TOSHIBA CMOS Digital Integrated Circuit   Silicon Monolithic

T6A36S,JT6A36X-AS

T6A36S, JT6A36X-AS CMOS Single-Chip LSI for LCD Calculator

The T6A36S, JT6A36X-AS is a single-chip microcomputer for 8-digit 1-memory calculator.

T6A36S, JT6A36X-AS can drive the liquid crystal display (LCD). Single power supply operation, low-power consumption make it suitable for single battery operated pocketable calculator.

LQFP60-P-1414-0.80

Weight: 0.66 g (typ.)

Features

- 8 digits of data and one symbol digit for calculator.
- Algebraic calculation mode.
- Punctuation.
- Standard 4 functions (+, −, ×, ÷), mark up percent with automatic add-on/discount, automatic constant calculations, chain calculations, memory calculations with memory overflow protection.
- Internal keyboard decoding and denouncing.
- Complementary output buffer for direct driving of liquid crystal display (LCD: FEM type −3.0 V, 1/2 bias, 1/3 duty).
- Single power supply (−1.5 V typ.).
- Quad in line flat package (60 pin).
- Very low-power consumption (3.0 µW typ. at wait).
- Very wide range of operating voltage (V_{SS} = −1.2~−2.0 V).
- Automatic power off (A time for about 7 min).

Pin Assignment (top view)

T6A36S

(TOP VIEW)

Top pins (left to right, 45–31): C_8, B_8, A_8, C_7, B_7, A_7, C_6, B_6, A_6, C_5, B_5, A_5, C_4, B_4, A_4

Left pins (top to bottom, 46–60): 46 A_9, 47 B_9, 48 C_9, 49 A_{10}, 50 B_{10}, 51 C_{10}, 52 OS1, 53 V_{DD}, 54 OS2, 55 TS2, 56 C_1(+), 57 C_2(−), 58 V_{SS2}, 59 NC, 60 NC

Right pins (top to bottom, 30–16): 30 C_3, 29 B_3, 28 A_3, 27 C_2, 26 B_2, 25 A_2, 24 C_1, 23 V_{DD}, 22 B_1, 21 A_1, 20 OS3, 19 COM3, 18 COM2, 17 COM1, 16 K_1

Bottom pins (left to right, 1–15): 1 NC, 2 TS4, 3 V_{SS1}, 4 TS3, 5 TS1, 6 RESET, 7 K_8, 8 K_7, 9 K_6, 10 K_5, 11 K_4, 12 K_3, 13 K_2, 14 NC, 15 NC
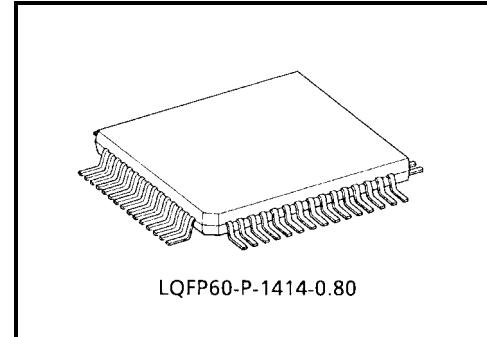
System Block Diagram

Battery Type
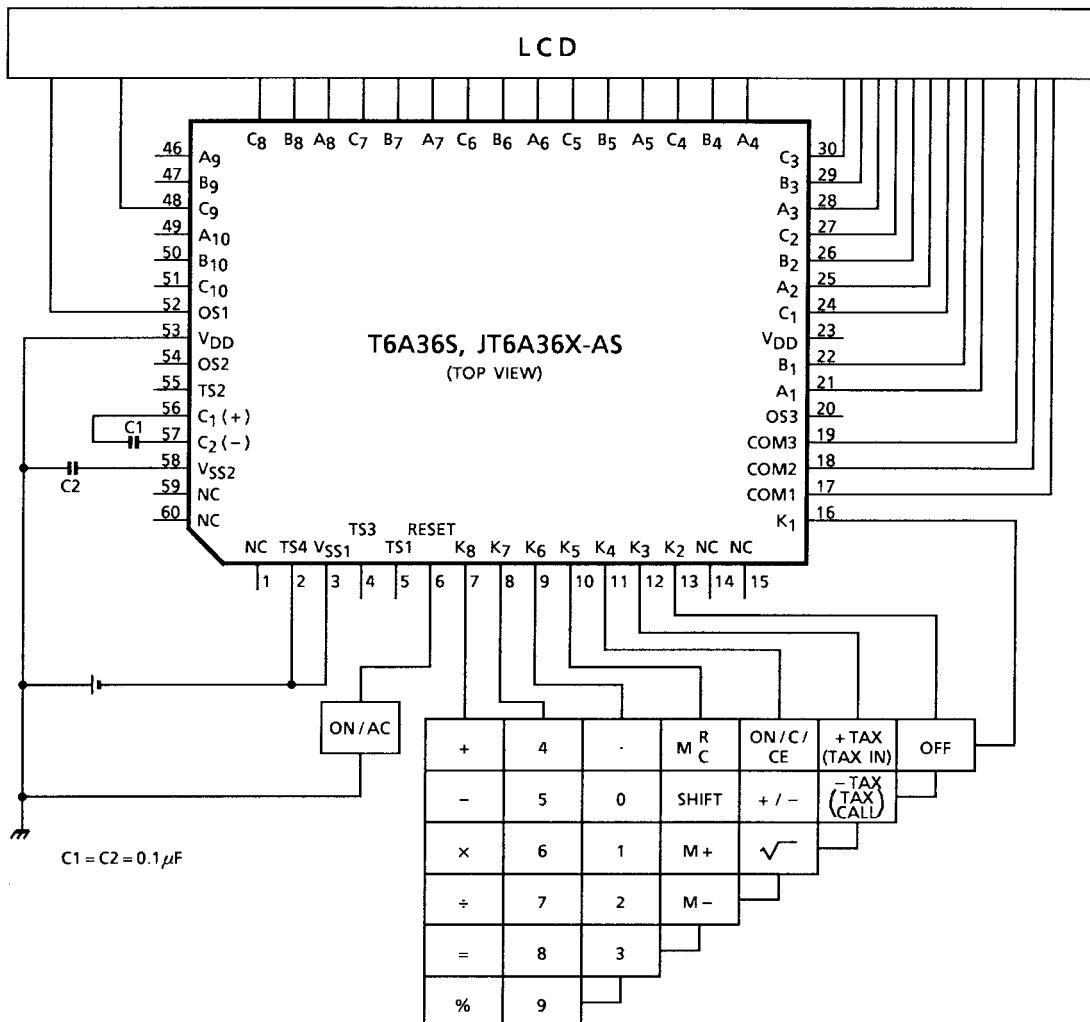
Note 1:

