

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

T7987A, JT7987AY-CS

T7987A, JT7987AY-CS CMOS 1 CHIP LSI FOR LCD ELECTRONIC CALCULATOR

The T7987A, JT7987AY-CS is a 1 chip microcomputer for 10-digits+2-digits electronic scientific calculation. T7987A, JT7987AY-CS is the complete single chip CMOS LSI for electronic calculator with 10 digit, 67 function, 3 expression and hexadecimal, octal and binary, statistic calculation, fractional number calculation, and logic operation with the following features.

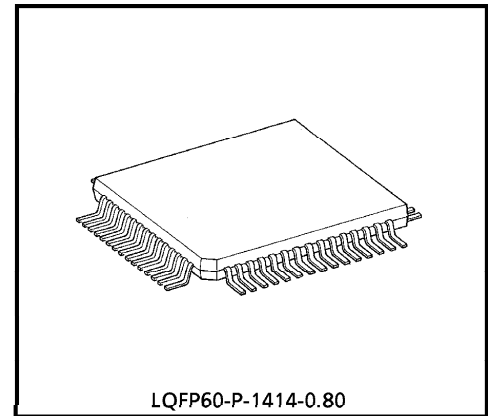
FEATURES

- Display 12 display digits plus 2 digits code at the right margin.
 - Scientific and engineering display.
 - Mantissa 10 digits plus exponent 2 digits plus negative code 2 digits.
 - Other than above
 - Mantissa 10 digits plus negative code 1 digit.

- 13 kinds of special display

M	Memory	HEX	Hexadecimal mode
-	Mantissa and exponent Minus	SD	Statistic calculation mode
E	Error	DEG	Degree
INV	Inverse	RAD	Radian
HYP	Hyperbolic	GRAD	Gradian
BIN	Binary mode	()	Parenthesis calculation
OCT	Octal mode		

- The minus sign of the mantissa is floating minus.
- The arithmetic key operation in clouding Y^X or $X\sqrt{Y}$ has same sequence as mathematical equation. 6 pending operations are allowed and () are up to continuous 15 levels.
- Fractional number calculation.
- Statistic calculation includes 3 kinds of the normal distribution, total 9 kinds.
- It is possible to convert mutually between decimal, binary, octal and hexadecimal, and the four operations in arithmetic in binary, octal and hexadecimal.
- One independent accumulating memory.



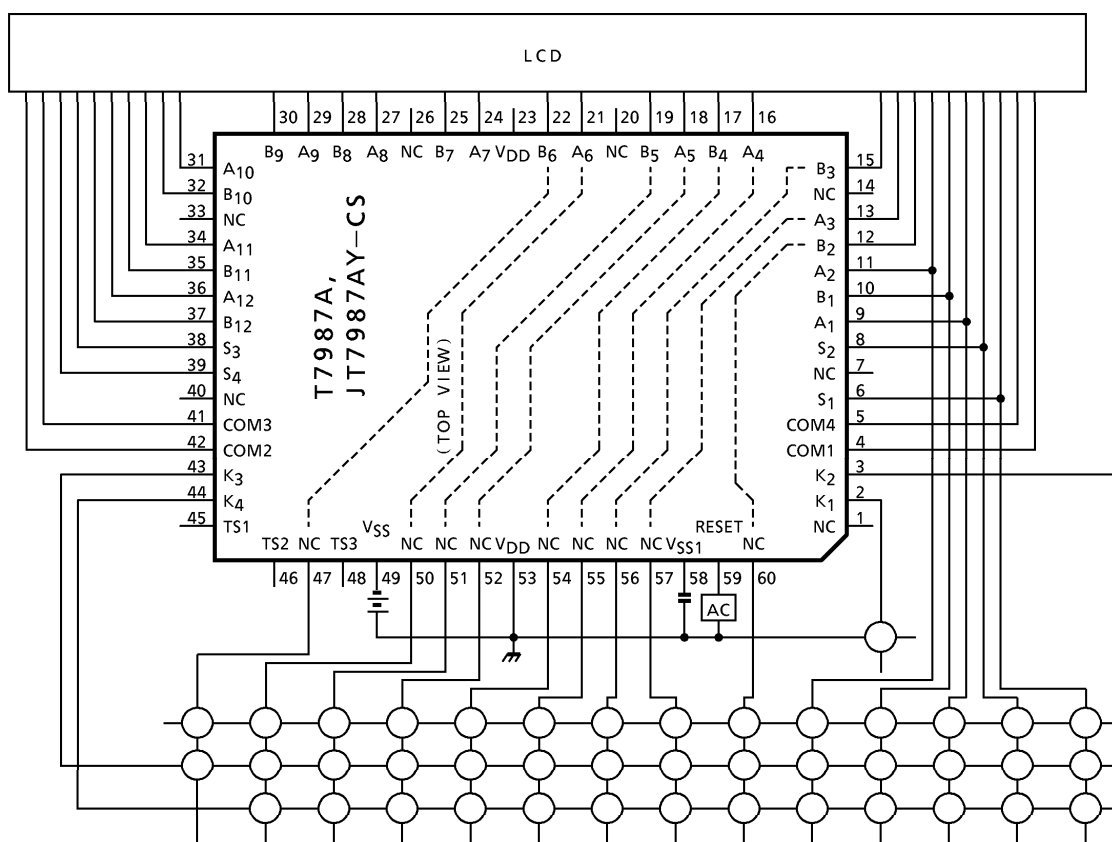
Weight : 0.66g (Typ.)

980910EBA2

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- It is possible to convert or fix the display number system by FLO (Floating) , SCI (Scientific) or ENG (Engineering) key.
- It is possible to specify decimal part digits (0~9) by FIX key.
- Direct drive for FEM LCD (1/3 prebias, 1/4 duty) .
- Automatic power on clear.
- Low power consumption. $V_{SS} = -3.0V$ single power supply.
- The 60 pin flat package is used.

