

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

T6M45, JT6M45-AS

T6M45, JT6M45-AS CMOS Single-Chip LSI for LCD Calculator

The T6M45, JT6M45-AS is a single-chip microcomputer for 12-digit or 10-digit 2-memory calculator.

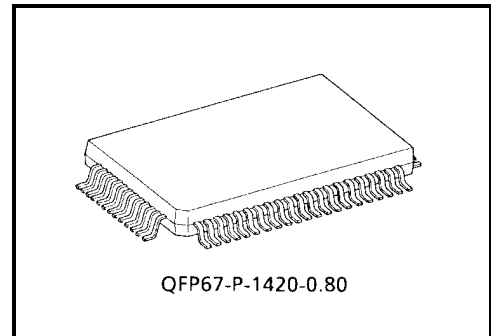
T6M45, JT6M45-AS can drive the liquid crystal display (LCD). Single power supply operation, wide operating voltage range and low-power consumption make it suitable for 1.5 V solar battery operated calculator.

Besides T6M45, JT6M45-AS can be 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.

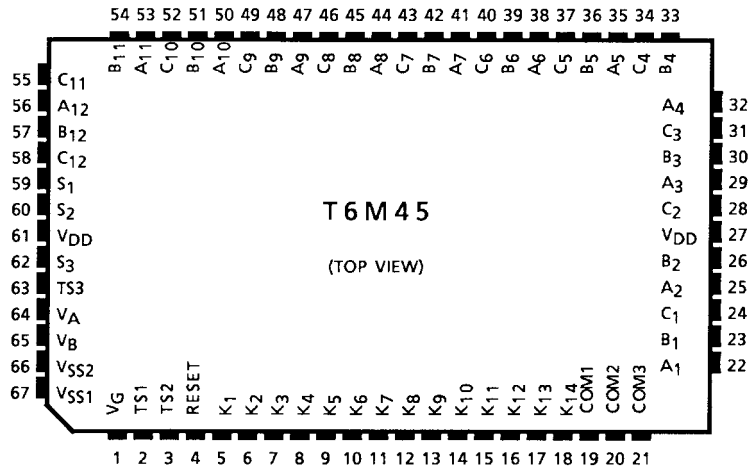


Weight: 1.20 g (typ.)