$$\text{TS4} \begin{cases} V_{DD} \dots \dots \text{OFF mode disable} \\ V_{SS1} \dots \dots \text{OFF mode enable} \end{cases}$$

$R_{key} \leqq 20\ \text{k}\Omega\ (-1.2\ \text{V})$

Dual Type
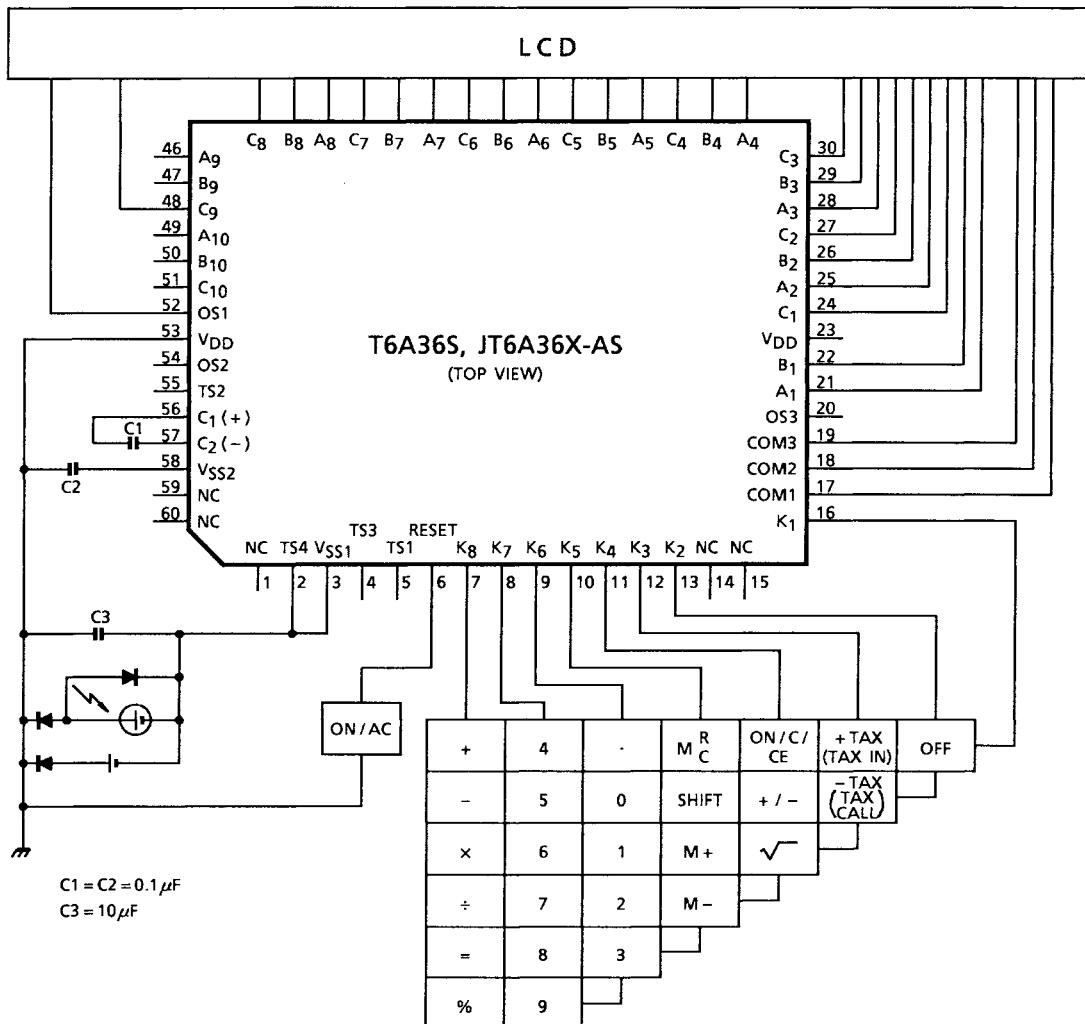
Note 2:

$$TS4 \begin{cases} V_{DD} \text{...........OFF mode disable} \\ V_{SS1} \text{.........OFF mode enable} \end{cases}$$