SYSTEM BLOCK DIAGRAM

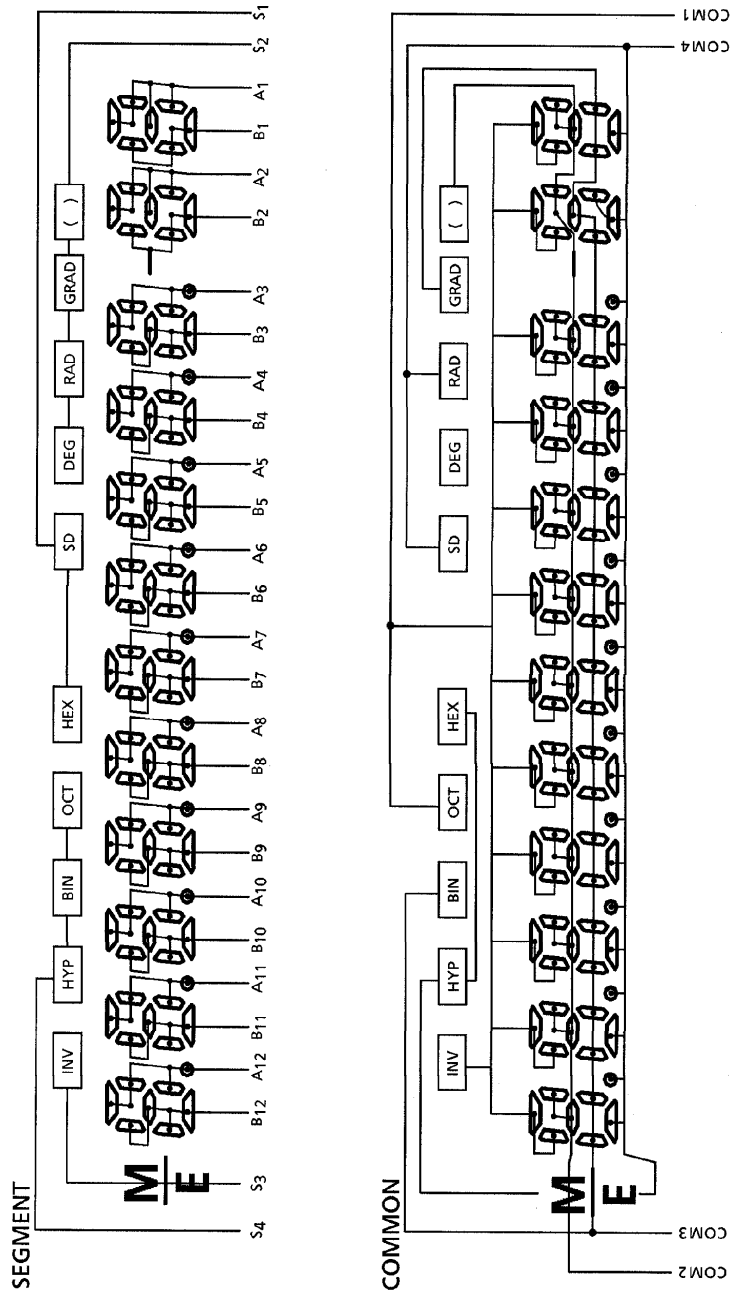


NOTE Input capacity ≤ 400 (pF) at $V_{SS} = -3.0$ (V)
 Key resistance ≤ 3.0 (k Ω) at $V_{SS} = -3.0$ (V)

980910EBA2'

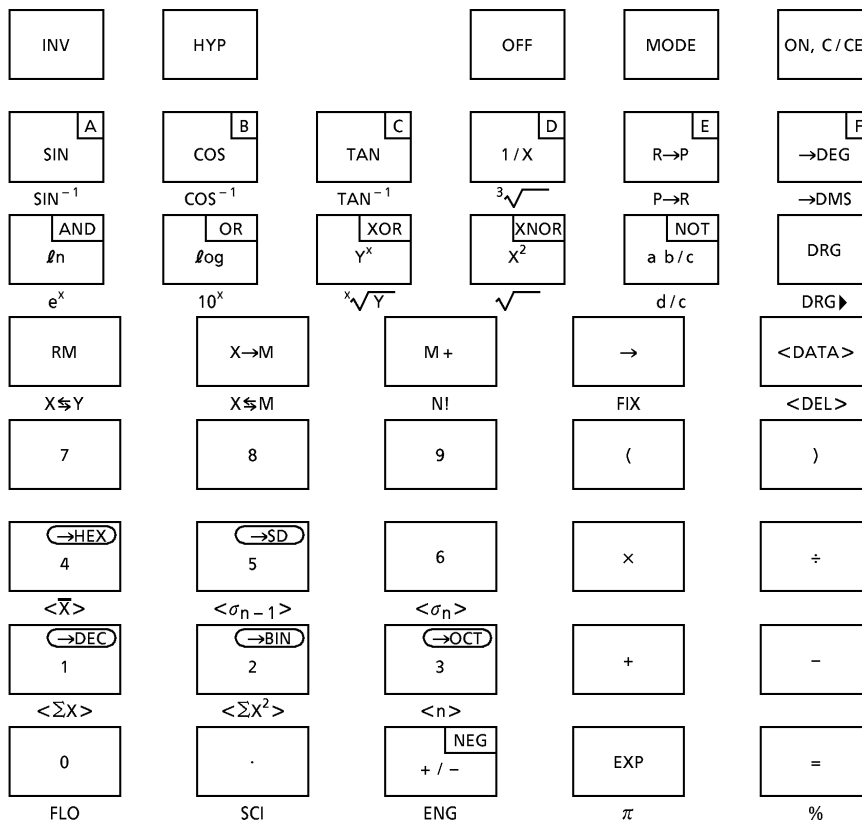
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CONNECTION OF LCD

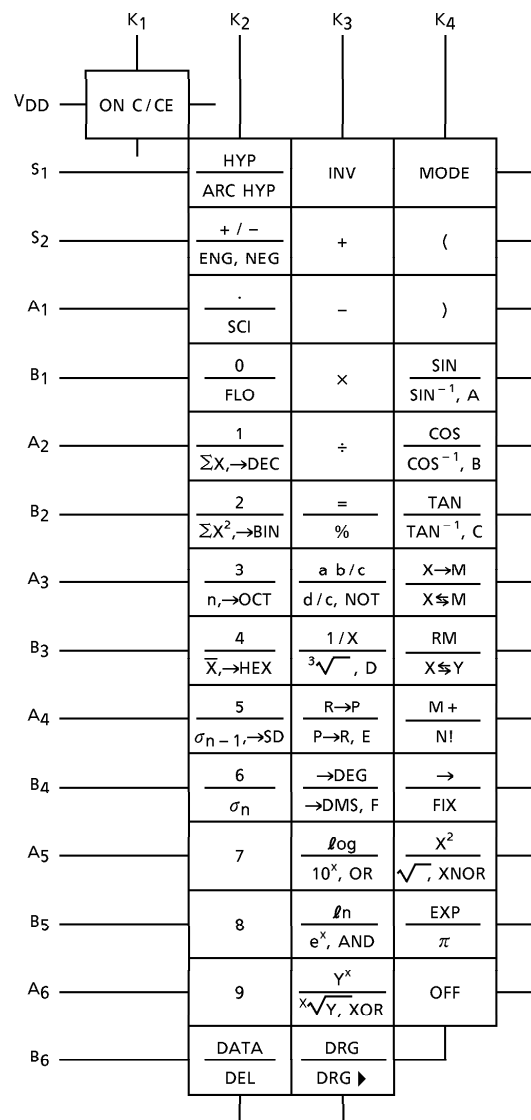


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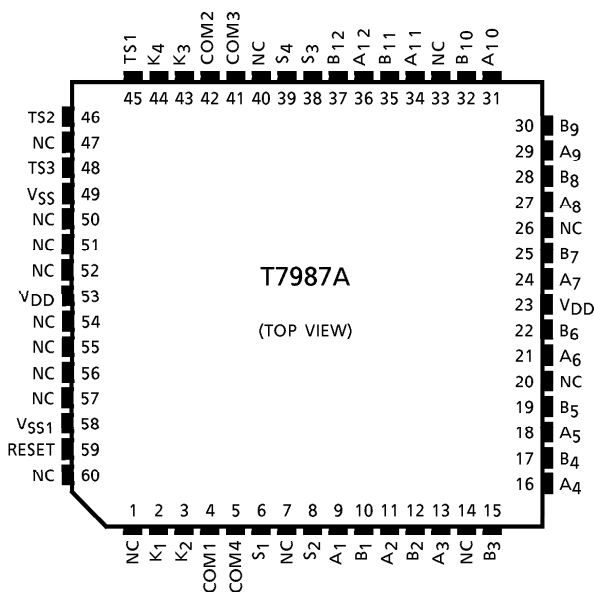
SET KEY LAYOUT (Example)



KEY LAYOUT



PIN LAYOUT



SPECIFICATION OF CALCULATOR

Speed of calculation
Key on 4.8ms

Key off 34.4ms

$f_{\phi} \text{WAIT} = 15\text{kHz}$, $f_{\phi} \text{op} = 80\text{kHz}$

The calculation speed doesn't include the key on or off time.

