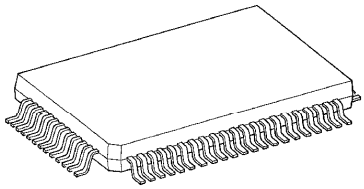
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

T6A11A, JT6A11AX-AS

T6A11A, JT6A11AX-AS CMOS SINGLE-CHIP LSI FOR LCD CALCULATOR

The T6A11A, JT6A11AX-AS is a single-chip microcomputer for 12-digits 2-memory or 10-digits 2-memory calculator. T6A11A, JT6A11AX-AS can drive the liquid crystal display (LCD) with single power supply.
Single power supply operation, wide operating voltage range and low power consumption make it suitable for 1.5V solar battery operated calculator.
Besides T6A11A, JT6A11AX-AS can selectable with a pin-programmable to function of Power timer and Memory hold.



QFP67-P-1420-0.80

Weight : 1.20 g (Typ.)

FEATURES

Operational Features :

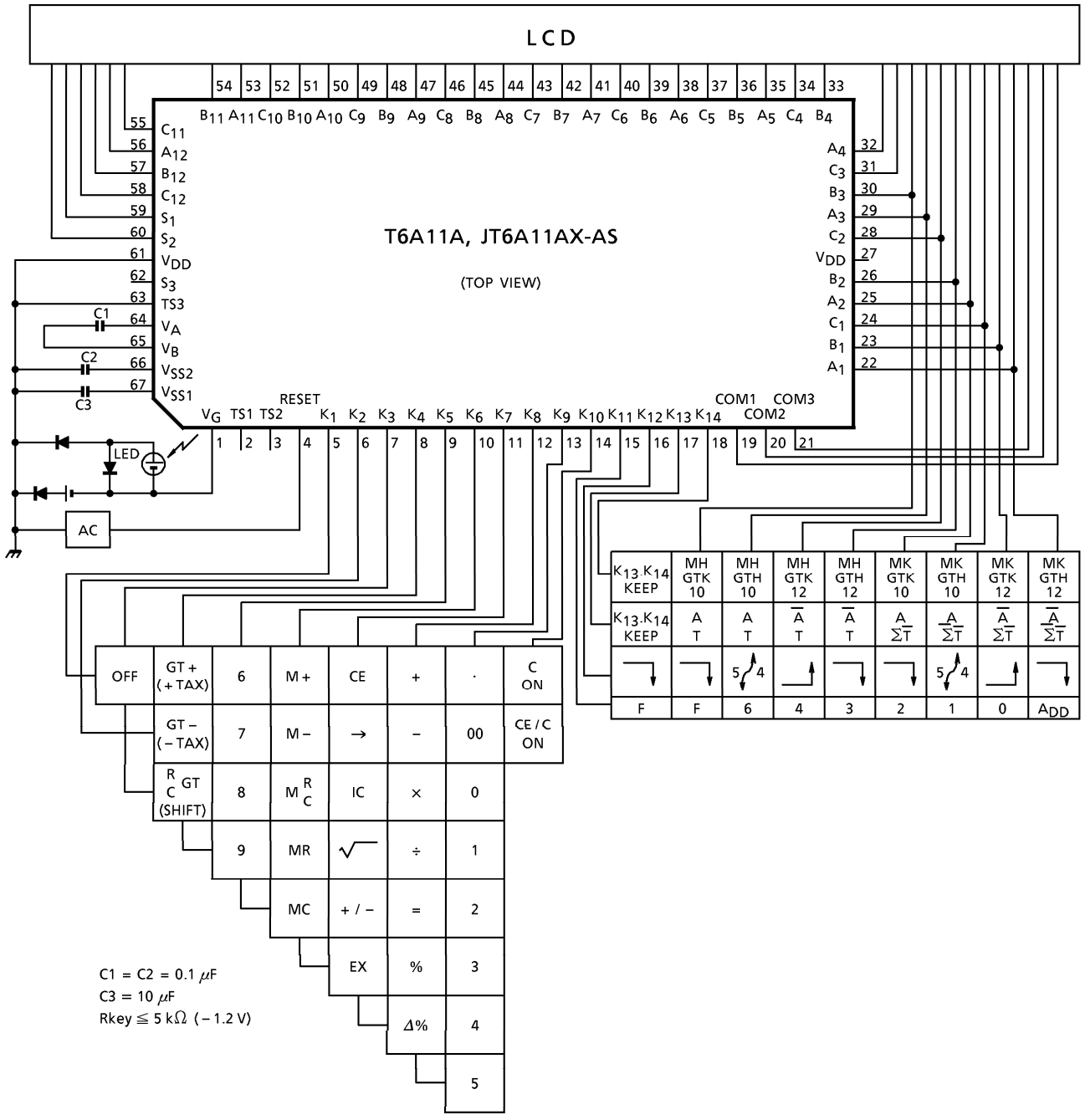
- Display : 12 digits or 10 digits (selectable with a pin-programmable) of data, 2-digits of sign, error symbol, memory load symbol.
- Algebraic mode.
- Standard 4 functions (+, −, ×, ÷).
- Memory and grand total (GT) memory calculation.
- Accumulating GT memory register with count up (down) item counter.
- Automatic percentage operation with add-on, discount.
- Automatic delta percentage, mark-up and 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 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.
- TAX calculation.