$Rkey \leqq 20\ k\Omega\ (-1.2\ V)$

Solar Type
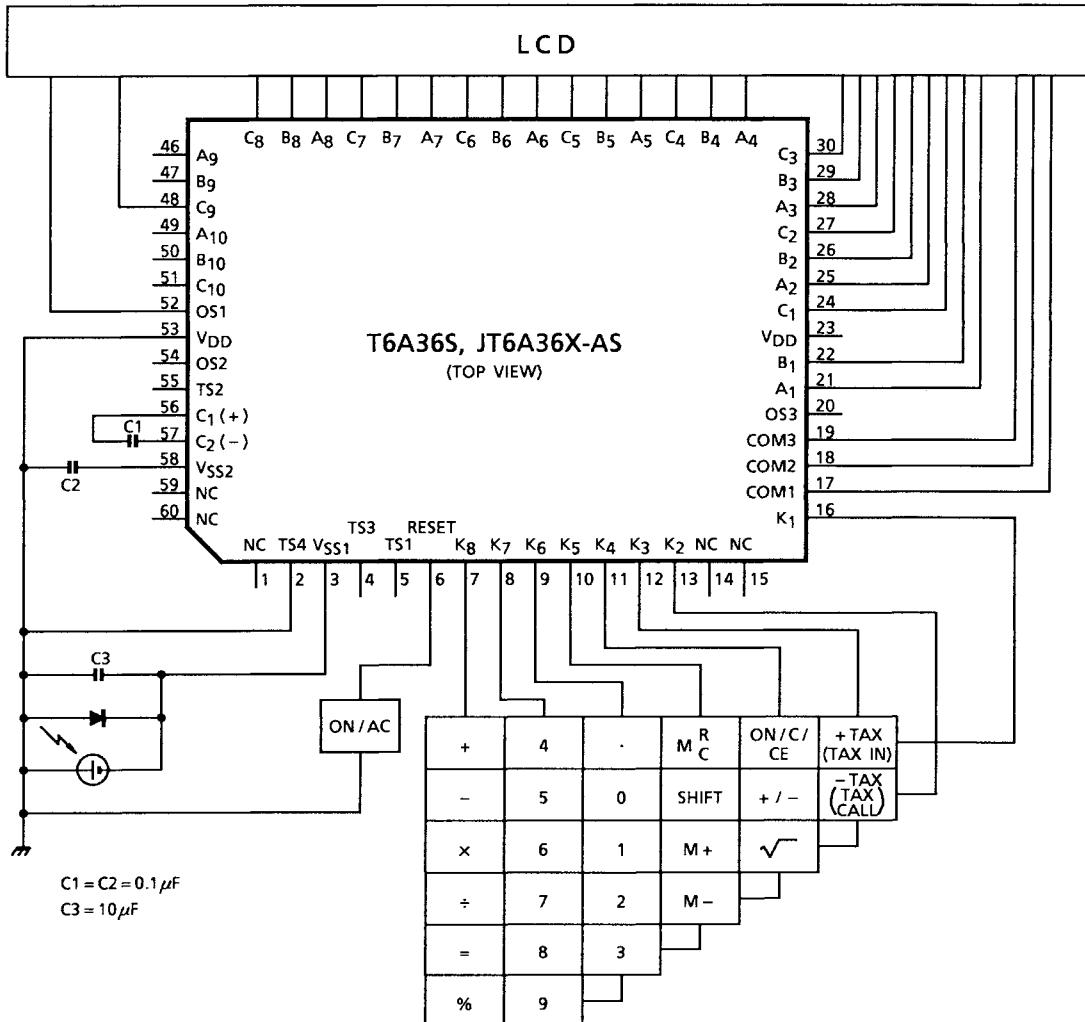
Note 3:

$$TS4 \begin{cases} V_{DD} \ldots\ldots\ldots\ldots \text{OFF mode disable} \\ V_{SS1} \ldots\ldots\ldots \text{OFF mode enable} \end{cases}$$