ITEM	OPERATION			CALCULATION SPEED (ms)
Number	DEC		5	8
			5	8
	HEX		A	9
			A	9
Function	DEC		+	20
			×	21
	HEX		-	51
			÷	52
4 operation	DEC		1 + 2	29
			1 0 0 0 0 0 0 0 0 - 1	31
			5 × 9	31
			5 5 5 5 5 × 9 9 9 9 9	36
			5 ÷ 9	47
			5 5 5 5 5 ÷ 9 9 9 9 9	58
	HEX		A B C + D E F	88
			A B C - D E F	144
$Y^X, X\sqrt{Y}$		3 Y ^x 4	252	
		3 ^x √Y 4	262	

ITEM	OPERATION			CALCULATION SPEED (ms)
SIN	DEG	3 0	SIN	241
	RAD	$\pi \div 6 =$	SIN	231
	GRAD	$1\ 0\ 0 \div 3 =$	SIN	350
COS	DEG	6 0	COS	244
	RAD	$\pi \div 3 =$	COS	311
	GRAD	$2\ 0\ 0 \div 3 =$	COS	354
TAN	DEG	4 5	TAN	118
	RAD	$\pi \div 4 =$	TAN	45
	GRAD	5 0	TAN	48
SIN ⁻¹	DEG	0. 5	SIN ⁻¹	252
	RAD	0. 5	SIN ⁻¹	198
	GRAD	0. 5	SIN ⁻¹	249
COS ⁻¹	DEG	0. 5	COS ⁻¹	322
	RAD	0. 5	COS ⁻¹	230
	GRAD	0. 5	COS ⁻¹	319
TAN ⁻¹	DEG	1	TAN ⁻¹	73
	RAD	1	TAN ⁻¹	46
	GRAD	1	TAN ⁻¹	72
Ln		2 0	ln	47
Log		2 0	log	99
e ^x		2 0	e ^x	94
10 ^x		1. 2 3	10 ^x	113
		1 0	10 ^x	40
X!		6 9	N!	291
HYP		3 hyp	SIN	189
		3 hyp	COS	190
		3 hyp	TAN	232
ARC HYP		3 hyp ⁻¹	SIN	184
		3 hyp ⁻¹	COS	205
		0.5 hyp ⁻¹	TAN	174
X ²		2 0	X ²	18
$\sqrt{\quad}$		2 0	$\sqrt{\quad}$	64
1/X		2 0	1/X	23
$\sqrt[3]{\quad}$		2 0	$\sqrt[3]{\quad}$	180
Mutual Conversion	DEC	1 2 3	→BIN	35
		1 2 3 4 5	→OCT	40
		1 2 3 4 5	→HEX	35
	BIN	1 0 1 0 1	→DEC	27
	OCT	1 2 3 4 5	→DEC	33
	HEX	A B C D E	→DEC	54
→DEG		1.2 3 4 5	→DEG	78
→DMS		1.2 3 4 5	→DMS	87

ITEM	OPERATION				CALCULATION SPEED (ms)		
R→P	DEG	$\sqrt[3]{X \leftrightarrow Y}$		1	R→P	275	
	RAD	$\sqrt[3]{X \leftrightarrow Y}$		1	R→P	216	
	GRAD	$\sqrt[3]{X \leftrightarrow Y}$		1	R→P	274	
P→R	DEG	2	$X \leftrightarrow Y$	3 0	P→R	462	
	RAD	2	$X \leftrightarrow Y$	30 DRG▶	P→R	437	
	GRAD	2	$X \leftrightarrow Y$	30 DRG▶ DRG▶	P→R	626	
→RAD	DEG			3 6 0	DRG▶	43	
→GRAD	RAD			2 × π =	DRG▶	29	
→DEG	GRAD			4 0 0	DRG▶	20	
Memory					1 2 3	X→M	17
					1 2 3 X → M	M +	19
					1 2 3 X → M	RM	12
					1 2 3 X → M	X↔M	19
%					1 2 3 + 4 5 6	%	26
					1 2 3 - 4 5 6	%	26
					1 2 3 × 4 5 6	%	17
					1 2 3 ÷ 4 5 6	%	17
Exchange					1 2 3 + 4 5 6	X↔Y	15
Shift					1 2 3	→	8
Statistic Calculation	1 DATA 2 DATA 3 DATA 8 DATA 9				DATA	38	
	The above-mentioned data				n	16	
					\bar{X}	21	
					ΣX	15	
					ΣX ²	15	
					σ _{n-1}	90	
		σ _n	104				
Logic operation	HEX	A B C AND		D E F	=	181	
		A B C OR		D E F	=	195	
		A B C XOR		D E F	=	171	
		A B C XNOR		D E F	=	289	
				A B C	NOT	118	
NEG	HEX			A B C	NEG	112	
Fractional number calculation	Function	2 ab/c 3 6 ab/c 2 3 4		-	75		
		2 ab/c 3 6 ab/c 2 3 4		÷	76		
	4-operation	2 $\frac{_}{36}$ 234 + 3 $\frac{_}{45}$ 345		=	161		
		2 $\frac{_}{36}$ 234 - 3 $\frac{_}{45}$ 345		=	153		
		2 $\frac{_}{36}$ 234 × 3 $\frac{_}{45}$ 345		=	149		
2 $\frac{_}{36}$ 234 ÷ 3 $\frac{_}{45}$ 345		=	168				

OPERATION RANGE AND ACCURACY

FUNCTION	ANGLE UNIT	OPERATION RANGE	UNDER FLOW AREA	NORMAL ACCURACY
SIN X	DEG	$0 \leq X \leq 4.499999999 \times 10^{10}$	$0 \leq X \leq 5.729577951 \times 10^{-98}$	10 digits ± 1
	RAD	$0 \leq X \leq 785398163.3$	—	
	GRAD	$0 \leq X \leq 4.999999999 \times 10^{10}$	$0 \leq X \leq 6.366197723 \times 10^{-98}$	
COS X	DEG	$0 \leq X \leq 4.500000008 \times 10^{10}$	—	
	RAD	$0 \leq X \leq 785398164.9$	—	
	GRAD	$0 \leq X \leq 5.000000009 \times 10^{10}$	—	
TAN X	DEG	SAME AS SIN X except for $ X = (2n - 1) \cdot 90$	SAME AS SIN X	
	RAD	SAME AS SIN X except for $ X = (2n - 1) \cdot \pi / 2$	SAME AS SIN X	
	GRAD	SAME AS SIN X except for $ X = (2n - 1) \cdot 100$	SAME AS SIN X	
SIN ⁻¹ X	DEG	$0 \leq X \leq 1$	$0 \leq X \leq 1.570796326 \times 10^{-99}$	
	RAD	$0 \leq X \leq 1$	—	
	GRAD	$0 \leq X \leq 1$	$0 \leq X \leq 1.570796326 \times 10^{-99}$	
COS ⁻¹ X	DEG	SAME AS SIN ⁻¹ X	—	
	RAD	SAME AS SIN ⁻¹ X	—	
	GRAD	SAME AS SIN ⁻¹ X	—	
TAN ⁻¹ X	DEG	$0 \leq X \leq 9.999999999 \times 10^{99}$	SAME AS SIN ⁻¹ X	
	RAD	$0 \leq X \leq 9.999999999 \times 10^{99}$	—	
	GRAD	$0 \leq X \leq 9.999999999 \times 10^{99}$	SAME AS SIN ⁻¹ X	

