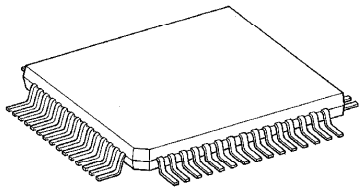
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

T7987A, JT7987AY-CS

T7987A, JT7987AY-CS SINGLE-CHIP CMOS LSI FOR LCD CALCULATORS

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



LQFP60-P-1414-0.80

Weight : 0.66g (Typ.)

FEATURES

- 12-digit display 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

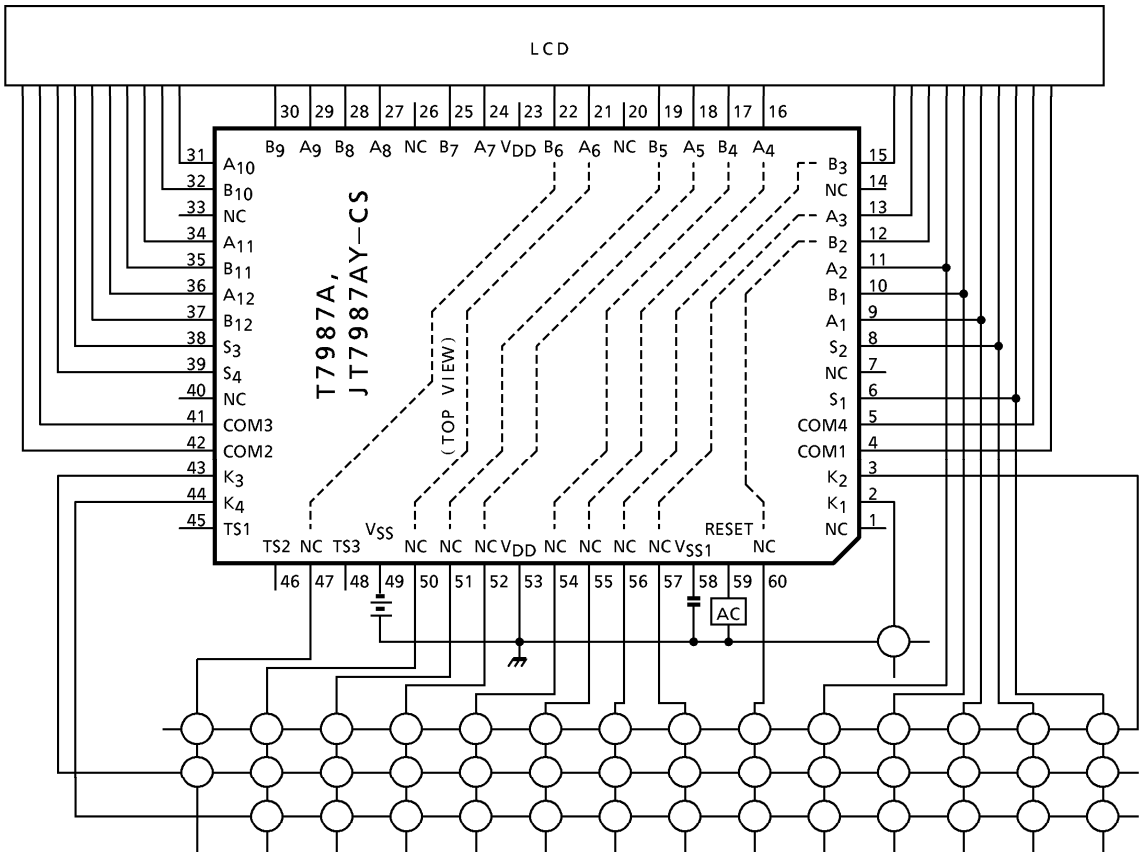
    Mantissa 10 digits plus negative code 1 digit.
- 13 kinds of special display

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 $\sqrt[X]{Y}$ 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.