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.).
- Quad in line flat package.

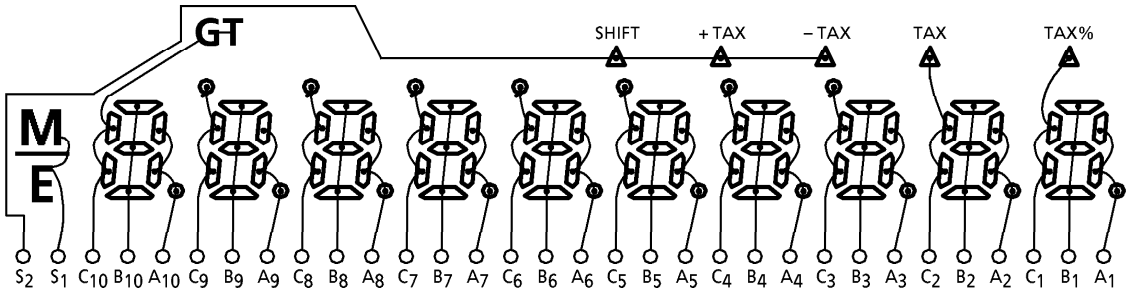
SYSTEM BLOCK DIAGRAM



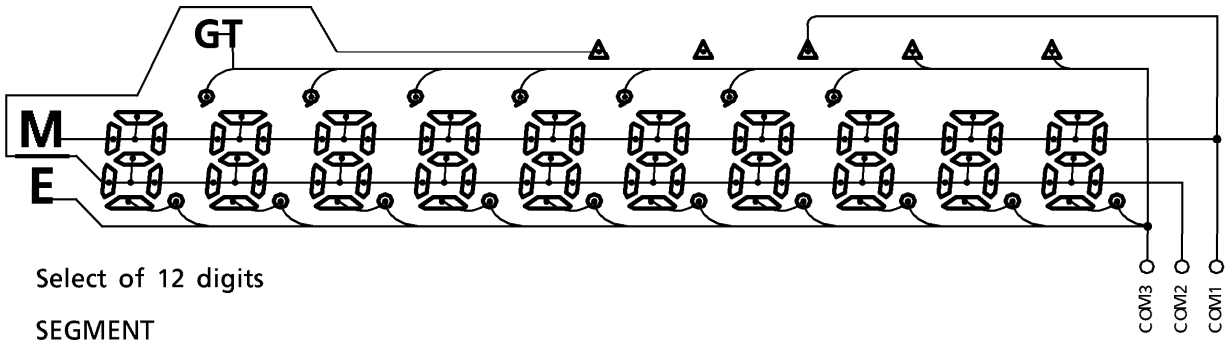
CONNECTION OF LCD

(1) Select of 10 digits

SEGMENT

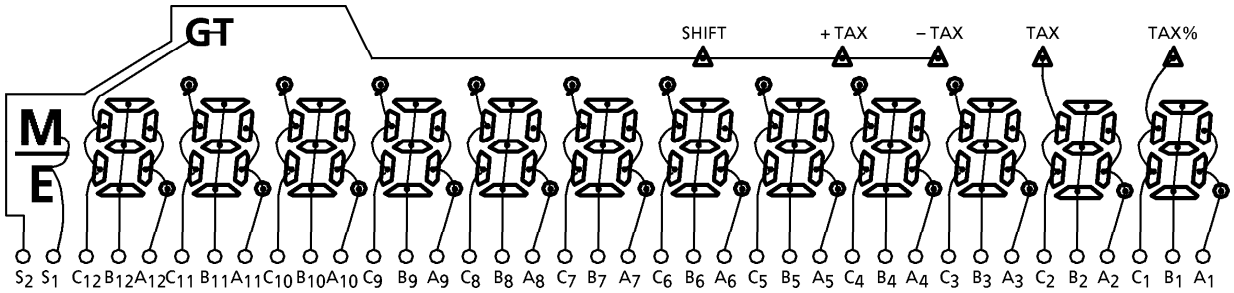


COMMON

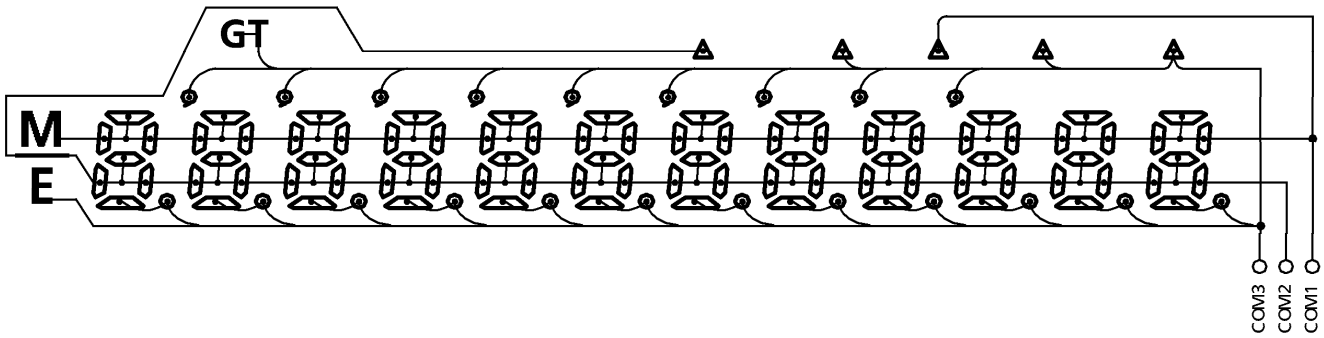


(2) Select of 12 digits

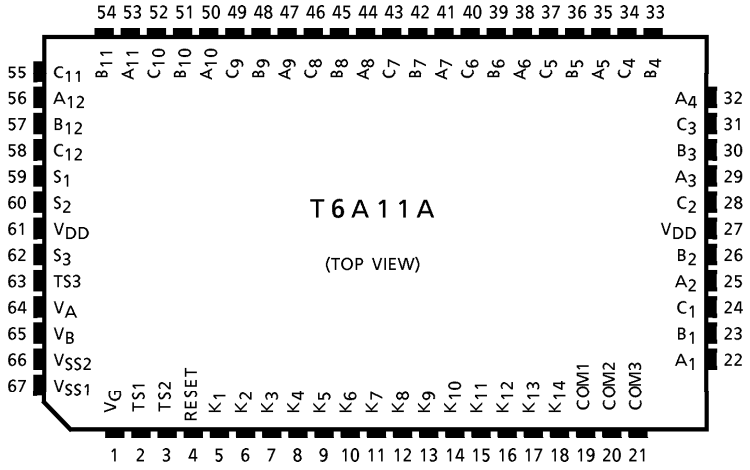