FUNCTION	OPERATION RANGE	UNDER FLOW AREA	NORMAL ACCURACY
LN X	$0 < X$	—	10 digits ± 1
LOG X	$0 < X$	—	
e ^x	$-9.999999999 \times 10^{99} \leq X \leq 230.2585092$	$-9.999999999 \times 10^{99} \leq X \leq -227.9559243$	
10 ^x	$-9.999999999 \times 10^{99} \leq X \leq 99.99999999$	$-9.999999999 \times 10^{99} \leq X \leq -99.00000001$	
X!	$0 \leq X \leq 69$ (INTEGER)	—	
$\frac{1}{X}$	$1 \times 10^{-99} \leq X \leq 9.999999999 \times 10^{99}$	$1.000000001 \times 10^{99} \leq X \leq 9.999999999 \times 10^{99}$	
X ²	$0 \leq X \leq 9.999999999 \times 10^{49}$	$0 \leq X \leq 3.162277660 \times 10^{-50}$	
\sqrt{X}	$0 \leq X \leq 9.999999999 \times 10^{99}$	—	
$\sqrt[3]{X}$	$0 \leq X \leq 9.999999999 \times 10^{99}$	—	
DMS→DEG	$0 \leq X \leq 9.999999999 \times 10^9$	—	
DEG→DMS	$0 \leq X \leq 9999999.999$	$0 \leq X \leq 1.388888888 \times 10^{-6}$	lowest digits ± 1

FUNCTION	OPERATION RANGE	UNDER FLOW AREA	NORMAL ACCURACY
SINH X	$0 \leq X \leq 230.2585092$	—	10 digits ± 1
COSH X	$0 \leq X \leq 230.2585092$	—	
TANH X	$0 \leq X \leq 9.999999999 \times 10^{99}$	—	
SINH ⁻¹ X	$0 \leq X \leq 4.999999999 \times 10^{99}$	—	
COSH ⁻¹ X	$1 \leq X \leq 4.999999999 \times 10^{99}$	—	
TANH ⁻¹ X	$0 \leq X \leq 9.999999999 \times 10^{-1}$	—	
R→P (xy→γθ)	$ x , y \leq 9.999999999 \times 10^{49}$ $(x^2 + y^2) \leq 9.999999999 \times 10^{99}$ $\frac{Y}{X}$; SAME AS TAN ⁻¹ X	$\frac{Y}{X}$; SAME AS TAN ⁻¹ X	
P→R (γθ→xy)	$0 \leq \gamma \leq 9.999999999 \times 10^{99}$ θ ; SAME AS SIN X, COS X	θ ; SAME AS SIN X, COS X	
DEG→RAD	$0 \leq X \leq 9.999999999 \times 10^{99}$	$0 \leq X \leq 5.729577951 \times 10^{-98}$	
RAD→GRAD	$0 \leq X \leq 1.570796326 \times 10^{98}$	—	
GRAD→DEG	$0 \leq X \leq 9.999999999 \times 10^{99}$	$0 \leq X \leq 1.111111111 \times 10^{-99}$	
Y ^X	$-9.999999999 \times 10^{99}$ $\leq X \cdot \text{LN } Y \leq 230.2585092$ (1) Y>0…The above-mentioned operation range. (2) Y<0…X (Integer) or, 1/X (Odd, X≠0) …The above-mentioned operation range. (3) Y=0…0<X	$-9.999999999 \times 10^{99}$ $\leq X \cdot \text{LN } Y \leq -227.9559243$	10 digits ± 1
$\sqrt[X]{Y}$	$-9.999999999 \times 10^{99}$ $\leq \frac{1}{X} \cdot \text{LN } Y \leq 230.2585092$ (1) Y>0…The above-mentioned operation range. (2) Y<0…X (Odd) or 1/X (Integer, X≠0) …The above-mentioned operation range. (3) Y=0…0<X	$-9.999999999 \times 10^{99}$ $\leq \frac{1}{X} \cdot \text{LN } Y \leq -227.95593243$	10 digits ± 1
→DEC	Operation range The following operation range after the conversion. $0 \leq X \leq 9999999999$		—
→BIN	The following operation range after the conversion. $1000000000 \leq X \leq 1111111111$ $0 \leq X \leq 1111111111$		—
→OCT	The following operation range after the conversion. $4000000000 \leq X \leq 7777777777$ $0 \leq X \leq 3777777777$		—
→HEX	The following operation range after the conversion. FDABF41CO1 ≤ X ≤ FFFFFFFF $0 \leq X \leq 2540BE3FF$		—

FUNCTION		OPERATION RANGE	NORMAL ACCURACY
AND		BIN ; 1000000000 ≤ X ≤ 1111111111 0 ≤ X ≤ 1111111111	—
OR		OCT ; 4000000000 ≤ X ≤ 7777777777 0 ≤ X ≤ 3777777777	
XOR		HEX ; The following operation range after the operation.	
XNOR		FDABF41CO1 ≤ X ≤ FFFFFFFF 0 ≤ X ≤ 2540BE3FF	
NOT		BIN ; SAME AS AND OCT ; SAME AS AND HEX ; FDABF41CO1 ≤ X ≤ FFFFFFFF 0 ≤ X ≤ 2540BE3FE	—
NEG		BIN ; 1000000001 ≤ X ≤ 1111111111 0 ≤ X ≤ 1111111111 OCT ; 4000000001 ≤ X ≤ 7777777777 0 ≤ X ≤ 3777777777 HEX ; FDABF41CO1 ≤ X ≤ FFFFFFFF 0 ≤ X ≤ 2540BE3FF	—
Statistic	DATA DEL	$ x \leq 9.999999999 \times 10^{49}$ $ \sum x \leq 9.999999999 \times 10^{99}$ $\sum x^2 \leq 9.999999999 \times 10^{99}$ $0 \leq n \leq 9999999999$. n = Integer	10 digits ± 1
	\bar{x}	n ≠ 0	
	σ_{n-1}	n ≠ 1, n ≠ 0 $0 \leq \frac{\sum X^2 - \{(\sum X)^2 / n\}}{n-1} \leq 9.999999999 \times 10^{99}$	
	σ_n	n ≠ 0 $0 \leq \frac{\sum X^2 - \{(\sum X)^2 / n\}}{n} \leq 9.999999999 \times 10^{99}$	

MAXIMUM RATINGS (Ta = 25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V _{SS}	+0.3 ~ -3.5	V
Input Voltage	V _{IN}	+0.3 ~ V _{SS} - 0.3	V
Operating Temperature	T _{opr}	0 ~ 40	°C
Storage Temperature	T _{stg}	-55 ~ 125	°C

ELECTRICAL CHARACTERISTICS ($V_{SS} = -3.0 \pm 0.2V$, $V_{DD} = 0V$, $T_a = 25 \pm 1.5^\circ C$)