$Rkey \leqq 20\ k\Omega\ (-1.2\ V)$

Connection of LCD

Segment
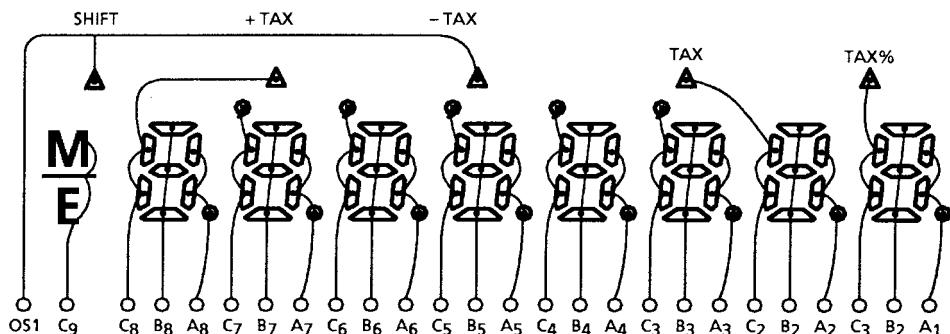
Common
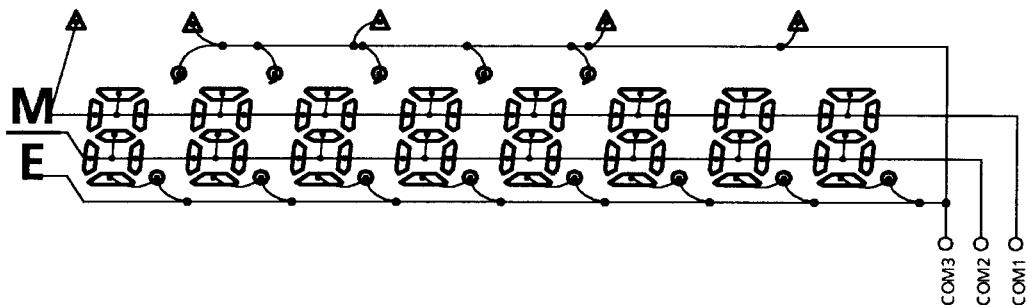
Key Connection
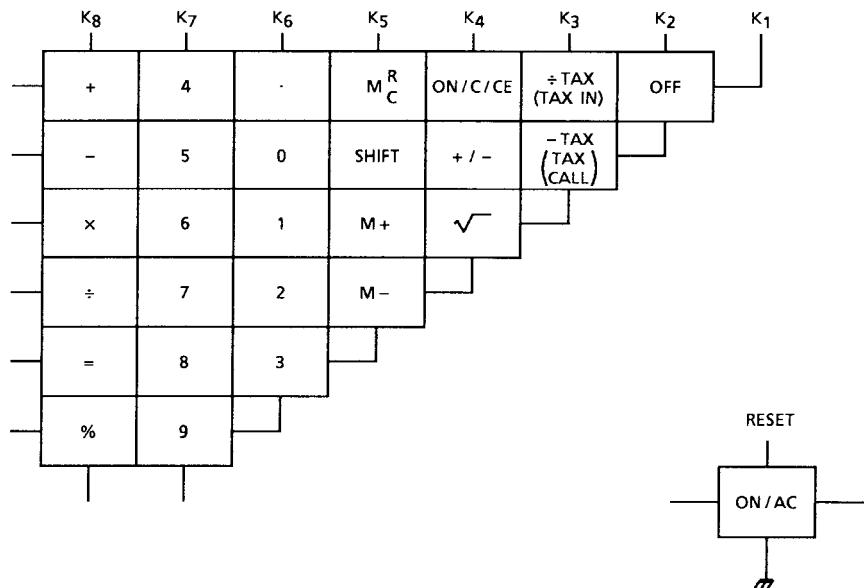
Specification of Calculator

Operational Features

(1)   8 digits of data and one symbol digit.
(2)   Algebraic mode.
(3)   Full floating point.
(4)   Standard 4 functions +, −, ×, ÷.
(5)   Memory calculation and memory hold.
(6)   TAX calculation.
(7)   Percent with automatic add-on and discount.
(8)   Constant calculation (automatic constant) .
(9)   Chain calculation.
(10) Leading zero suppression.
(11) Trailing zero suppression.
(12) Square root.
(13) Change sign.

Capacity of Calculation

(1)	Numeral entry	8 digits
(2)	Addition/Subtraction	8 digits + (−) 8 digits = 8 digits
(3)	Multiplication/Division	8 digits × (÷) 8 digits = 8 digits
(4)	Memory calculation	8 digits + (−) 8 digits = 8 digits

Display Font

Arithmetic Operations

1.   Addition

Key Op.	Display
A	A
+	A
B	B
+	A + B
C	C
=	A + B + C
D	D
+	D
E	E
+	D + E
=	D + E

2. Subtraction

	Key Op.	Display
(1)	A	A
	−	A
	B	B
	−	A − B
	C	C
	=	A − B − C
	−	A − B − C
	D	D
	+ / −	− D
	−	A − B − C + D
	=	− (A − B − C + D)

3. Multiplication

	Key Op.	Display
(1)	A	A
	×	A
	B	B
	=	A·B
	+	A·B
	C	C
	=	A·B + C
(2)	−	0.
	A	A
	×	− A
	B	B
	=	− A·B

4. Division

	Key Op.	Display
(1)	A	A
	$\div$	A
	B	B
	$=$	A / B
(2)	$-$	0.
	A	A.
	$\div$	$-$ A
	B	B
	$=$	$-$ A / B

5. Power Calculation

	Key Op.	Display
(1)	A	A
	$\times$	A
	$=$	A^2
	$=$	A^3
(2)	A	A
	$\div$	A
	$=$	1 / A
	$=$	$1 / A^2$
(3)	$-$	0.
	A	A
	$\times$	$-$ A
	$=$	A^2
	$=$	$-A^3$
(4)	$-$	0.
	A	A
	$\div$	$-$ A
	$=$	$-$ 1 / A
	$=$	$1 / A^2$
(5)	A	A
	$\times$	A
	$=$	A^2
	$\times$	A^2
	$=$	A^4

6. Mixed Calculation

	Key Op.	Display
(1)	A	A
	$\times$	A
	B	B
	$+$	$A \cdot B$
	C	C
	$\div$	$A \cdot B + C$
	D	D
	$-$	$\dfrac{A \cdot B + C}{D}$
	E	E
	$=$	$\dfrac{A \cdot B + C}{D} - E$