Electrical Features

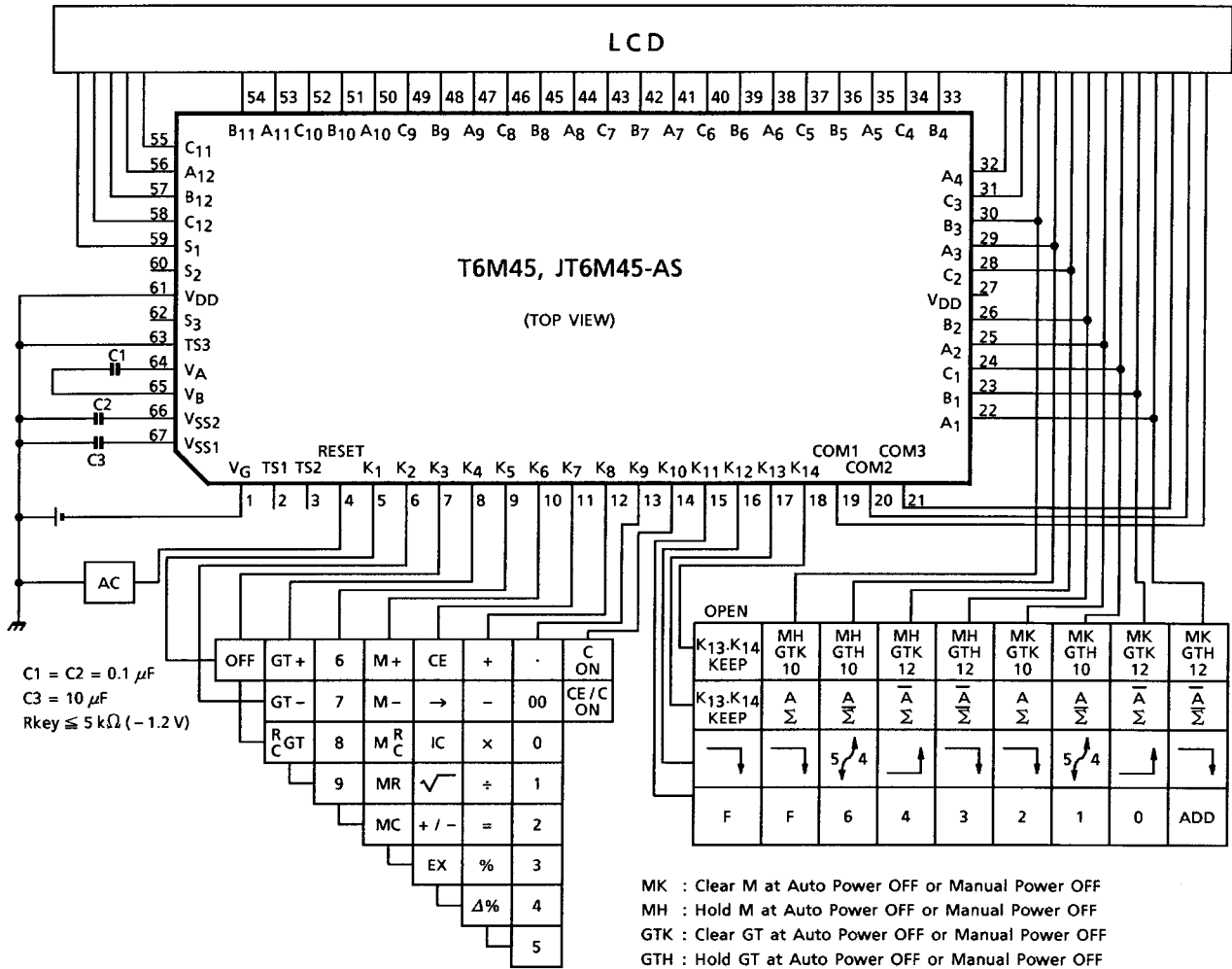
- Complementary output buffer for direct driving of liquid crystal display (F.E.M LCD).
- Oscillator/clock generator internal to chip.
- Keyboard encoding internal to chip.
- Keyboard denouncing internal to chip.
- Automatic power on clear.
- Wide supply voltage range (-1.2~-2.0 V).
- Very low power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

Pin Assignment (top view)