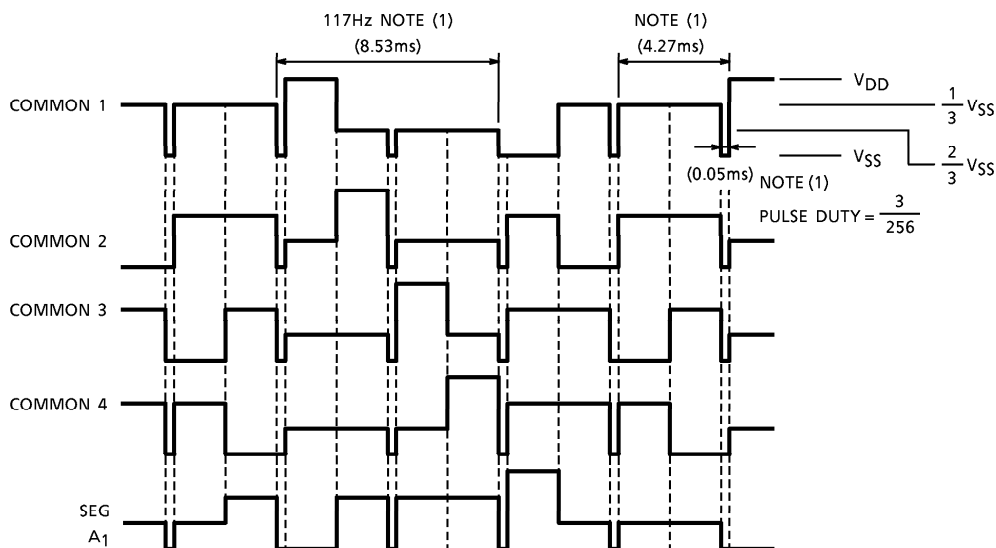
PARAMETER	SYMBOL	TEST CIRCUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	—	—	—	—	-2.5	-3.0	-3.4	V
Supply Current	I_{DD} WAIT	—	—	$V_{SS} = -3.0V$, wait	—	20	35	μA
Supply Current	I_{DD} OP	—	—	$V_{SS} = -3.0V$, operate	—	70	120	μA
Supply Current	I_{DD} OFF	—	—	$V_{SS} = -3.0V$, off	—	1	3	μA
Oscillating Frequency	$F\phi$ WAIT	—	—	$V_{SS} = -3.0V$, wait	9	15	21	kHz
Oscillating Frequency	$F\phi$ OP	—	—	$V_{SS} = -3.0V$, operate	48	80	112	kHz
Fram Frequency	f_F	—	—	$V_{SS} = -3.0V$, wait	70	117	164	Hz
Timer	T timer	—	—	$V_{SS} = -3.0V$	430	603	1005	s
"1" Input Voltage	V_{IH}	—	K1~K4 RESET	—	$V_{SS} + 0.5$	—	V_{SS}	V
"0" Input Voltage	V_{IL}	—	K1~K4 RESET	—	V_{DD}	—	-0.5	V
"1" Output Resistance	R_{KEY}	—	SEG	$V_{OUT} = V_{SS} + 0.5V$: KEY STROBE	—	—	2	k Ω
"0" Output Resistance	$R_{SEG} (L)$	—	SEG	$V_{OUT} = V_{DD} - 0.5V$	—	—	90	k Ω
"1" Output Resistance	$R_{SEG} (H)$	—	SEG	$V_{OUT} = V_{SS} + 0.5V$: $\overline{KEY STROBE}$	—	—	90	k Ω
"0" Output Resistance	$R_{COM} (L)$	—	COM	$V_{OUT} = V_{DD} - 0.5V$	—	—	25	k Ω
"1" Output Resistance	$R_{COM} (H)$	—	COM	$V_{OUT} = V_{SS} + 0.5V$	—	—	25	k Ω
KEY Pull Up Resistance	$R_{PULL UP}$	—	K1	$V_{OUT} = 0V$ (Note 1)	27	45	63	k Ω
KEY Pull Down Resistance	$R_{PULL DOWN}$	—	K2~K4	$V_{OUT} = V_{SS}$ (Note 1)	27	45	63	k Ω
KEY Pull Up Resistance	$R_{RESET} (H)$	—	RESET	$V_{OUT} = 0V$	24	40	56	k Ω
KEY Pull Down Resistance	$R_{RESET} (L)$	—	RESET	$V_{OUT} = V_{DD} - 0.5V$	—	—	10	k Ω
"M" Output Resistance	R_{OM}	—	SEG	$V_{OUT} = \frac{1}{3}V_{SS} - 0.5V$	—	125	—	k Ω
"M" Output Resistance	R_{OM}	—	SEG	$V_{OUT} = \frac{2}{3}V_{SS} + 0.5V$	—	125	—	k Ω
"M" Output Resistance	R_{OM}	—	COM	$V_{OUT} = \frac{1}{3}V_{SS} - 0.5V$	—	85	—	k Ω
"M" Output Resistance	R_{OM}	—	COM	$V_{OUT} = \frac{2}{3}V_{SS} + 0.5V$	—	85	—	k Ω
"1" Output Voltage	V_{OH}	—	RESET	—	$V_{SS} + 0.2$	V_{SS}	V_{SS}	V

PARAMETER	SYMBOL	TEST CIRCUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
"0" Output Voltage	V _{OL}	—	RESET	—	V _{DD}	V _{DD}	V _{DD} - 0.2	V
"1" Output Voltage	V _{OH}	—	K ₁	(Note 1)	V _{SS} + 0.2	V _{SS}	V _{SS}	V
"0" Output Voltage	V _{OL}	—	K ₂ ~K ₄	(Note 1)	V _{DD}	V _{DD}	V _{DD} - 0.2	V
"1" Output Voltage	V _{OH}	—	SEG COM	—	V _{SS} + 0.2	V _{SS}	V _{SS}	V
"M" Output Voltage	V _{OM}	—	SEG COM	—	2/3 V _{SS} + 0.2	2/3 V _{SS}	2/3 V _{SS} - 0.2	V
"M" Output Voltage	V _{OM}	—	SEG COM	—	1/3 V _{SS} + 0.2	1/3 V _{SS}	1/3 V _{SS} - 0.2	V
"0" Output Voltage	V _{OL}	—	SEG COM	—	V _{DD}	V _{DD}	V _{DD} - 0.2	V

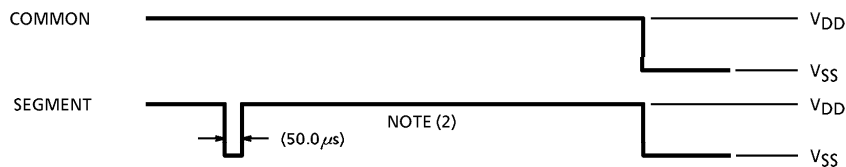
(Note 1) The key buffer is high impedance at keystroke.