SEGMENT



COMMON

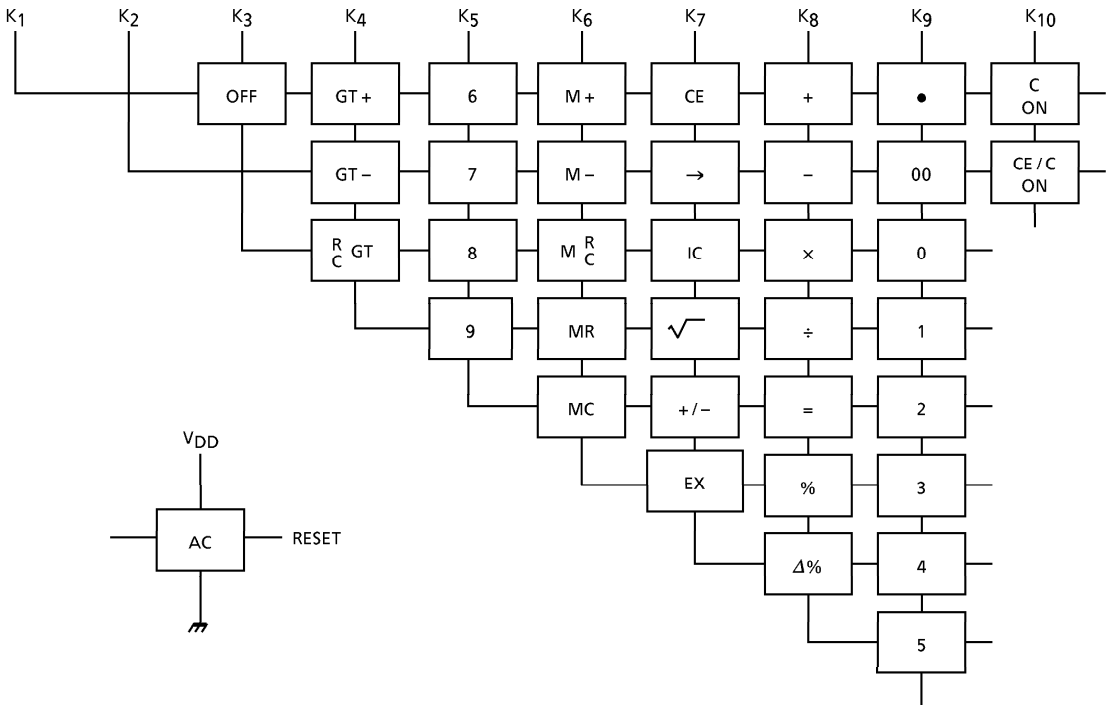


PIN ASSIGNMENT

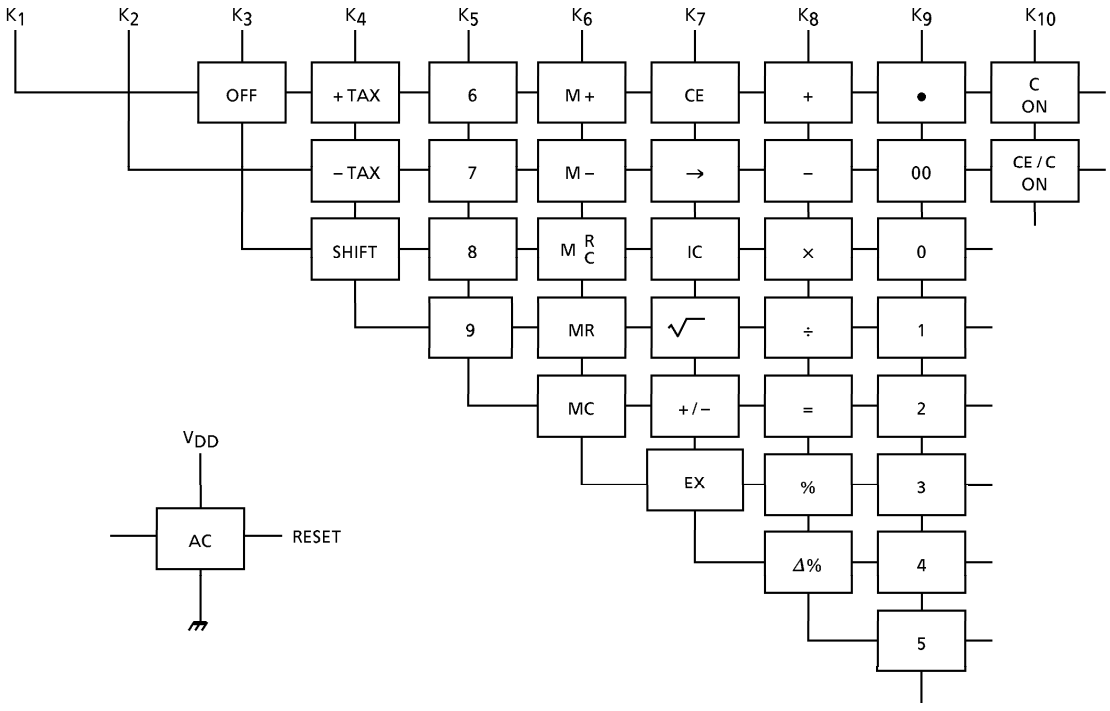


KEY CONNECTION

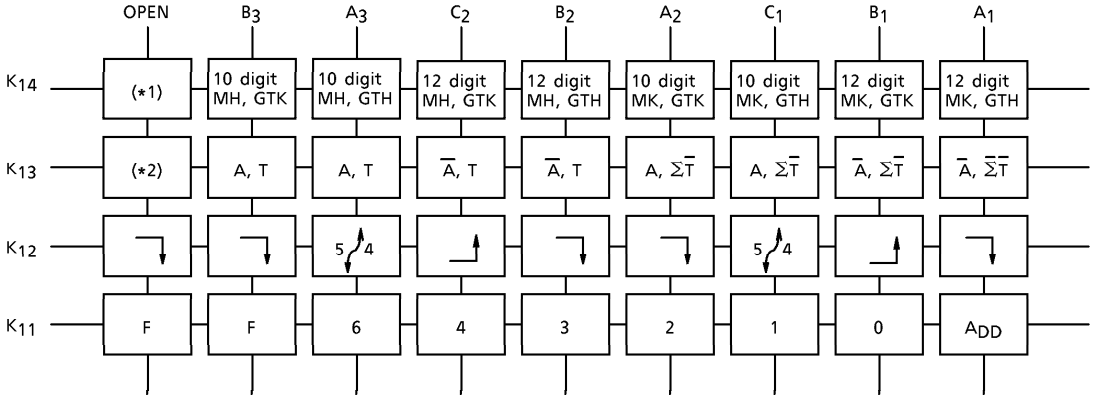
- Touch Key (Ground total memory type)



- Touch Key (TAX calculation type)



- Lock Key



K_{14} ... Selectable with calculated digits and memory hold status.
- 10 digit / 12 digit : Digits of calculation
- MH : Memory hold at auto power off or off function.
- MK : Memory kill at auto power off or off function.
- GTH : GT memory hold at auto power off or off function.
- GTK : GT memory kill at auto power off or off function.

K_{13} ... Selectable with auto power off mode and TAX calculation mode and total (Σ mode) switch.
- A : Auto power off enable.
- $\overline{A}$: Auto power off disable.
- (*3) T : TAX calculation mode.
- $\overline{T}$: GT memory mode.
- Σ : Σ mode enable.
- $\overline{\Sigma}$: Σ mode disable.

K_{12} ... Rounding switches.

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

(*1), (*2) : If K_{13} or K_{14} get opened, the status before these keys open is hold. In the case of power on with K_{13} or K_{14} open, the status 10 digit and $\overline{\Sigma}$, $\overline{A}$ mode is selected automatically.