7. Constant Calculation

	Key Op.	Display
(1)	A	A
	$\boxed{\times}$	A
	B	B
	$\boxed{=}$	A·B
	C	C
	$\boxed{=}$	A·C
(2)	$\boxed{-}$	0.
	A	A
	$\boxed{\times}$	− A
	B	B
	$\boxed{=}$	− A·B
	C	C
	$\boxed{=}$	− A·C
(3)	A	A
	$\boxed{\div}$	A
	B	B
	$\boxed{=}$	A / B
	C	C
	$\boxed{=}$	C / B
	D	D
	$\boxed{\times}$	D
	$\boxed{=}$	D²
(4)	A	A
	$\boxed{+}$	A
	B	B
	$\boxed{=}$	A + B
	C	C
	$\boxed{=}$	C + B
(5)	A	A
	$\boxed{-}$	A
	B	B
	$\boxed{=}$	A − B
	C	C
	$\boxed{=}$	C − B

	Key Op.	Display
(6)	A	A
	☒	A
	B	B
	☐=	A·B
	C	C
	☒	C
	D	D
	☐=	C·D
	E	E
	☐=	C·E
	☒	C·E
	F	F
	☐=	C·E·F
	G	G
	☐÷	G
	H	H
	☐=	G / H
	I	I
	☐=	I / H
(7)	A	A
	☒	A
	B	B
	☐%	A·B / 100
	C	C
	☐%	A·C / 100
	D	D
	☐÷	D
	E	E
	☐%	100·D / E
	F	F
	☐%	100·F / E

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8. Mark-up/Discount Calculator

	Key Op.	Display
(1)	A	A
	☒	A
	B	B
	＋	A·B
	＝	A + A·B
(2)	A	A
	☒	A
	B	B
	－	A·B
	＝	A − A·B
(3)	A	A
	☒	A
	B	B
	％	A·B / 100
	＋	A·B / 100
	＝	A + A·B / 100
(4)	A	A
	☒	A
	B	B
	％	A·B / 100
	－	A·B / 100
	＝	A − A·B / 100
(5)	A	A
	＋	A
	B	B
	％	A + A·B / 100
(6)	A	A
	－	A
	B	B
	％	A − A·B / 100

9. Memory Calculation

	Key Op.	Display	Memory
(1)	A	A	0.
	M +	A (M)	A
	B	B (M)	A
	M +	B (M)	A + B
	C	C (M)	A + B
	M −	C (M)	A + B − C
	D	D (M)	A + B − C
	M R/C	A + B − C (M)	A + B − C
	M R/C	A + B − C	0.
(2)	A	A	0.
	+	A	0.
	B	B	0.
	M +	A + B (M)	A + B
	+	A + B (M)	A + B
	M +	A + B (M)	2 (A + B)
	C	C (M)	2 (A + B)
	M −	C (M)	2 (A + B) − C
(3)	A	A	0.
	×	A	0.
	B	B	0.
	M +	A·B (M)	A·B
	C	C (M)	A·B
	×	C (M)	A·B
	D	D (M)	A·B
	M −	C·D (M)	A·B − C·D
	M R/C	A·B − C·D (M)	A·B − C·D
	M −	A·B − C·D	0.

	Key Op.	Display	Memory
(4)	A	A	0.
	×̲	A	0.
	B	B	0.
	=̲	A·B	0.
	C	C	0.
	M+̲	C (M)	C
	=̲	A·C (M)	C
	D	D (M)	C
	M−̲	D (M)	C − D
	=̲	A·D (M)	C − D
(5)	A	A	0.
	M+̲	A (M)	A
	B	B (M)	A
	M+̲	B (M)	A + B
	M$_C^R$	A + B (M)	A + B
	×̲	A + B (M)	A + B
	M$_C^R$	A + B (M)	A + B
	+̲	$(A + B)^2$ (M)	A + B
	C	C (M)	A + B
	=̲	$(A + B)^2 + C$ (M)	A + B
(6)	1.0000001	1.0000001	0.
	M+̲	1.0000001 (M)	1.0000001
	99999999	99999999. (M)	1.0000001
	M+̲	0. (^M_E)	1.0000001
	ON/C/CE	0. (M)	1.0000001
	M$_C^R$	1.0000001 (M)	1.0000001

10. Square Root

	Key Op.	Display	Memory
(1)	A	A	
	$\boxed{\sqrt{}}$	$\sqrt{A}$	
	B	B	
(2)	A	A	
	$\boxed{\times}$	A	
	B	B	
	$\boxed{\sqrt{}}$	$\sqrt{B}$	
	$\boxed{=}$	$A\sqrt{B}$	
(3)	A	A	
	$\boxed{\times}$	A	
	$\boxed{\sqrt{}}$	$\sqrt{A}$	
	B	B	
	$\boxed{=}$	A·B	
(4)	$\boxed{-}$	0.	
	A	A	
	$\boxed{=}$	– A	
	$\boxed{\sqrt{}}$	$\sqrt{A}$ (E)	
(5)	A	A	0.
	$\boxed{M+}$	A (M)	A
	$\boxed{M\frac{R}{C}}$	A (M)	A
	$\boxed{\div}$	A (M)	A
	B	B (M)	A
	$\boxed{+/-}$	– B (M)	A
	$\boxed{\sqrt{}}$	$\sqrt{B}$ ($\frac{M}{E}$)	A
	$\boxed{ON/C/CE}$	0. (M)	A