WAVEFORMS FOR DISPLAY

Display



Key pulse output



NOTE (1) F_φWAIT = 15kHz

NOTE (2) F_φOP = 80kHz

PAD LOCATION TABLE

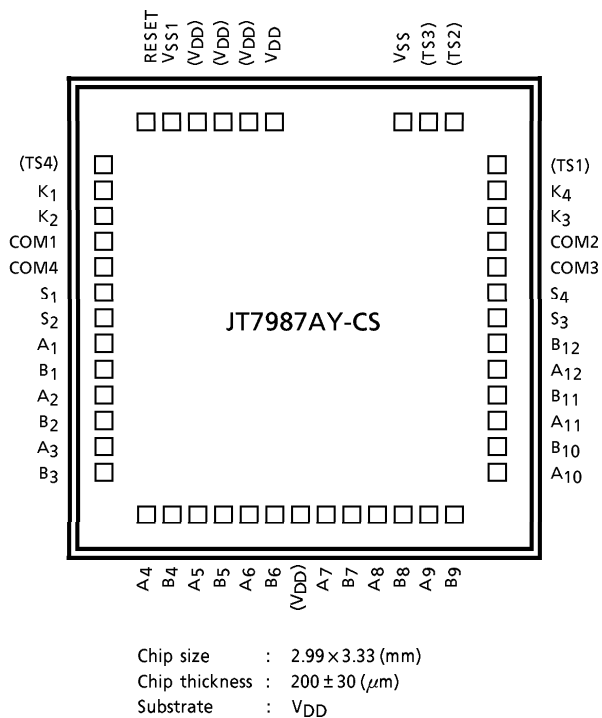
NAME	X POINT	Y POINT
RESET	- 890	1451
V _{SS1}	- 731	1451
(V _{DD})	- 505	1451
(V _{DD})	- 346	1451
(V _{DD})	- 186	1451
V _{DD}	8	1451
V _{SS}	574	1451
*(TS3)	734	1451
*(TS2)	1055	1451
*(TS1)	1270	993
K ₄	1270	829
K ₃	1270	666
COM2	1270	503
COM3	1270	339
S ₄	1270	175
S ₃	1270	13
B ₁₂	1270	- 149
A ₁₂	1270	- 315
B ₁₁	1270	- 478
A ₁₁	1270	- 641
B ₁₀	1270	- 805
A ₁₀	1270	- 968
B ₉	1076	- 1414
A ₉	888	- 1414

(μm)

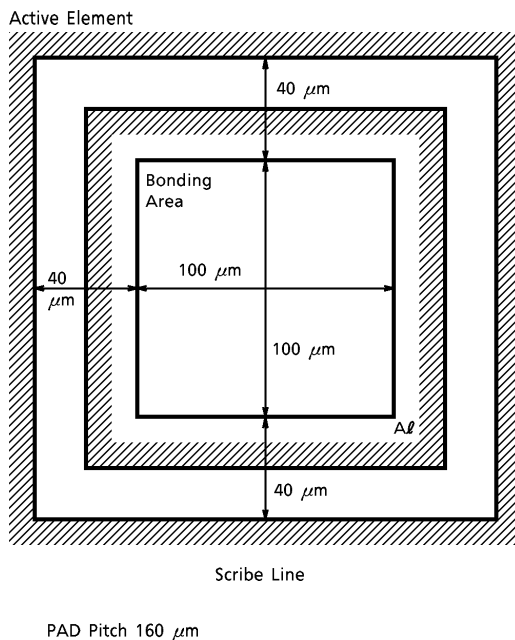
NAME	X POINT	Y POINT
B ₈	715	- 1414
A ₈	553	- 1414
B ₇	390	- 1414
A ₇	228	- 1414
(V _{DD})	0	- 1414
B ₆	- 231	- 1414
A ₆	- 393	- 1414
B ₅	- 555	- 1414
A ₅	- 717	- 1414
B ₄	- 879	- 1414
A ₄	- 1069	- 1414
B ₃	- 1270	- 958
A ₃	- 1270	- 795
B ₂	- 1270	- 631
A ₂	- 1270	- 468
B ₁	- 1270	- 304
A ₁	- 1270	- 141
S ₂	- 1270	23
S ₁	- 1270	186
COM4	- 1270	350
COM1	- 1270	513
K ₂	- 1270	676
K ₁	- 1270	840
*(TS4)	- 1270	1003

*() Do not connect.

CHIP LAYOUT

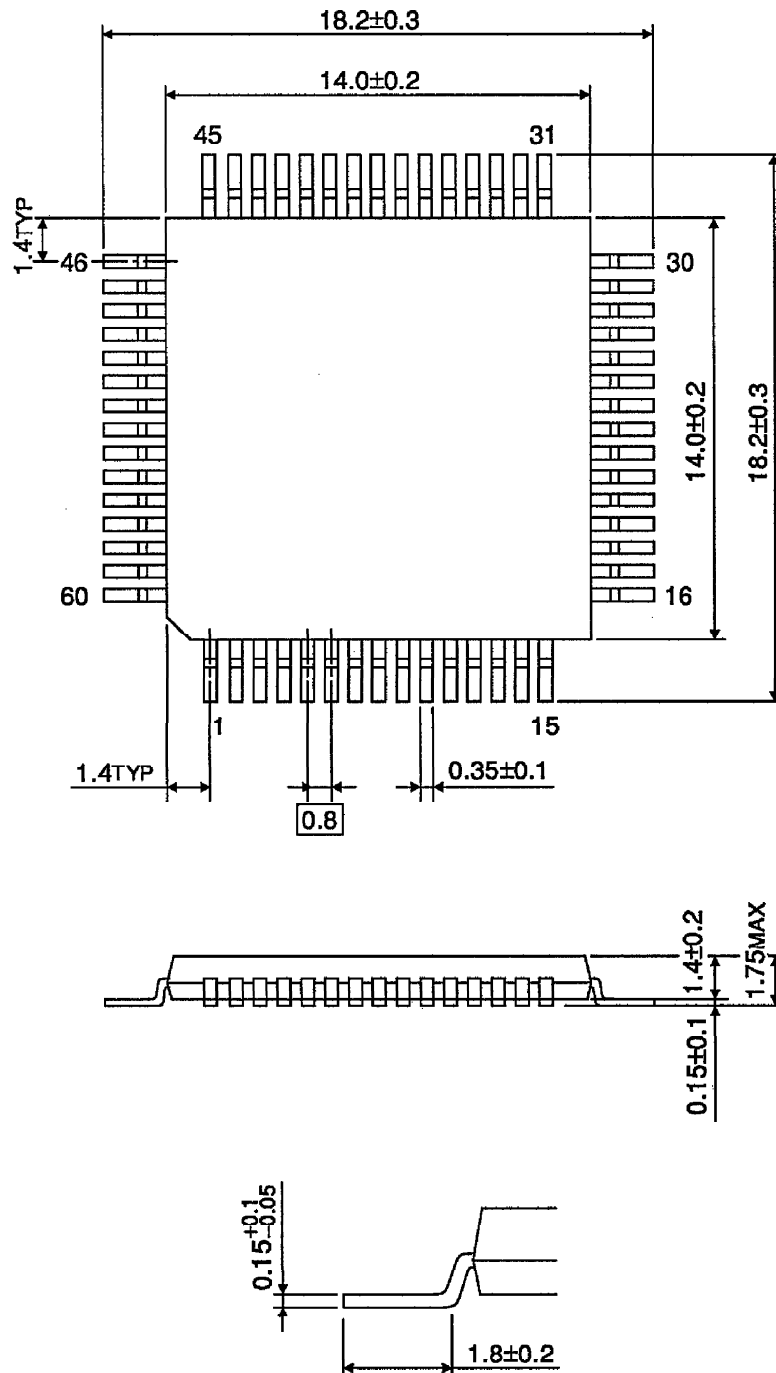


PAD LAYOUT



OUTLINE DRAWING
LQFP60-P-1414-0.80

Unit : mm



Weight : 0.66g (Typ.)

GENERAL SPECIFICATION FOR CALCULATOR LSI BARE CHIP**1. Purpose**

This is to specify the quality standard for the integrated circuit produced by TOSHIBA CORPORATION (hereinafter referred as to VENDOR) to be delivered to PURCHASER.

2. Definition

This specification applies only to the calculator LSI bare chip produced by VENDOR and purchased by PURCHASER and defined the general specification items.

3. Priority of specifications

When the discrepancies or questions happen to the specifications and instructions provided by VENDOR, the priority shall be ranked as follows.