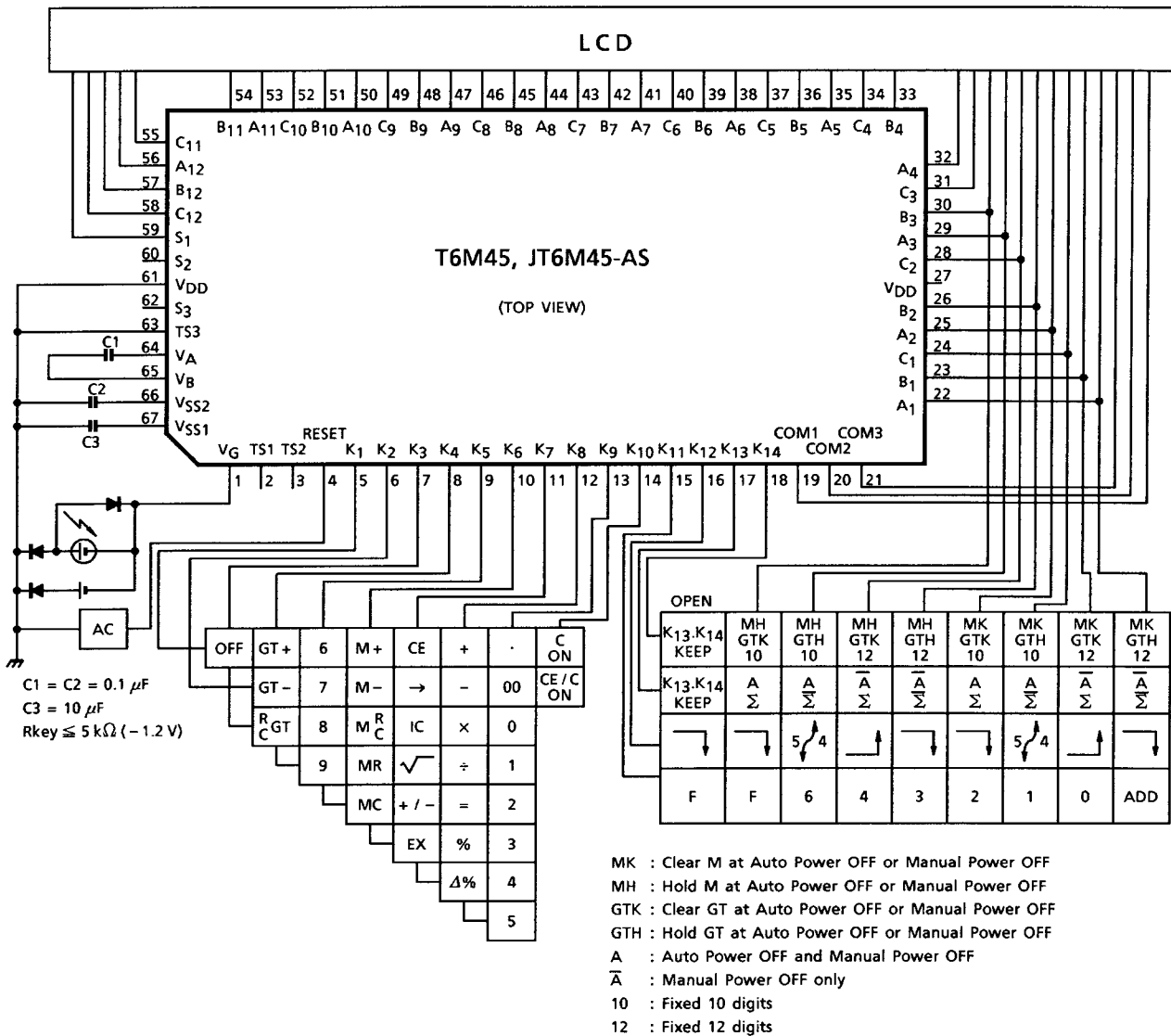
System Block Diagram

Battery Type

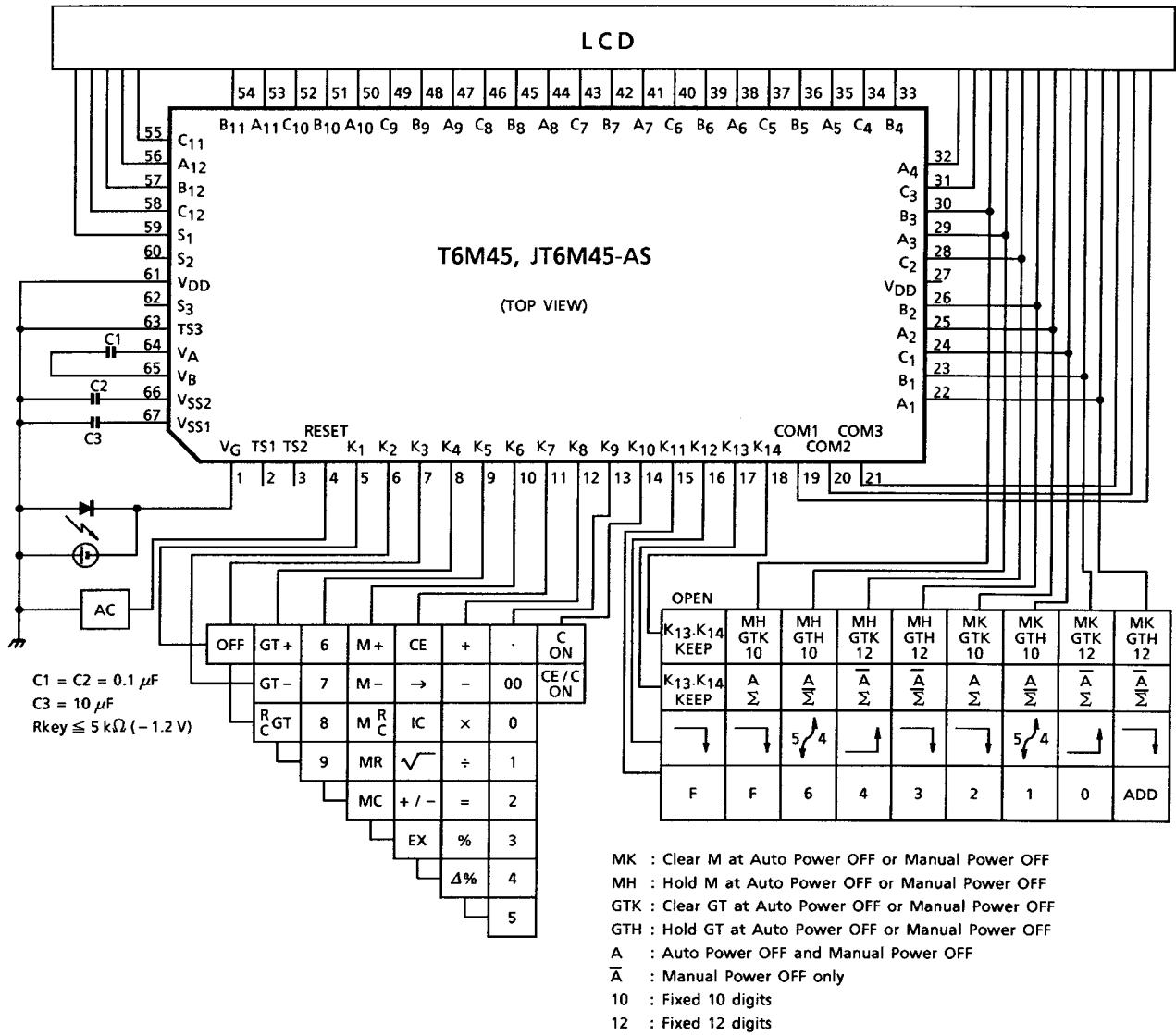


- MK : Clear M at Auto Power OFF or Manual Power OFF
- MH : Hold M at Auto Power OFF or Manual Power OFF
- GTK : Clear GT at Auto Power OFF or Manual Power OFF
- GTH : Hold GT at Auto Power OFF or Manual Power OFF
- A : Auto Power OFF and Manual Power OFF
- \bar{A} : Manual Power OFF only
- 10 : Fixed 10 digits
- 12 : Fixed 12 digits