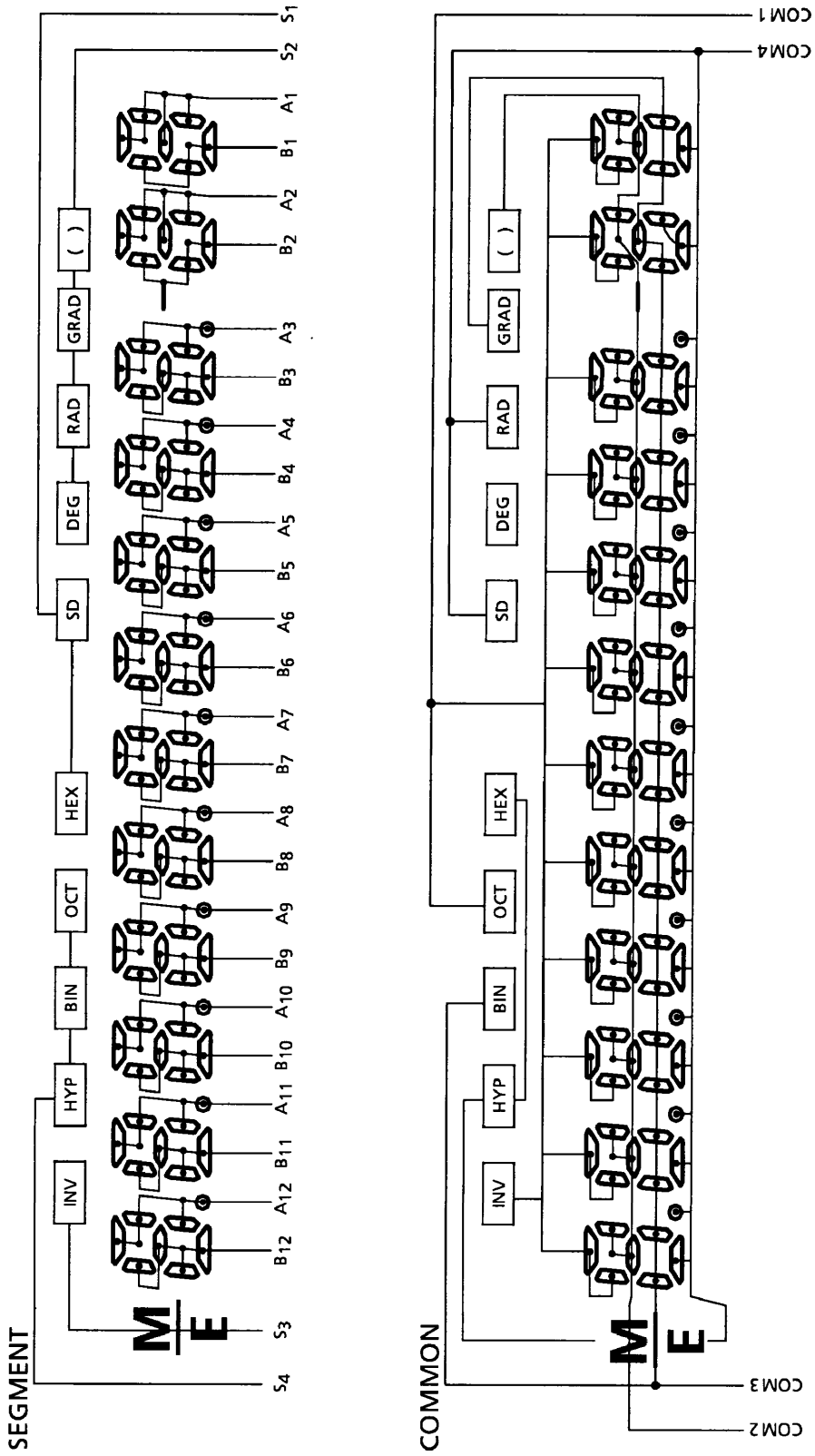
- It is possible to convert or fix the display number system by FLO (Floating), SCI (Scientific) or ENG (Engineering) key.
- It is possible to specify decimal part digits (0~9) by FIX key.
- Direct drive for FEM LCD (1/3 prebias, 1/4 duty).
- Automatic power on clear.
- Low-power consumption. V_{SS}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

SYSTEM BLOCK DIAGRAM



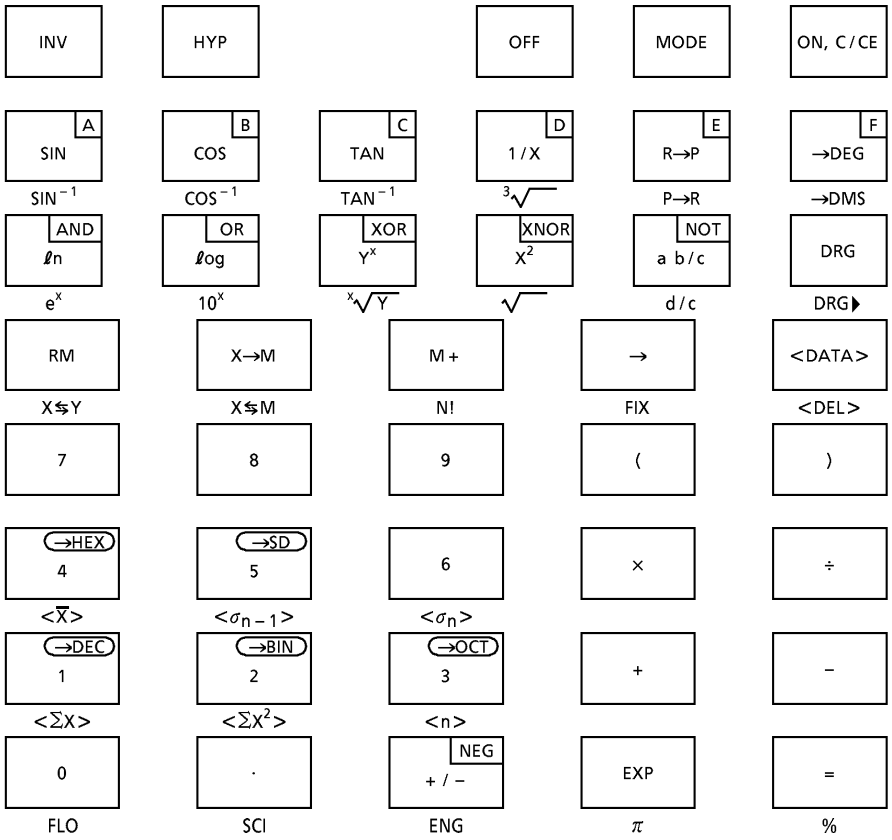
(Note) Input capacity ≦ 400 (pF) at V_{SS} = −3.0 (V)
Key resistance ≦ 3.0 (kΩ) at V_{SS} = −3.0 (V)