11. Percentage Calculation

	Key Op.	Display	Memory
(1)	A	A	
	$\times$	A	
	B	B	
	%	A·B / 100	
	C	C	
	%	A·C / 100	
	D	D	
	%	A·D / 100	
(2)	A	A	
	%	A	
	B	B	
	%	B	
	C	C	
	%	C	
(3)	A	A	
	−	A	
	B	B	
	%	A − A·B / 100	
	−	A − A·B / 100	
	+	A − A·B / 100	
	C	C	
	%	$\left(A - \dfrac{A \cdot B}{100}\right) + \dfrac{\left(A - \dfrac{A \cdot B}{100}\right) \cdot C}{100}$	

12. Key Correction

	Key Op.	Display	Memory
(1)	A	A	0.
	$\times$	A	0.
	$\div$	A	0.
	$-$	A	0.
	$+$	A	0.
	$\sqrt{}$	$\sqrt{A}$	0.
	M$+$	$A + \sqrt{A}$ (M)	$A + \sqrt{A}$
	$+/-$	$-(A + \sqrt{A})$ (M)	$A + \sqrt{A}$
	M^R_C	$A + \sqrt{A}$ (M)	$A + \sqrt{A}$
	M^R_C	$A + \sqrt{A}$ (M)	0.
	B	B	0.
	$+$	B	0.
	$-$	B	0.
	$\times$	B	0.
	$\div$	B	0.
	$=$	1 / B	0.

13. Others

	Key Op.	Display	Memory
(1)	A	A	
	$+$	A	
	$=$	A	
(2)	A	A	
	$\times$	A	
	$\div$	A	
	$=$	1 / A	
(3)	A	A	
	$\div$	A	
	$+$	A	
	$=$	A	

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	Key Op.	Display	Memory
(4)	A	A	
	$\times$	A	
	$-$	A	
	$=$	$-$A	
(5)	A	A	
	$\div$	A	
	$-$	A	
	$=$	$-$A	
(6)	A	A	
	$\times$	A	
	ON / C / CE	0.	
	B	B	
	$=$	B	
(7)	A	A	
	$\times$	A	
	B	B	
	ON / C / CE	0.	
	C	C	
	$=$	A·C	

14. 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	$B\cdot A/100$	TAX
	+TAX	$B(1+A/100)$	+TAX
	+TAX	$B\cdot A/100$	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 Characteristics

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{SS1}	+0.3~−2.2	V
Input voltage	V_{IN}	+0.3~V_{DD1} −0.3	V
Operating temperature	T_{opr}	+0.0~40	°C
Storage temperature	T_{stg}	−55~125	°C

Electrical Characteristics
($V_{SS1} = -1.5$ V ± 0.2 V, $V_{SS2} = -3.0$ V ± 4.0 V, $V_{DD} = 0$ V, Ta = 25°C)

	Characteristics	Symbol	Test Circuit	Pin Name	Test Condition		Min	Typ.	Max	Unit
	Operating voltage	V_{SS1}	—	—	—		−1.2	−1.5	−2.0	V
Voltage	Input "1"	V_{IH}	—	K_2~K_8, RESET	—		V_{SS1} + 0.4	—	V_{SS1}	V
	Input "0"	V_{IL}	—	K2~K_8, RESET	—		0	—	−0.4	V
	Onput "1"	V_{OH}	—	Segment, Common	—		V_{SS2} + 0.2	—	V_{SS2}	V
	Output "0"	V_{OL}	—	Segment, Common	—		0	—	−0.2	V
	Output "1"	V_{OH}	—	K_1~K_8, RESET	—		V_{SS1} + 0.2	—	V_{SS1}	V
	Output "0"	V_{OL}	—	K_1~K_6, RESET	—		0	—	−0.2	V
Resistance	Output "1"	R_{OH}	—	Segment	$V_{OUT} = V_{DD2} + 0.5$ V		—	—	70	kΩ
	Output "0"	R_{OL}	—	Segment	$V_{OUT} = -0.5$ V		—	—	70	kΩ
	Output "1"	R_{OH}	—	Common	$V_{OUT} = V_{DD2} + 0.5$ V		—	—	70	kΩ
	Output "0"	R_{OL}	—	Common	$V_{OUT} = -0.5$ V		—	—	70	kΩ
	Pull up	R_{KH}	—	K_1~K_8	$V_{OUT} = 0$ V		60	400	1500	kΩ
		RESET	—	RESET	$V_{OUT} = 0$ V		200	300	400	
	Output "0"	R_{OL}	—	K_1~K_6	$V_{OUT} = -0.5$ V		—	—	10	kΩ
	Supply current 1 (on display)	I_{DD1}	—	—	$V_{SS1} = -1.5$ V (no keys)		—	−2.2	−3.6	μA
	Supply current 2 (operation)	I_{DD2}	—	—	$V_{SS1} = -1.2$ V (peak OF A11 9 $\sqrt{\ }$)		—	−4.4	−6.6	μA
	Supply current 3 (off)	I_{DD3}	—	—	$V_{SS1} = -1.5$ V (off status)		—	−0.5	−2.0	μA
	Oscillating frequency	fosc (WAIT)	—	—	$V_{SS1} = -1.5$ V	On Display	5.4	9	12.6	kHz
		fosc (OP)				On Operating	10.8	18	25.2	
	Frame frequency	f_F	—	—	$V_{SS1} = -1.5$ V (wait)		50	83	117	Hz
	Power off timer	T timer	—	—	$V_{SS1} = -1.5$ V		252	420	588	s