(*3) : If exchange the mode of TAX calculation and GT memory, please reset the system for [AC] key.

SPECIFICATION OF CALCULATOR

Speed of Calculator (standard oscillating frequency $f\phi$ = 48k Hz)

- Numeral ..... 11.8~17.7 ms
- Function
  - 1 [+] ..... 25.6 ms
  - 1 [+] 2 [+] ..... 95.2 ms
- Addition and Subtract
  - 1 2 3 [+] 1 [=] ..... 89.1 ms
  - 9999999999 [−] 0.000000001 [=] ..... 111.8 ms
- Multiply
  - 1 2 3 [×] 2 [=] ..... 109.6 ms
  - 1 [×] 9999999999 [=] ..... 207.7 ms
- Device
  - 1 2 3 [÷] 3 [=] ..... 147.9 ms
  - 9999999999 [÷] 1 [=] ..... 249.0 ms
- Memory calculation
  - 2 [M+] ..... 143.3 ms
  - 9999999999 [÷] 1 [M+] ..... 296.2 ms
- Square root
  - 9999999999 [√] ..... 167.7 ms
  - 2 [√] ..... 125.0 ms

Key for Calculator

[0 0], [0]~[9]	: Number
[·]	
[+/−]	: Changer Sign
[+] [−] [×] [÷]	: Function
[=] [√] [%] [Δ%]	
[M+] [M−] [GT+] [GT−]	: Memory
[MC] [MR] [M RC] [RC GT]	
[EX]	: Exchange
[→]	: Shift
[IC]	: Item Counter Grand total memory type ··· MAX. count 999. TAX calculation type ··· MAX. count 99.
[CE] [CE/C (ON)] [C (ON)]	: Clear
[OFF]	: OFF
[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	
[MR]	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	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	
[×]	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

k	k	
[×]	k	
a	a	
[%]	k·a / 100	k×
b	b	k×
[%]	k·b / 100	k×

⑥ Percentage

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) − 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 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)

7. Average Operation use of the Item Counter

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

8. TAX Calculation

	Key Op.	Display	
(1)	A	A	
	[SHIFT]	A	[SHIFT]
	[+TAX]	A	[TAX%]
(2)	[SHIFT]	0.	[SHIFT]
	[−TAX]	A	[TAX%]
(3)	B	B	
	[+TAX]	B (1 + A / 100)	[+TAX]
	[+TAX]	B·A / 100	[TAX]
	[+TAX]	B (1 + A / 100)	[+TAX]
	[+TAX]	B·A / 100	[TAX]
(4)	B	B	
	[−TAX]	B / (1 + A / 100)	[−TAX]
	[−TAX]	B − B / (1 + A / 100)	[TAX]
	[−TAX]	B / (1 + A / 100)	[−TAX]
	[−TAX]	B − B / (1 + A / 100)	[TAX]