Dual Type



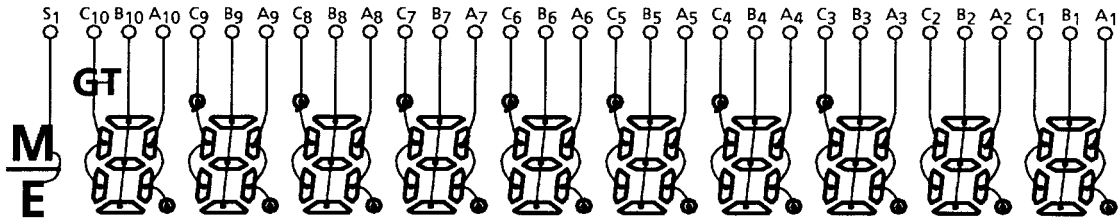
Solar Type



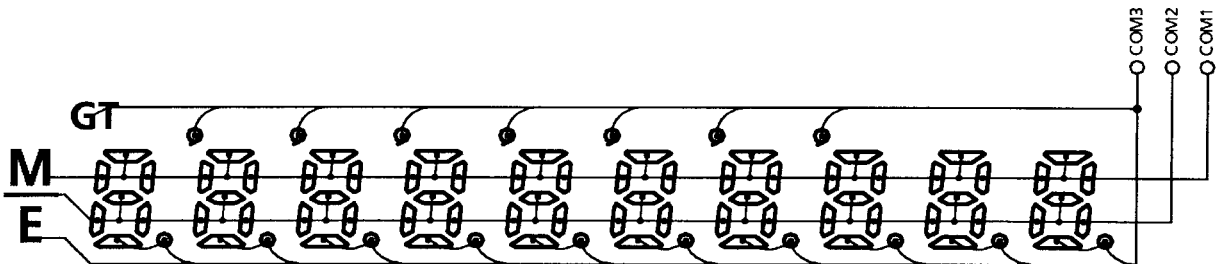
Connection of LCD

Select of 10 digits

Segment

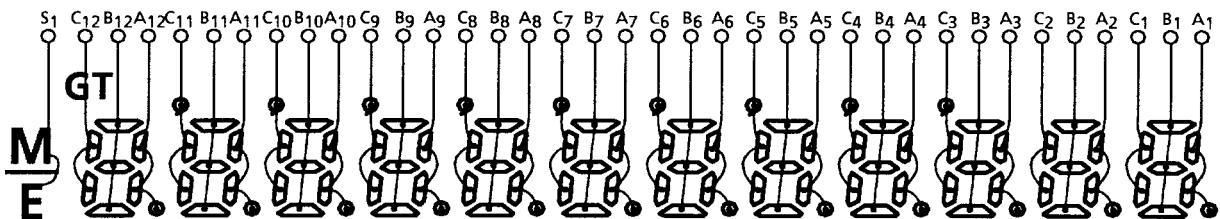


Common

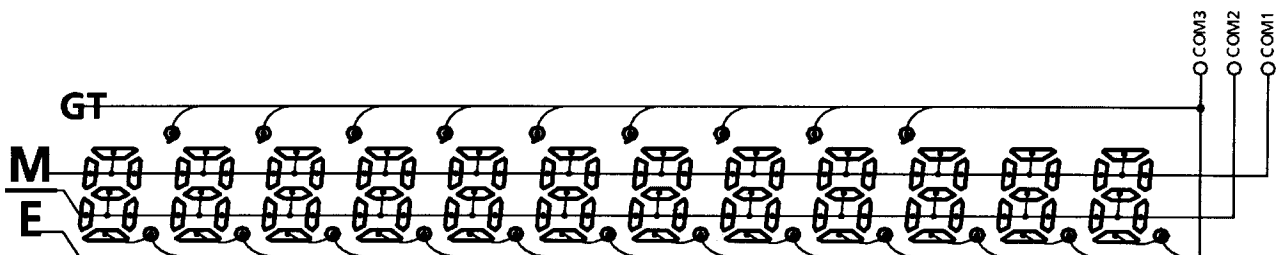


Select of 12 digits

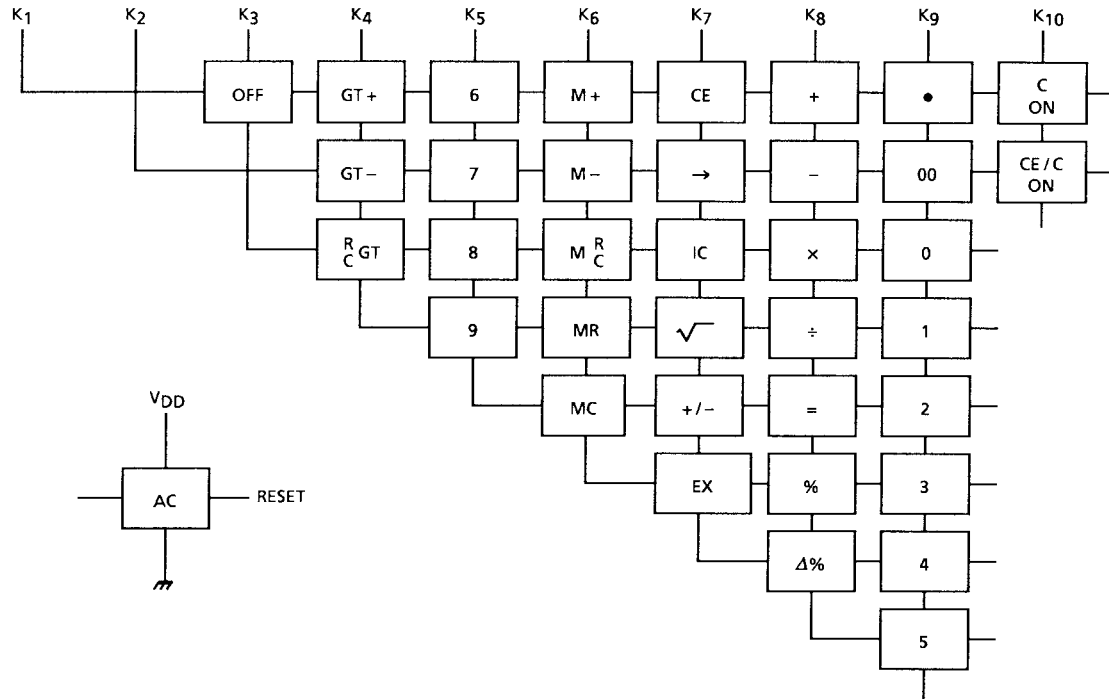
Segment



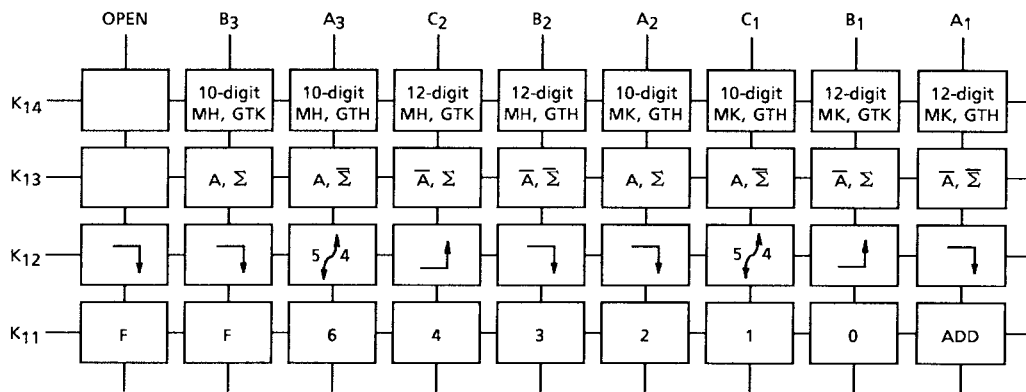
Common



Key Connection



Touch Key



Lock Key

K14: 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.

K13: Selectable with auto power OFF mode and total switch.

K12: Rounding switches.

K11: Selectable with fixed point or floating mode.

Operation Example

1. Fixed Point Calculation

(1)	Key	Display	Fixed Point Place	(2)	Key	Display	Fixed Point Place
	C	0.	DP = 3 (5 / 4)		C	0.	DP = 0 (\uparrow)
	2	2.			1	1.	
	÷	2.			.	1.	
	3	3.			2	1.2	
	=	0.667			3	1.23	
	2	2.			+	1.23	
	.	2.			1	1.	
	3	2.3			.	1.	
	+	2.3			1	1.1	
	4	4.			=	3.	
	M+	6.300			9	9.	
	1	1.			√	3.	
	.	1.			×	3.	
	2	1.2			1	1.	
	M+	1.200			.	1.	
					1	1.1	DP = F
	MR	7.5			=	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	MR	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	
\times	k	
a	a	
$=$	$k \cdot a$	$k \times$
b	b	$k \times$
$=$	$k \cdot b$	$k \times$

(2) Division

Key	Display	Constant
a	a	
\div	a	
k	k	
$=$	a / k	$\div k$
b	b	$\div k$
$=$	b / k	$\div k$