Waveforms for Display
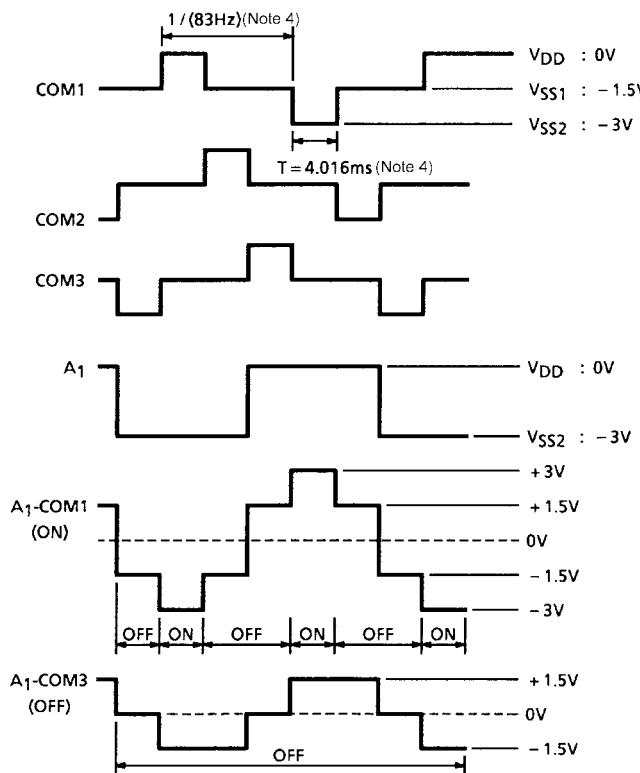
Note 4: fϕ = 9 kHz

Pad Location Table

(μm)

Name	X Point	Y Point		Name	X Point	Y Point
TS4	779	1086		B_4	−1097	−1412
V_{SS1}	628	1086		C_4	−946	−1412
TS3	476	1086		A_5	−794	−1412
TS1	324	1086		B_5	−642	−1412
RESET	172	1086		C_5	−491	−1412
K_8	21	1086		A_6	−339	−1412
K_7	−131	1086		B_6	−187	−1412
K_6	−283	1086		C_6	−36	−1412
K_5	−434	1086		A_7	116	−1412
K_4	−586	1086		B_7	268	−1412
K_3	−738	1086		C_7	420	−1412
K_2	−889	1086		A_8	571	−1412
K_1	−1462	931		B_8	723	−1412
COM1	−1462	733		C_8	1084	−1240
COM2	−1462	581		A_9	1084	−1088
COM3	−1462	430		B_9	1084	−936
OS3	−1462	278		C_9	1084	−785
A_1	−1462	126		A_{10}	1084	−633
B_1	−1462	−26		B_{10}	1084	−481
C_1	−1462	−177		C_{10}	1084	−330
A_2	−1462	−329		OS1	1084	−178
B_2	−1462	−481		V_{DD}	1084	−26
C_2	−1462	−632		OS2	1084	125
A_3	−1462	−784		TS2	1084	326
B_3	−1462	−936		C_1 (+)	1084	534
C_3	−1462	−1087		C_2 (−)	1084	735
A_4	−1462	−1239		V_{SS2}	1084	937

Chip Layout

Top pads (left to right): K2, K3, K4, K5, K6, K7, K8, RESET, (TS1), (TS3), Vss1, TS4

Left pads (top to bottom): K1, COM1, COM2, COM3, OS3, A1, B1, C1, A2, B2, C2, A3, B3, C3, A4

Right pads (top to bottom): Vss2, C2, C1, (TS2), OS2, VDD, OS1, C10, B10, A10, C9, B9, A9, C8

Bottom pads (left to right): B4, C4, A5, B5, C5, A6, B6, C6, A7, B7, C7, A8, B8

Center label: JT6A36X-AS

Chip size   : 3.04 × 3.02 [mm]
Chip thickness : 440 ± 30 [μm]
Substrate   : V_{DD}
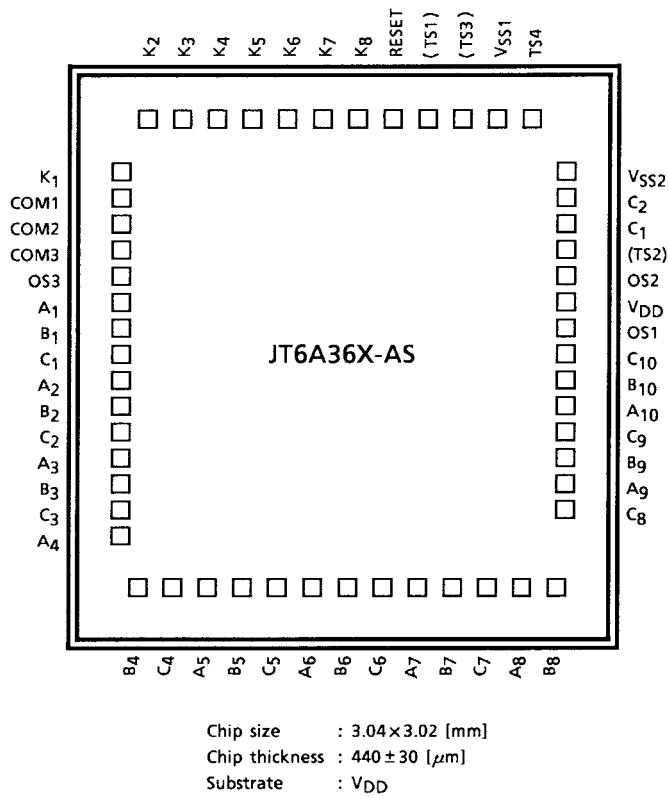
Pad Layout