CONNECTION OF LCD

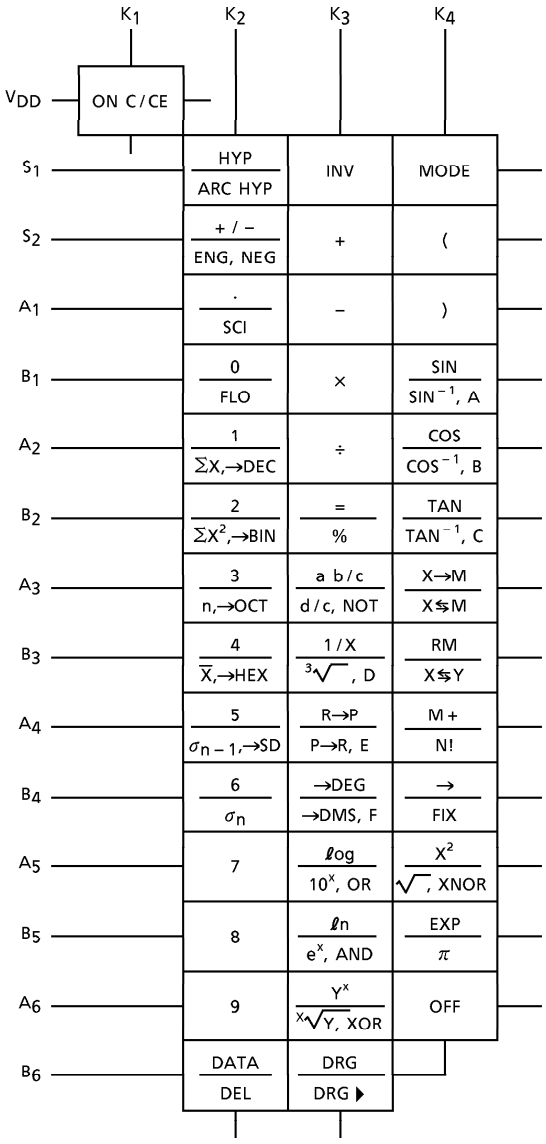


T7987A, JT7987AY-CS—03

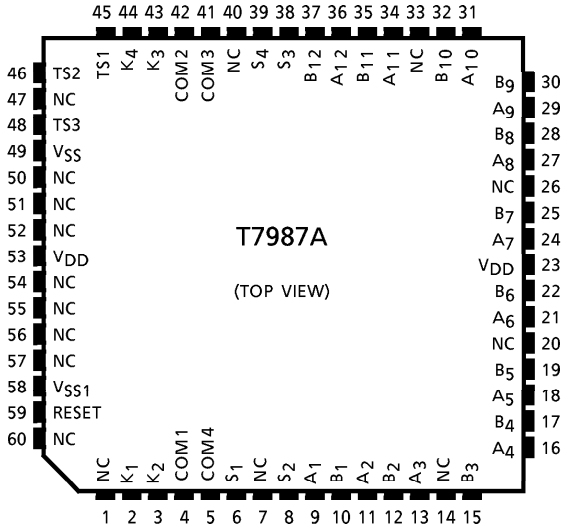
SET KEY LAYOUT (Example)



KEY CONNECTION



PIN ASSIGNMENT



SPECIFICATION OF CALCULATOR

Speed of calculation

Key on 4.8ms Key off 34.4ms $f\phi WAIT = 15kHz$, $f\phi op = 80kHz$

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

ITEM	OPERATION			CALCULATION SPEED (ms)
Number	DEC		5	8
		5	5	8
	HEX		A	9
		A	A	9
Function	DEC	5	+	20
		5	×	21
	HEX	A	−	51
		A	÷	52
4 operation	DEC	1 + 2	+	29
		1 0 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
		A B C × D E F	×	100
		A B C ÷ D E F	÷	98
Y^X, $\sqrt[X]{Y}$		$3\ Y^X\ 4$	=	252
		$3\ \sqrt[X]{Y}\ 4$	=	262