(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

k	k	
\times	k	
a	a	
$\%$	$k \cdot a / 100$	$k \times$
b	b	$k \times$
$\%$	$k \cdot b / 100$	$k \times$

(6) Percentage

a	a	
\div	a	
k	k	
$\%$	$100 \cdot a / k$	$+k$
b	b	$\div k$
$\%$	$100 \cdot b / k$	$\div k$

(7) Add-on

k	k	
$+$	k	
a	a	
$\%$	$k \cdot (1 + a / 100)$	$k +$
b	b	$k +$
$\%$	$k \cdot (1 + b / 100)$	$k +$

(8) Discount

k	k	
$-$	k	
a	a	
$\%$	$k \cdot (1 - a / 100)$	$k -$
b	b	$k -$
$\%$	$k \cdot (1 - b / 100)$	$k -$

4. Δ% Calculation

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

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

5. Mark-Up, Mark-Down Calculation

(1) Mark-up
 Key Display
 a a
 ÷ a
 b b
 Δ% $a / (1 - b / 100)$
 Δ% $|a / (1 - b / 100) - a|$

(2) Mark-down
 Key Display
 a a
 ÷ a
 b b
 +/- - b
 Δ% $a / (1 + b / 100)$
 Δ% $|a / (1 + b / 100) - a|$

6. Add-On, Discount Calculation

Add-on
 (1) Key Display
 a a
 × a
 b b
 % $a \cdot b / 100$
 + $a \cdot b / 100$
 = $a(1 + b / 100)$
 (3) a a
 + a
 b b
 % $a(1 + b / 100)$
 (5) a a
 × a
 b b
 Δ% $a(1 + b / 100)$

Discount
 (2) Key Display
 a a
 × a
 b b
 % $a \cdot b / 100$
 - $a \cdot b / 100$
 = $a(1 - b / 100)$
 (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
$\boxed{+}$	A	1
B	B	1
$\boxed{+}$	A + B	2
C	C	2
$\boxed{+}$	A + B + C	3
D	D	3
$\boxed{+}$	A + B + C + D	4