Active Element

40 μm

Bonding Area (100 μm)

Al 8 μm

40 μm

100 μm

(138 μm)

Scribe Line

PAD Pitch 151 μm
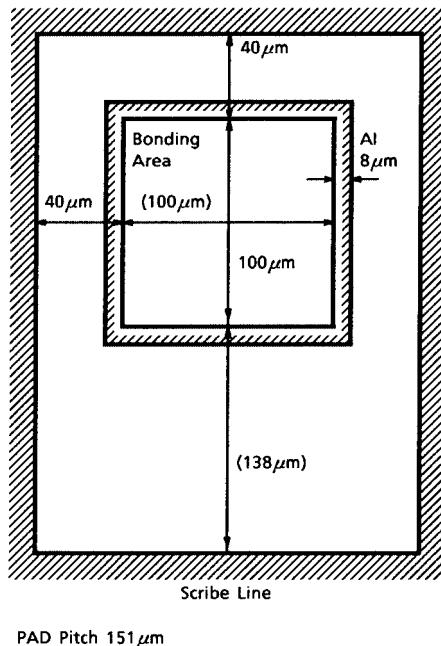
Package Dimensions

LQFP60-P-1414-0.80   Unit : mm
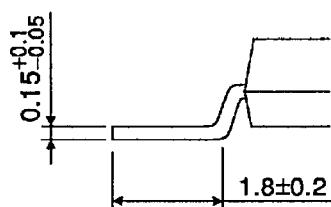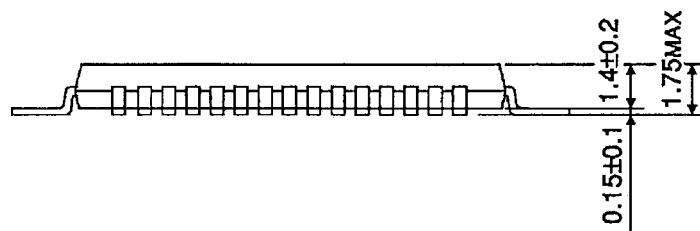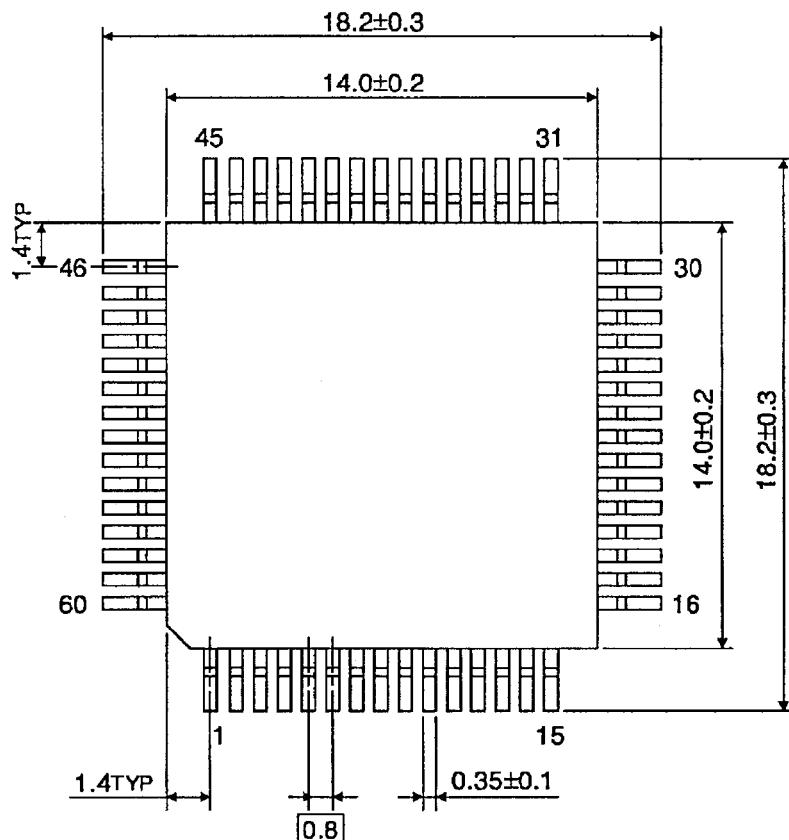
Weight: 0.66 g (typ.)

RESTRICTIONS ON PRODUCT USE

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..

- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.

- The products described in this document are subject to the foreign exchange and foreign trade laws.

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2003-02-19