ITEM	OPERATION			CALCULATION SPEED (ms)
SIN	DEG	3 0	SIN	241
	RAD	π ÷ 6 =	SIN	231
	GRAD	1 0 0 ÷ 3 =	SIN	350
COS	DEG	6 0	COS	244
	RAD	π ÷ 3 =	COS	311
	GRAD	2 0 0 ÷ 3 =	COS	354
TAN	DEG	4 5	TAN	118
	RAD	π ÷ 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
$\sqrt{}$		2 0	$\sqrt{}$	64
1 / X		2 0	1 / X	23
$\sqrt[3]{}$		2 0	$\sqrt[3]{}$	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⇆Y 1	R→P	275
	RAD	$\sqrt[3]{\ }$ X⇆Y 1	R→P	216
	GRAD	$\sqrt[3]{\ }$ X⇆Y 1	R→P	274
P→R	DEG	2 X⇆Y 3 0	P→R	462
	RAD	2 X⇆Y 30 DRG▶	P→R	437
	GRAD	2 X⇆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
			$\overline{X}$	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 _ 36⌟ 234 + 3 _ 45 ⌟ 345	=	161
		2 _ 36⌟ 234 − 3 _ 45 ⌟ 345	=	153
		2 _ 36⌟ 234 × 3 _ 45 ⌟ 345	=	149
		2 _ 36⌟ 234 ÷ 3 _ 45 ⌟ 345	=	168

OPERATION RANGE AND ACCURACY

FUNCTION	ANGLE UNIT	OPERATION RANGE	UNDER FLOW AREA	NORMAL ACCURACY
SIN X	DEG	$0 \leqq \|X\| \leqq 4.499999999 \times 10^{10}$	$0 \leqq \|X\| \leqq 5.729577951 \times 10^{-98}$	±1 in 10th significant digit
	RAD	$0 \leqq \|X\| \leqq 785398163.3$	—	
	GRAD	$0 \leqq \|X\| \leqq 4.999999999 \times 10^{10}$	$0 \leqq \|X\| \leqq 6.366197723 \times 10^{-98}$	
COS X	DEG	$0 \leqq \|X\| \leqq 4.500000008 \times 10^{10}$	—	
	RAD	$0 \leqq \|X\| \leqq 785398164.9$	—	
	GRAD	$0 \leqq \|X\| \leqq 5.000000009 \times 10^{10}$	—	
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	$0 \leqq \|X\| \leqq 1$	$0 \leqq \|X\| \leqq 1.570796326 \times 10^{-99}$	
	RAD	$0 \leqq \|X\| \leqq 1$	—	
	GRAD	$0 \leqq \|X\| \leqq 1$	$0 \leqq \|X\| \leqq 1.570796326 \times 10^{-99}$	
$COS^{-1}X$	DEG	SAME AS $SIN^{-1}X$	—	
	RAD	SAME AS $SIN^{-1}X$	—	
	GRAD	SAME AS $SIN^{-1}X$	—	
$TAN^{-1}X$	DEG	$0 \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	SAME AS $SIN^{-1}X$	
	RAD	$0 \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	—	
	GRAD	$0 \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	SAME AS $SIN^{-1}X$	
LN X		$0 < X$	—	
LOG X		$0 < X$	—	
e^X		$-9.999999999 \times 10^{99} \leqq X \leqq 230.2585092$	$-9.999999999 \times 10^{99} \leqq X \leqq -227.9559243$	
10^X		$-9.999999999 \times 10^{99} \leqq X \leqq 99.99999999$	$-9.999999999 \times 10^{99} \leqq X \leqq -99.00000001$	
X!		$0 \leqq X \leqq 69$ (INTEGER)	—	
$\frac{1}{X}$		$1 \times 10^{-99} \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	$1.000000001 \times 10^{99} \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	
X^2		$0 \leqq \|X\| \leqq 9.999999999 \times 10^{49}$	$0 \leqq \|X\| \leqq 3.162277660 \times 10^{-50}$	
$\sqrt{X}$		$0 \leqq X \leqq 9.999999999 \times 10^{99}$	—	
$\sqrt[3]{X}$		$0 \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	—	
DMS→DEG		$0 \leqq \|X\| \leqq 9.999999999 \times 10^{9}$	—	
DEG→DMS		$0 \leqq \|X\| \leqq 9999999.999$	$0 \leqq \|X\| \leqq 1.388888888 \times 10^{-6}$	±1 in least significant digit