Key	Display	Item Counter
$\boxed{-}$	A + B + C + D	2
D	D	2
$\boxed{+}$	A + B + C	3
E	E	3
$\boxed{=}$	A + B + C + E	4
$\boxed{\div}$	A + B + C + E	4
\boxed{IC}	4	4
$\boxed{=}$	(A + B + C + E) / 4	5

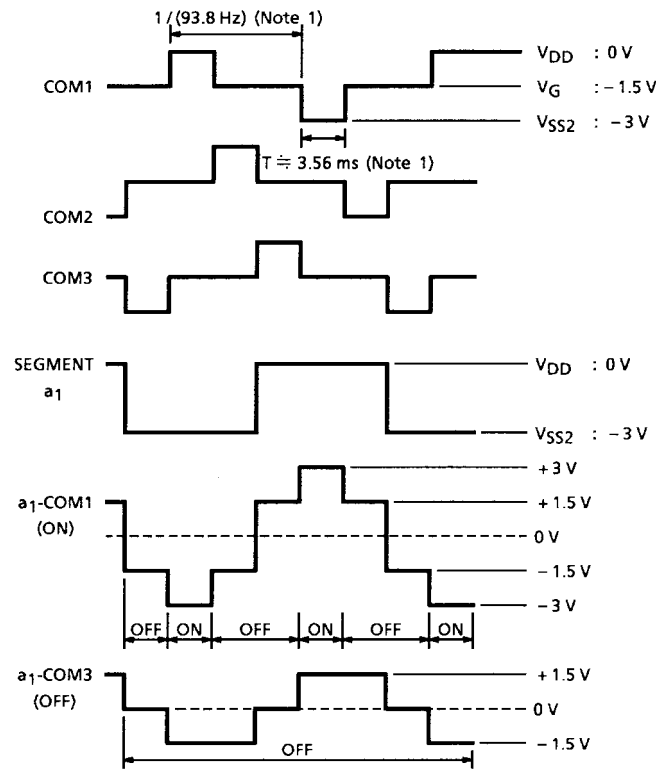
Maximum Ratings

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 ($V_G = -1.5 \pm 0.2$ V, $V_{SS2} = -3.0 \pm 0.4$ V, $V_{DD} = 0$ V, $T_a = 25^\circ\text{C}$)

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	k Ω
"0" output resistance	R_{OL}	—	SEGMENT COM1~3	$V_{OUT} = -0.5$ V	—	—	70	k Ω
Key pull up resistance	R_{KEYH} (1)	—	RESET	$V_{OUT} = 0$ V	156	—	364	k Ω
	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	k Ω
Key pull down resistance	R_{KEYL} (1)	—	RESET K ₁ ~K ₁₀	$V_{OUT} = -0.5$ V	—	—	10	k Ω
	R_{KEYH} (2)	—	K ₁₁ ~K ₁₄	$V_{OUT} = V_{SS2}$	120	—	800	
Oscillating frequency	(WAIT)	f_{ϕ} WAIT	—	$V_G = -1.5$ V	5.4	9.0	12.6	kHz
	(OPERATE)	f_{ϕ} 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_{DD} WAIT	—	$V_G = -1.5$ V	—	2.2	3.4	μ A
	2 (OPERATE)	I_{DD} OP	—	$V_G = -1.2$ V	—	7.0	11.0	
	3 (OFF)	I_{DD} OFF	—	$V_G = -1.5$ V	—	—	2.0	
Power off timer times	T	—	—	$V_G = -1.5$ V	429	600	1001	s