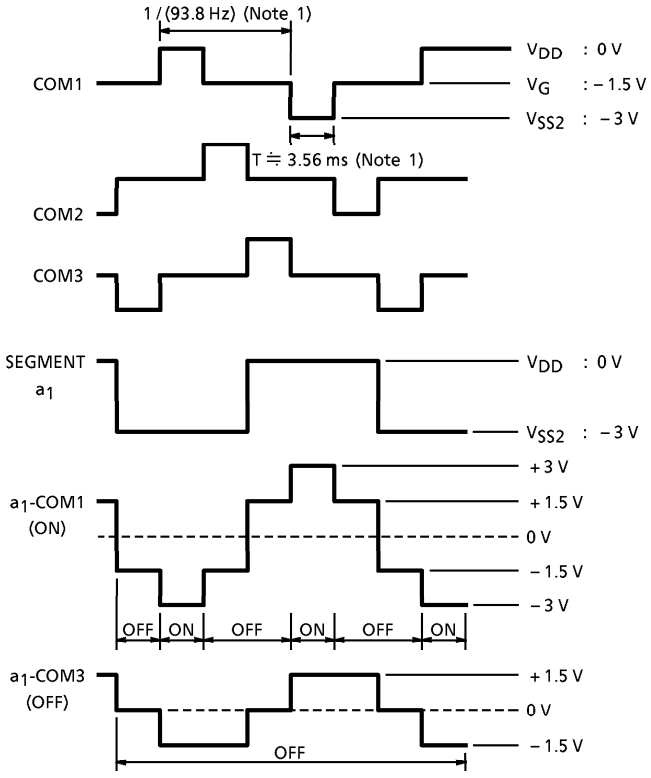
MAXIMUM RATINGS

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 ± 0.2 V, V_{SS2} = −3.0 ± 0.4 V, V_{DD} = 0 V, Ta = 25°C)

CHARACTERISTICS		SYMBOL	TEST CIR-CUIT	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_{KEYL} (1)	—	RESET K_1~K_{10}	V_{OUT} = −0.5 V	—	—	10	kΩ
		R_{KEYL} (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 f_ϕ = 9 kHz

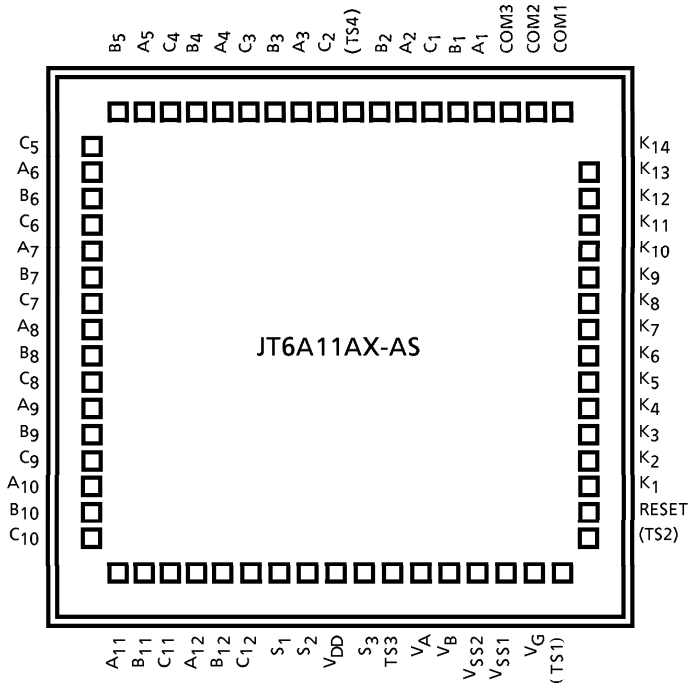
PAD LOCATION TABLE (μm)

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
C_{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) : ( ) Do not connect.

CHIP LAYOUT

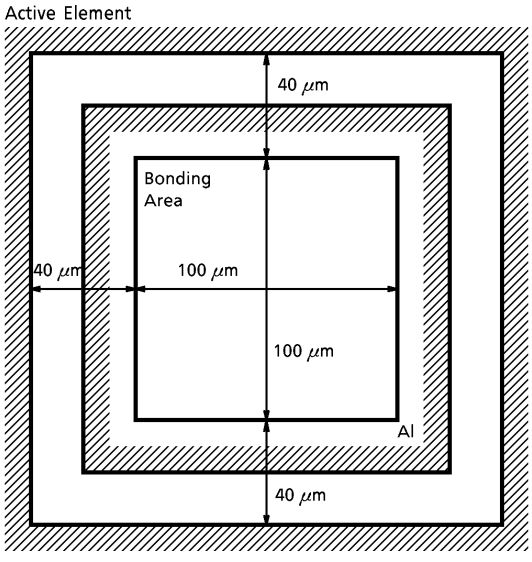


Chip size : 3.28 × 3.46 [mm]