FUNCTION	OPERATION RANGE	UNDER FLOW AREA	NORMAL ACCURACY
SINH X	$0 \leqq \|X\| \leqq 230.2585092$	—	±1 in 10th significant digit
COSH X	$0 \leqq \|X\| \leqq 230.2585092$	—	
TANH X	$0 \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	—	
$SINH^{-1}X$	$0 \leqq \|X\| \leqq 4.999999999 \times 10^{99}$	—	
$COSH^{-1}X$	$1 \leqq X \leqq 4.999999999 \times 10^{99}$	—	
$TANH^{-1}X$	$0 \leqq \|X\| \leqq 9.999999999 \times 10^{-1}$	—	
R→P ($xy \rightarrow \gamma\theta$)	$\|x\|, \|y\| \leqq 9.999999999 \times 10^{49}$ $(x^2 + y^2) \leqq 9.999999999 \times 10^{99}$ $\frac{Y}{X}$; SAME AS $TAN^{-1}X$	$\frac{Y}{X}$; SAME AS $TAN^{-1}X$	
P→R ($\gamma\theta \rightarrow xy$)	$0 \leqq \gamma \leqq 9.999999999 \times 10^{99}$ θ ; SAME AS SIN X, COS X	θ ; SAME AS SIN X, COS X	
DEG→RAD	$0 \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	$0 \leqq \|X\| \leqq 5.729577951 \times 10^{-98}$	
RAD→GRAD	$0 \leqq \|X\| \leqq 1.570796326 \times 10^{98}$	—	
GRAD→DEG	$0 \leqq \|X\| \leqq 9.999999999 \times 10^{99}$	$0 \leqq \|X\| \leqq 1.111111111 \times 10^{-99}$	
Y^X	$-9.999999999 \times 10^{99}$ $\leqq X \cdot LN \|Y\| \leqq 230.2585092$	$-9.999999999 \times 10^{99}$ $\leqq X \cdot LN \|Y\| \leqq -227.9559243$	±1 in 10th significant digit
	(1) $Y > 0$ ··· The above-mentioned operation range. (2) $Y < 0$ ··· X (Integer) or, 1 / X (Odd, $X \neq 0$) ··· The above-mentioned operation range. (3) $Y = 0$ ··· $0 < X$		
$\sqrt[X]{Y}$	$-9.999999999 \times 10^{99}$ $\leqq \frac{1}{X} \cdot LN \|Y\| \leqq 230.2585092$	$-9.999999999 \times 10^{99}$ $\leqq \frac{1}{X} \cdot LN \|Y\| \leqq -227.95593243$	±1 in 10th significant digit
	(1) $Y > 0$ ··· The above-mentioned operation range. (2) $Y < 0$ ··· X (Odd) or 1 / X (Integer, $X \neq 0$) ··· The above-mentioned operation range. (3) $Y = 0$ ··· $0 < X$		
→DEC	Operation range The following operation range after the conversion. $0 \leqq \|X\| \leqq 9999999999$		—
→BIN	The following operation range after the conversion. $1000000000 \leqq X \leqq 1111111111$ $0 \leqq X \leqq 111111111$		—
→OCT	The following operation range after the conversion. $4000000000 \leqq X \leqq 7777777777$ $0 \leqq X \leqq 3777777777$		—
→HEX	The following operation range after the conversion. $FDABF41CO1 \leqq X \leqq FFFFFFFFFF$ $0 \leqq X \leqq 2540BE3FF$		—

FUNCTION		OPERATION RANGE	NORMAL ACCURACY
AND OR XOR XNOR		BIN ; $1000000000 \leqq X \leqq 1111111111$ $0 \leqq X \leqq 111111111$ OCT ; $4000000000 \leqq X \leqq 7777777777$ $0 \leqq X \leqq 3777777777$ HEX ; The following operation range after the operation. $FDABF41CO1 \leqq X \leqq FFFFFFFFFF$ $0 \leqq X \leqq 2540BE3FF$	—
NOT		BIN ; SAME AS AND OCT ; SAME AS AND HEX ; $FDABF41CO1 \leqq X \leqq FFFFFFFFFF$ $0 \leqq X \leqq 2540BE3FE$	—
NEG		BIN ; $1000000001 \leqq X \leqq 1111111111$ $0 \leqq X \leqq 111111111$ OCT ; $4000000001 \leqq X \leqq 7777777777$ $0 \leqq X \leqq 3777777777$ HEX ; $FDABF41CO1 \leqq X \leqq FFFFFFFFFF$ $0 \leqq X \leqq 2540BE3FF$	—
Statistic	DATA DEL	$\lvert x \rvert \leqq 9.999999999 \times 10^{49}$ $\lvert \Sigma x \rvert \leqq 9.999999999 \times 10^{99}$ $\Sigma x^2 \leqq 9.999999999 \times 10^{99}$ $0 \leqq n \leqq 9999999999$. n = Integer	±1 in 10th significant digit
	$\bar{x}$	$n \neq 0$	
	$\sigma n-1$	$n \neq 1,\ n \neq 0$ $0 \leqq \frac{\Sigma X^2 - \{(\Sigma X)^2 / n\}}{n-1} \leqq 9.999999999 \times 10^{99}$	
	σn	$n \neq 0$ $0 \leqq \frac{\Sigma X^2 - \{(\Sigma X)^2 / n\}}{n} \leqq 9.999999999 \times 10^{99}$	

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTICS	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 ± 0.2V, V_{DD} = 0V, Ta = 25 ± 1.5°C)