- 1) Individual specification for the calculator LSI bare chip.
(Both PURCHASER and VENDOR are confirmed by the special sheets.)
- 2) General specifications for the calculator LSI bare chip.
- 3) Other related specifications and standards.

4. Characteristics

To be shown in the individual specification sheets.

The individual specification shall consist of the following 4 items in principle.

- 1) Rated specifications.
- 2) Electrical characteristics.
- 3) Pin configuration & mechanical dimensions.
- 4) Others.

5. Inspection of product for delivery**5.1 Inspection lot**

- a) Inspection lot shall consist of products produced by same material under same design, through same production process, and same facilities and assured same quality by same quality assurance method, and lot number shall be put on all trays to be able to trace the lot history.
- b) The quantity of products per Inspection lot shall consist of all the same VENDOR's lot number.

5.2 Sampling plan

Statistical sampling and inspection shall be in accordance with MIL-STD-105D single sampling plans for normal inspections, general inspection level II.

The acceptable quality level (AQL) shall be specified in following table :

TEST ITEM	AQL (%)
Electrical	2.5
Visual	4.0

5.3 Electrical criteria

Criteria of Electrical Characteristics are prescribed in Attachment-1.

5.4 Visual criteria

Visual Criteria are prescribed in Attachment-2.

6. Incoming inspection

6.1 General

- a) PURCHASER's incoming inspection should be done within 15 days after PURCHASER receives the quantity of products in principle.
- b) PURCHASER shall report the results of incoming inspection to VENDOR and provide VENDOR with detailed data in failure rate and items regarding VENDOR's lot number respectively, if VENDOR demands the report from PURCHASER.

6.2 Inspection procedure

PURCHASER should do his incoming inspection according to the following procedure.

- a) First : Visual inspection should be done.
- b) Next : Electrical and other inspection should be done under condition with bare chip before going into PURCHASER's process.

7. Treatment for defective lot and products

Regarding the defective lot and defective products which are found through PURCHASER's incoming inspection, PURCHASER can be returned to VENDOR with detailed description on failures concerned.

However, if VENDOR cannot receive the defective items within 30 days after PURCHASER's incoming inspection, VENDOR should be able to make no reference to the defective problem.

8. Packing and labeling

- a) Dice shall be placed in die tray with the top metalization facing up in order.
- b) In principle, a pile consists of 5 trays and several piles are packed in a package. These piles and packages are indicated with printed labels as shown below.

Date	
Name	
Lot No.	
Net	
TOSHIBA MADE IN JAPAN	

- c) PURCHASER shall return these packing materials to VENDOR on VENDOR's demand.

9. Storage criteria

Solid state chips, unlike packaged devices, are non-hermetic devices normally fragile and small in physical size, and therefore, require special handling considerations as follows :

- 9.1 Chips must be stored under proper conditions to insure that they are not subjected to a moist and/or contaminated atmosphere that alter their electrical, physical, or mechanical characteristics.
After the shipping container is opened, the chips must be stored under the following conditions :
 - A. Storage temperature, 40°C max.
 - B. Relative humidity, 50% max.
 - C. Clean, dust-free environment.
- 9.2 The user must exercise proper care when handling chips or wafers to prevent even the slightest physical damage to the chip.
- 9.3 During mounting and lead bounding of chips the user must use proper assembly techniques to obtain proper electrical, thermal, and mechanical performance.
- 9.4 After the chip has been mounted and bounded, any necessary procedure must be followed by the user to insure that these non-hermetic chips are not subjected to moist or contaminated atmosphere which might cause the development of electrical conductive paths across the relatively small insulating surfaces.
In addition, proper consideration must be given to the protection of these devices from other harmful environments which could conceivably adversely affect their proper performance.

10. Handling criteria

The user should find the following suggested precautions helpful in handling chips.

In any event, because of the extremely small size and fragile nature of chips, care should be taken in handling these devices.

10.1 Grounding

- a) Bonders, pellet pickup tools, table tops, trim and form tools, sealing equipment, and other equipment used in chip handling should be properly grounded.
- b) Operator should be properly grounded.

10.2 In-process handling

- a) Assemblies or subassemblies of chips should be transported and stored in conductive carriers.
- b) All external leads of the assemblies or subassemblies should be shorted together.

VISUAL INSPECTION CRITERIA

1. Visual inspection magnification shall be 40 × in principle.

2. Defects defined :

2.1 Thickness

See the technical data sheet.

2.2 Chip and crack

A die shall be rejected if :

- a) Any crack of chip extends greater than 35 μ m in length into the inside of the scribble line. (see Fig.1)

2.3 Metallization

A die shall be rejected if :

- a) More than 25% of the designed area of the metallization is missing at any bonding pad.
- b) There is a short or break which affects electrical characteristics in any lead pattern. (see Fig.2)

2.4 Glass protection coat

A die shall be rejected if :

- a) It exhibits glass protection coat which covers more than 25% of any active bonding pad.

2.5 Attached foreign material

A die shall be rejected if :

- a) A die is covered by stains or attached foreign material which size is more than 5 times as large as a bonding pad area.
- b) It exhibits residual ink, stains or attached foreign material which covers more than 20% of any active bonding pad. (see Fig.3)

2.6 Others

A die shall be rejected if :

- a) There have no evident probed impression on the bonding pads.
- b) A inked die, defective die, is intermized.