Waveforms for Display



Note 1: At $f\phi = 9 \text{ kHz}$

Pad Location Table

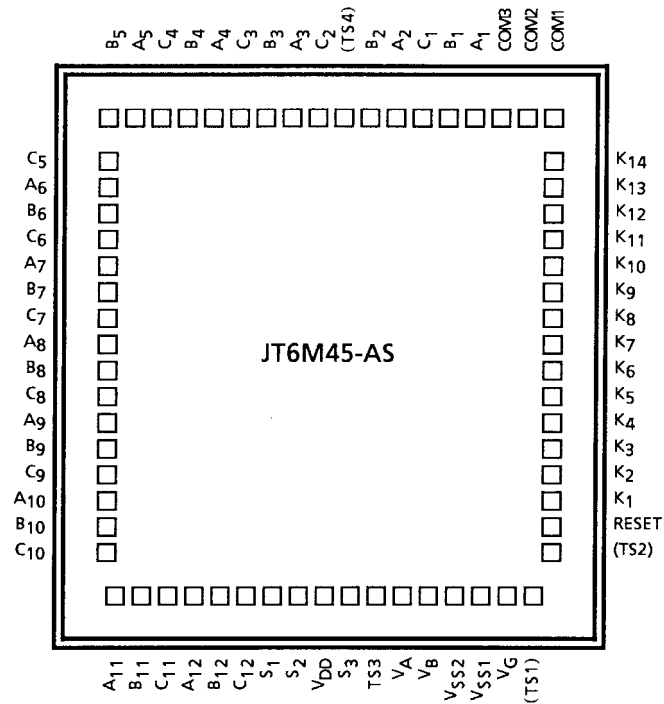
(μm)

Name	X Point	Y Point
V _{SS1}	971	-1469
V _{SS2}	775	-1469
V _B	609	-1469
V _A	424	-1469
TS3	252	-1469
S ₃	100	-1469
V _{DD}	-52	-1469
S ₂	-203	-1469
S ₁	-355	-1469
C ₁₂	-507	-1469
B ₁₂	-659	-1469
A ₁₂	-810	-1469
C ₁₁	-980	-1469
B ₁₁	-1162	-1469
A ₁₁	-1358	-1469
C ₁₀	-1408	-1193
B ₁₀	-1408	-1042
A ₁₀	-1408	-890
C ₉	-1408	-738
B ₉	-1408	-586
A ₉	-1408	-435
C ₈	-1408	-283
B ₈	-1408	-131
A ₈	-1408	20
C ₇	-1408	172
B ₇	-1408	324
A ₇	-1408	475
C ₆	-1408	627
B ₆	-1408	779
A ₆	-1408	936
C ₅	-1408	1119
B ₅	-1358	1469
A ₅	-1169	1469

Name	X Point	Y Point
C ₄	-999	1469
B ₄	-847	1469
A ₄	-696	1469
C ₃	-544	1469
B ₃	-392	1469
A ₃	-240	1469
C ₂	-89	1469
(TS4)	89	1469
B ₂	241	1469
A ₂	392	1469
C ₁	544	1469
B ₁	696	1469
A ₁	847	1469
COM3	999	1469
COM2	1166	1469
COM1	1358	1469
K ₁₄	1408	1175
K ₁₃	1408	1023
K ₁₂	1408	871
K ₁₁	1408	720
K ₁₀	1408	503
K ₉	1408	352
K ₈	1408	200
K ₇	1408	48
K ₆	1408	-104
K ₅	1408	-255
K ₄	1408	-407
K ₃	1408	-559
K ₂	1408	-710
K ₁	1408	-862
RESET	1408	-1023
(TS2)	1408	-1175
(TS1)	1367	-1469
V _G	1160	-1469

Note 2: () Do not connect.

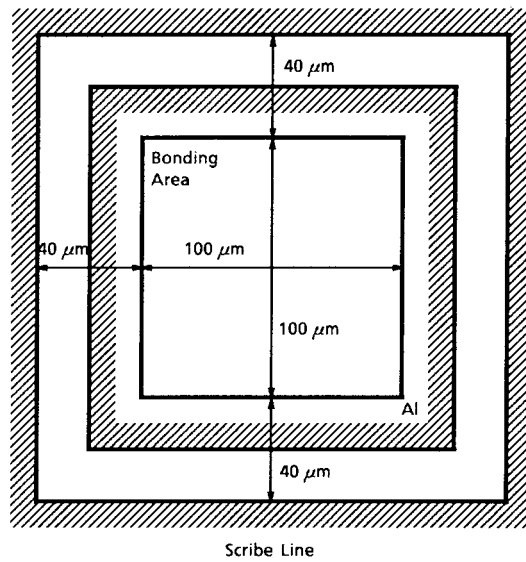
Chip Layout



Chip size : 3.28 x 3.46 (mm)
 Chip thickness : 440 ± 30 μm
 Substrate : VDD

Pad Layout

Active Element



PAD Pitch 160 μm

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