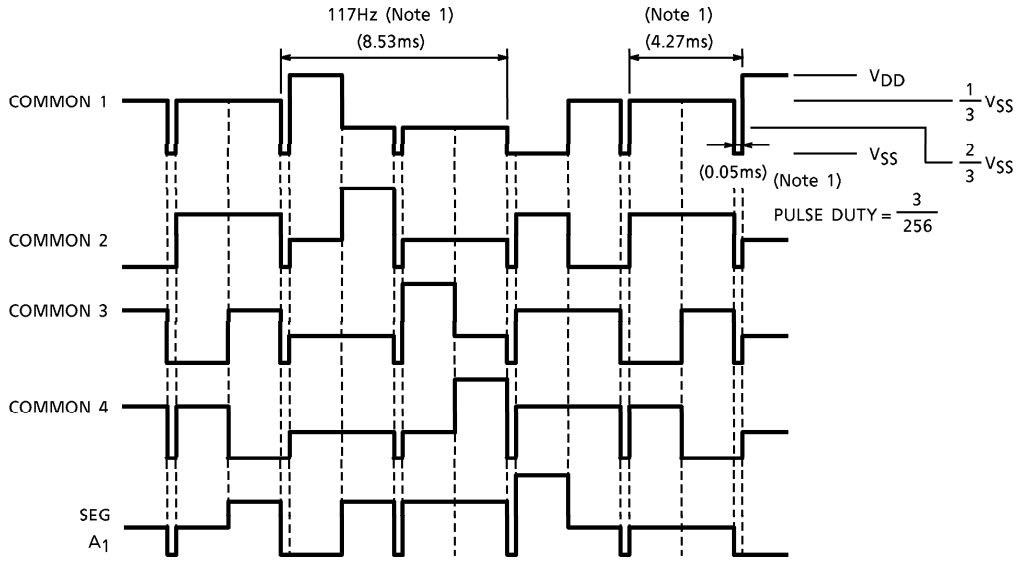
CHARACTERISTICS	SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN	TYP.	MAX	UNIT
Operating Voltage	—	—	—	—	−2.5	−3.0	−3.4	V
Supply Current	I_{DD} WAIT	—	—	V_{SS} = −3.0V, wait	—	20	35	μA
Supply Current	I_{DD} OP	—	—	V_{SS} = −3.0V, operate	—	70	120	μA
Supply Current	I_{DD} OFF	—	—	V_{SS} = −3.0V, off	—	1	3	μA
Oscillating Frequency	Fϕ WAIT	—	—	V_{SS} = −3.0V, wait	9	15	21	kHz
Oscillating Frequency	Fϕ 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}	—	K_1~K_4 RESET	—	V_{SS} +0.5	—	V_{SS}	V
"0" Input Voltage	V_{IL}	—	K_1~K_4 RESET	—	V_{DD}	—	−0.5	V
"1" Output Resistance	R_{KEY}	—	SEG	V_{OUT} = V_{SS} + 0.5V : KEY STROBE	—	—	2	kΩ
"0" Output Resistance	R_{SEG} (L)	—	SEG	V_{OUT} = V_{DD} − 0.5V	—	—	90	kΩ
"1" Output Resistance	R_{SEG} (H)	—	SEG	V_{OUT} = V_{SS} + 0.5V : $\overline{\text{KEY STROBE}}$	—	—	90	kΩ
"0" Output Resistance	R_{COM} (L)	—	COM	V_{OUT} = V_{DD} − 0.5V	—	—	25	kΩ
"1" Output Resistance	R_{COM} (H)	—	COM	V_{OUT} = V_{SS} + 0.5V	—	—	25	kΩ
KEY Pull Up Resistance	$R_{PULL\ UP}$	—	K_1	V_{OUT} = 0V (Note 1)	27	45	63	kΩ
KEY Pull Down Resistance	$R_{PULL\ DOWN}$	—	K_2~K_4	V_{OUT} = V_{SS} (Note 1)	27	45	63	kΩ
KEY Pull Up Resistance	R_{RESET} (H)	—	RESET	V_{OUT} = 0V	24	40	56	kΩ
KEY Pull Down Resistance	R_{RESET} (L)	—	RESET	V_{OUT} = V_{DD} − 0.5V	—	—	10	kΩ
"M" Output Resistance	R_{OM}	—	SEG	$V_{OUT} = \frac{1}{3}V_{SS} - 0.5V$	—	125	—	kΩ
"M" Output Resistance	R_{OM}	—	SEG	$V_{OUT} = \frac{2}{3}V_{SS} + 0.5V$	—	125	—	kΩ
"M" Output Resistance	R_{OM}	—	COM	$V_{OUT} = \frac{1}{3}V_{SS} - 0.5V$	—	85	—	kΩ
"M" Output Resistance	R_{OM}	—	COM	$V_{OUT} = \frac{2}{3}V_{SS} + 0.5V$	—	85	—	kΩ
"1" Output Voltage	V_{OH}	—	RESET	—	V_{SS} +0.2	V_{SS}	V_{SS}	V

CHARACTERISTICS	SYMBOL	TEST CIR-CUIT	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

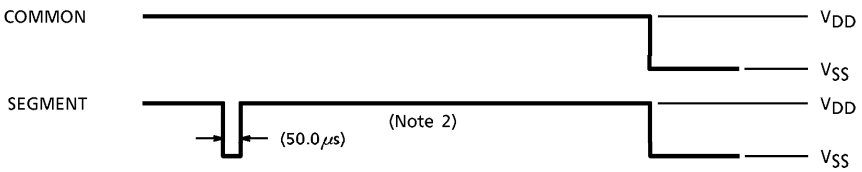
(Note 1) The key buffer is high impedance at $\overline{\text{keystrobe}}$.