3. Limit samples should be fized, if necessary.

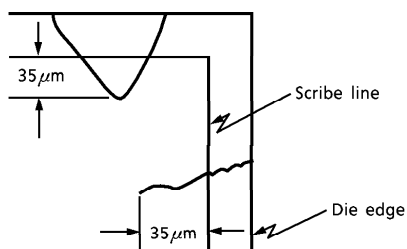


Fig.1

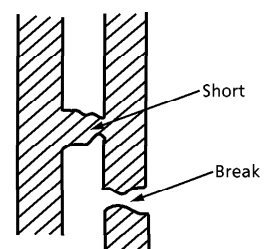


Fig.2 Lead pattern

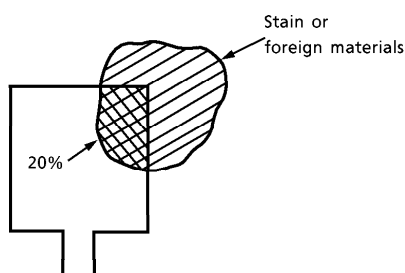
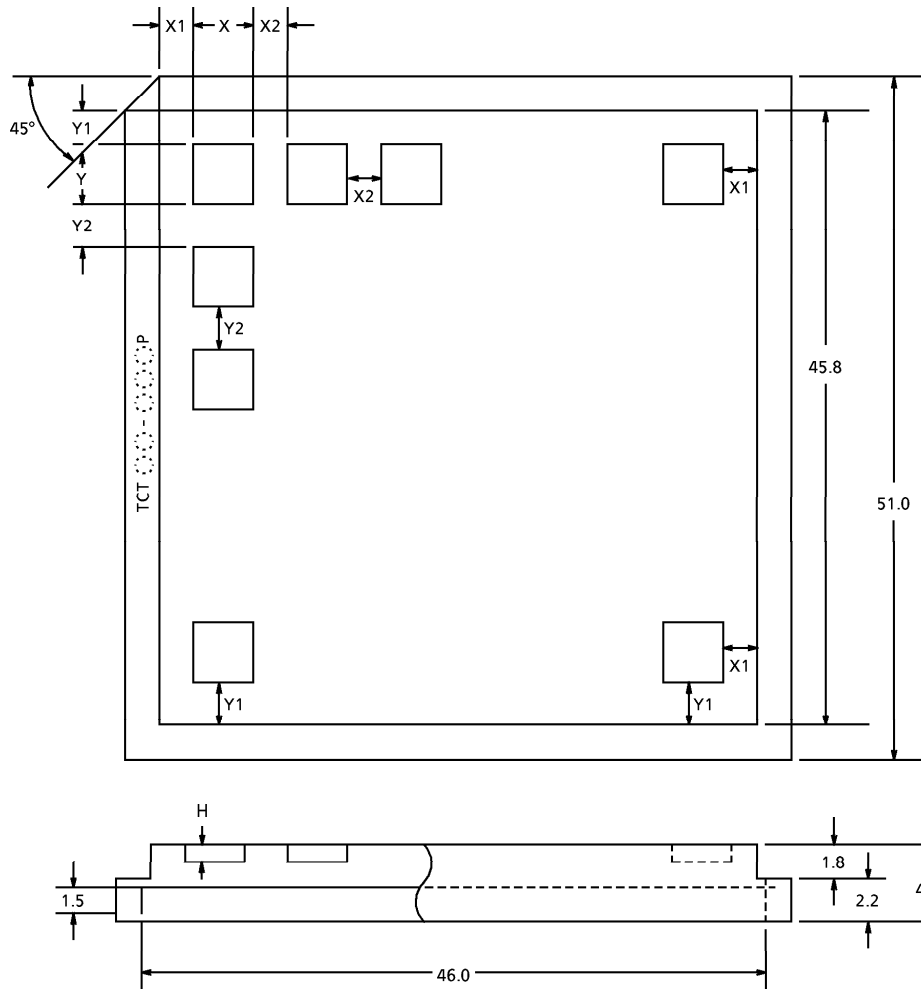


Fig.3

OUTSIDE DIMENSIONS OF CHIP TRAY



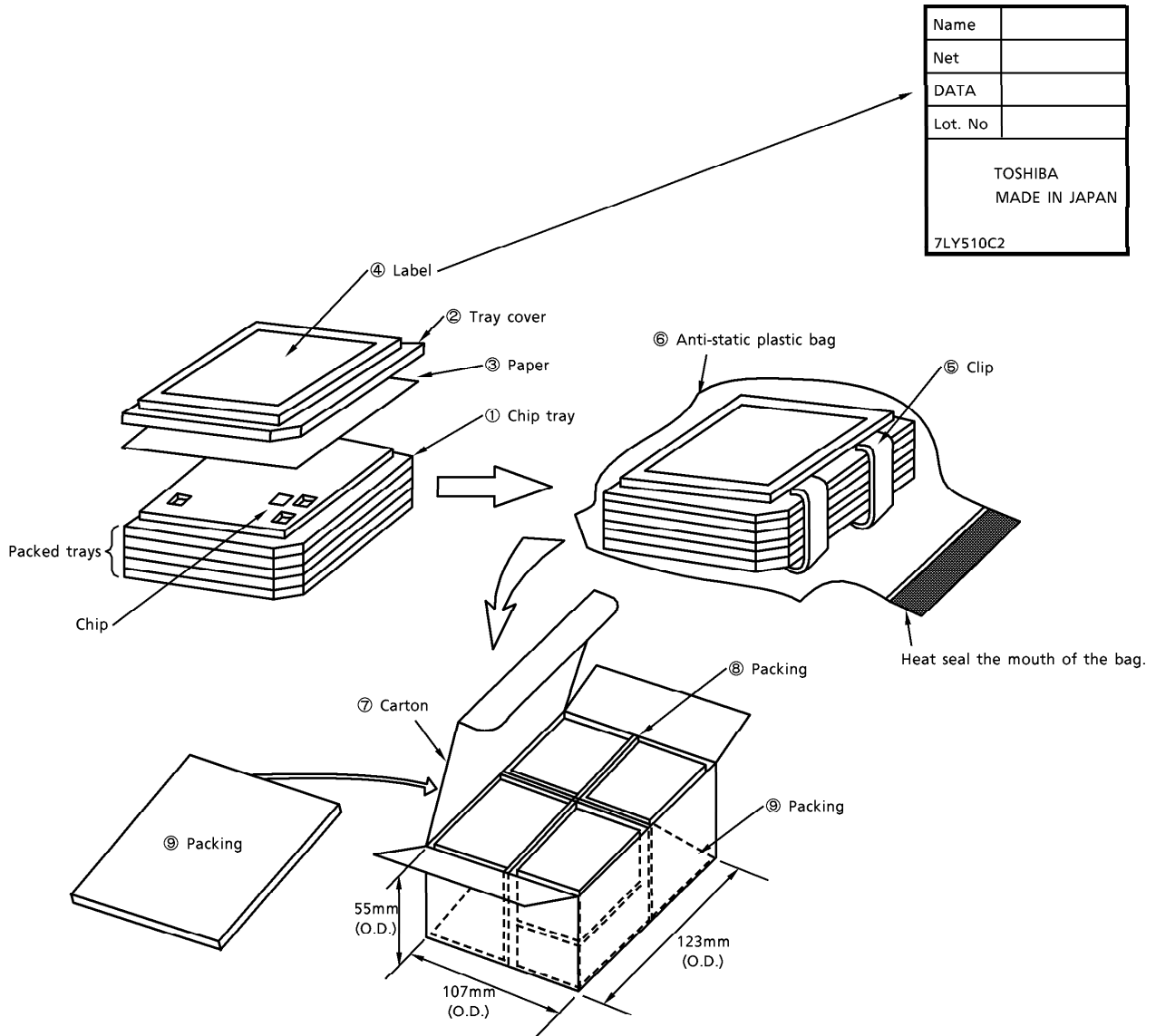
Unit : mm

CHIP NAME	TRAY NAME	X	Y	(H)	No. OF POCKETS	X1	X2	Y1	Y2
JT7987AY-CS	TCT38-060P	3.80	3.80	0.60	10 × 10 (100)	1.200	0.600	1.200	0.600

Tray material :

Carbon-containing polypropylene

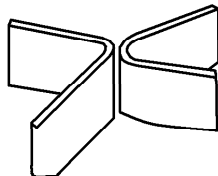
PACKING METHOD-1

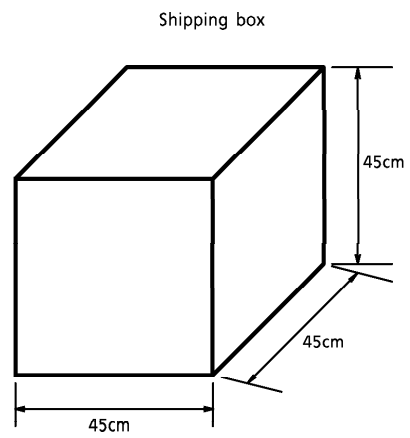


Name	
Net	
DATA	
Lot. No	
TOSHIBA MADE IN JAPAN	
7LY510C2	

Place eight bags of chip trays in each carton box ⑦. Lay one sheet of packing ⑨ (7UF44F) before closing the lid of the cart box. (See the diagram above.)

Prepare packing ⑨ by cutting 7UF44F into halves and folding each in half as shown below ; use them as inner partitions.



PACKING METHOD-2

- Inner box : Containing 20 boxes
- Weight : Approx. 15kg (including packing material)
- Material : Corrugated cardboard
- IC contents : $36 \times 5 \times 8 \times 20 = 28.8\text{kpcs}$.