitch 160 μm
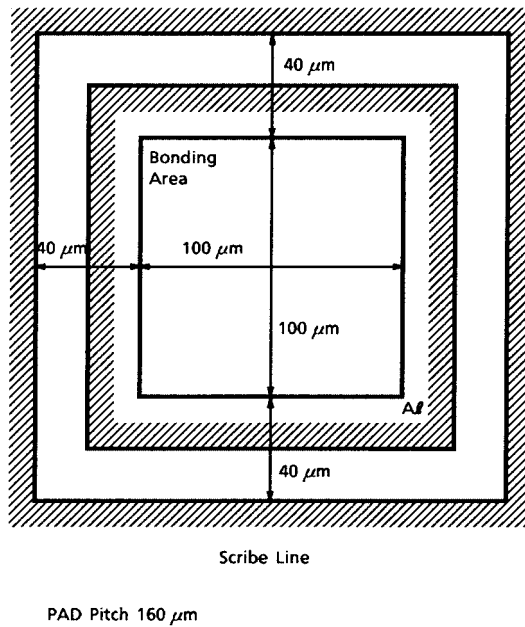
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