WAVEFORMS FOR DISPLAY

Display



Key pulse output



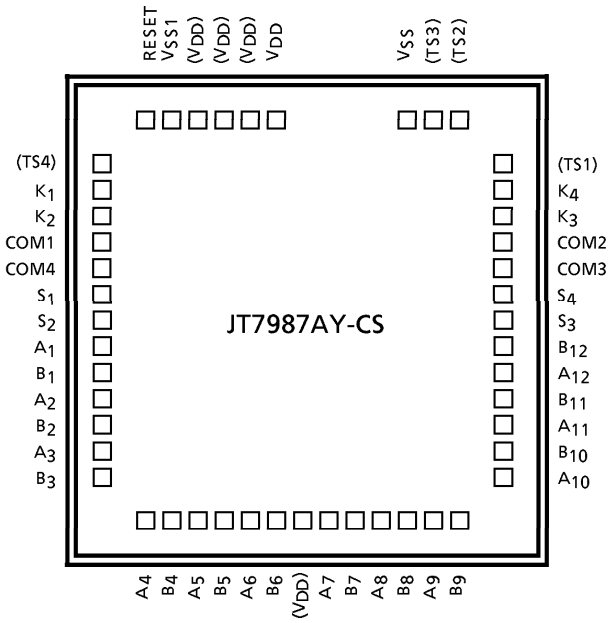
(Note 1) $F\phi WAIT = 15kHz$
(Note 2) $F\phi OP = 80kHz$

PAD LOCATION TABLE (μm)

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
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

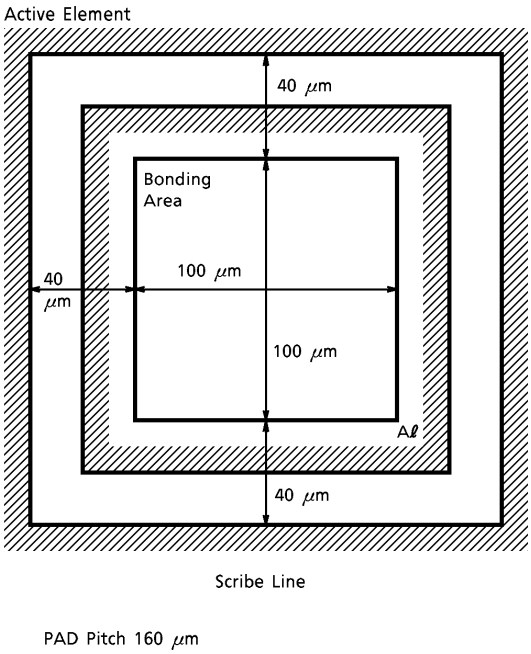
(Note) ( ) Do not connect.