Chip thickness : 440 ± 30 μm

Substrate : V_{DD}

PAD LAYOUT

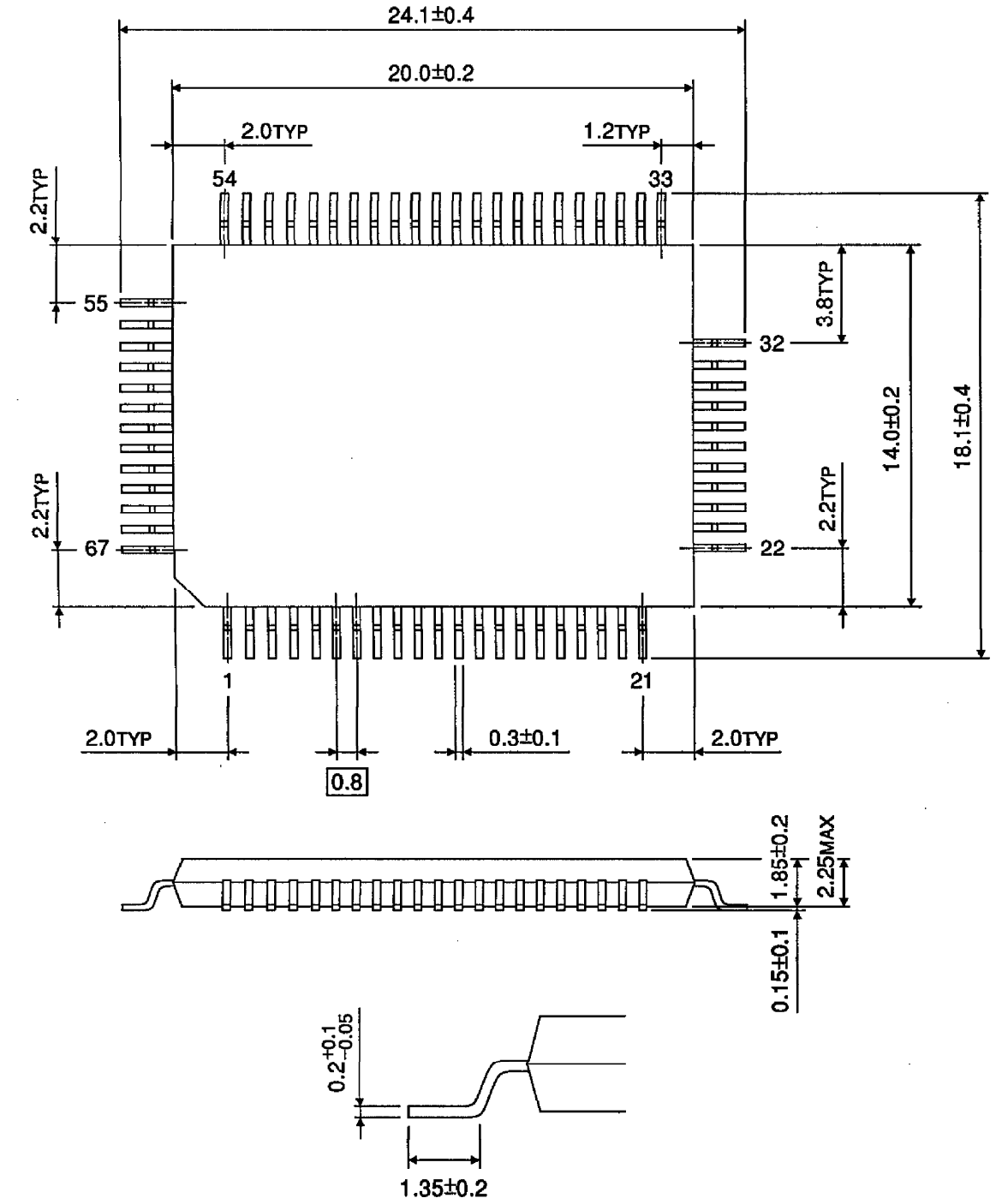


Scribe Line

PAD Pitch 160 μm

PACKAGE DIMENSIONS

QFP67-P-1420-0.80 Unit : mm



Weight : 1.20 g (Typ.)