CHIP LAYOUT



Chip size : 2.99 × 3.33 (mm)
Chip thickness : 200 ± 30 (μm)
Substrate : V_{DD}

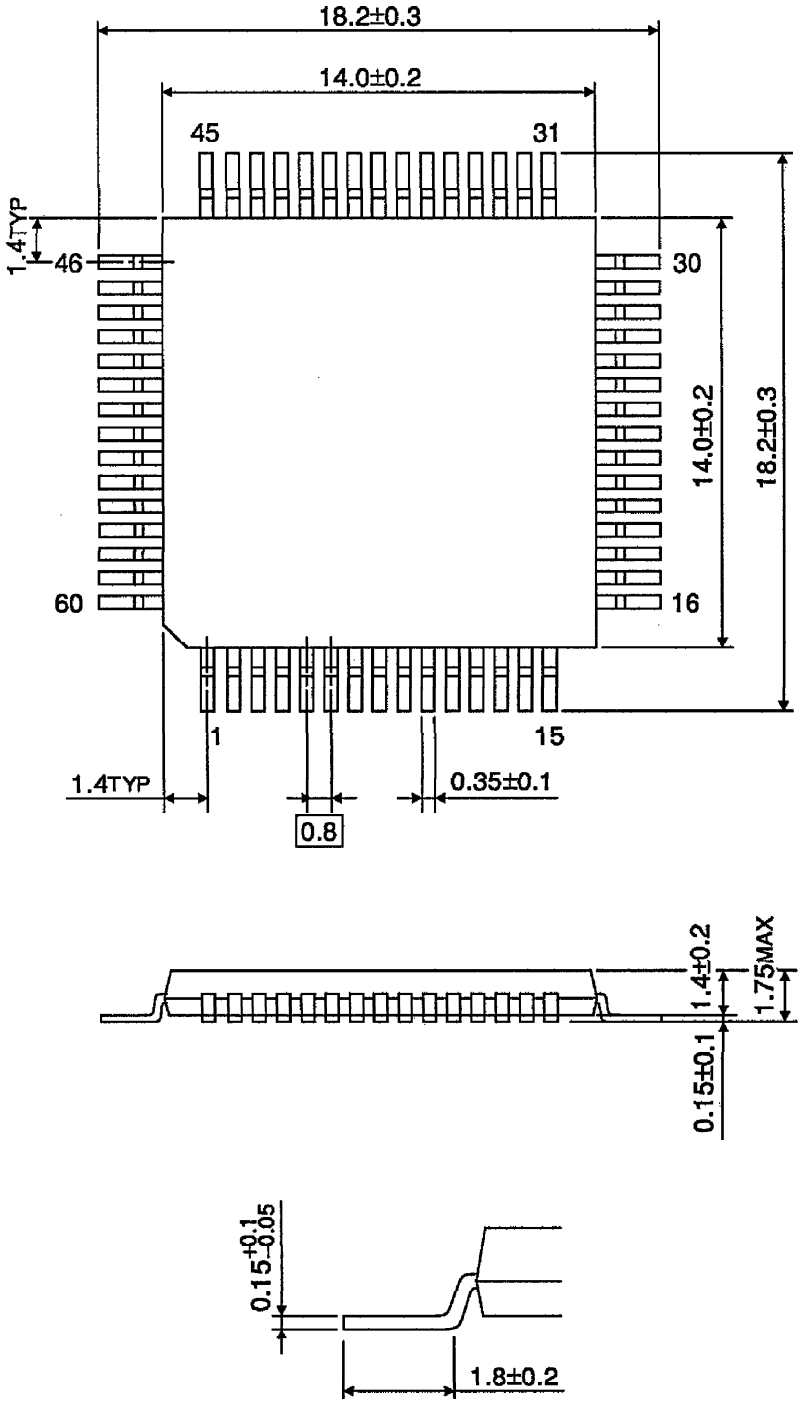
PAD LAYOUT



PAD Pitch 160 μm

PACKAGE DIMENSIONS

LQFP60-P-1414-0.80 Unit : mm



Weight : 0.66g (Typ.)

General Specification for Bare Calculator LSI Chip

1. Purpose

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

2. Definition

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

3. Priority of specifications

When there are discrepancies in or questions arising from the specifications and instructions provided by VENDOR, the following documents shall apply, in the priority order shown.

1) Individual specifications for the bare calculator LSI chip
(both PURCHASER and VENDOR should refer to the technical data sheet for the relevant product.)
2) General specifications for the bare calculator LSI chip
3) Other related specifications and standards

4. Characteristics

To be shown in the individual specification sheets.
The individual specifications shall consist of the following four items.

1) Rating specifications
2) Electrical characteristics
3) Pin configuration and mechanical dimensions
4) Others

5. Inspection of product for delivery

5.1 Inspection lot

a) The inspection lot shall consist of products produced using the same material, working from the same design, via the same production process, using the same facilities, with the same assured quality and using the same quality assurance method; the lot number shall be put on all trays to allow tracing of the lot history.

b) The products in an inspection lot number should all be taken from 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 as specified in the following table:

TEST	AQL (%)
Electrical	2.5
Visual	4.0

5.3 Electrical criteria

Criteria for 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 of PURCHASER receiving the products.

b) PURCHASER shall report the results of incoming inspection to VENDOR and provide VENDOR with detailed data of failure rate, quoting VENDOR's lot number for failed products, if VENDOR demands a report from PURCHASER.

6.2 Inspection procedure

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

a) First: Visual inspection should be carried out

b) Second: Electrical and other inspections should be carried out before PURCHASER's manufacturing process is started.

7. Treatment for defective lots and products

Defective lots and defective products which are found in PURCHASER's incoming inspection can be returned to VENDOR with detailed description of failures.
However, if VENDOR does not receive the defective items within 30 days of PURCHASER's incoming inspection, VENDOR is absolved of responsibility for defects.

8. Packing and labeling

a) Dies shall be placed in die tray in order with the top metal surface facing up.

b) A pile consists of five trays and several piles are packed in a package. These piles and packages have printed labels on them as shown below.

Date	
Name	
Lot No.	
Net	
TOSHIBA MADE IN JAPAN	

c) PURCHASER shall return these packing materials to VENDOR at VENDOR's request.

9. Storage criteria

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

9.1 Chips must be stored under proper conditions to ensure that they are not subjected to a moist and/or contaminated atmosphere that will 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 so as to prevent even the slightest physical damage to the chip.

9.3 During chip-mounting and leads bonding the user must use proper assembly techniques to obtain proper electrical, thermal and mechanical performance.

9.4 After the chip has been mounted and the leads bonded, all necessary procedures must be followed by the user to ensure that these non-hermetic chips are not subjected to a 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 environmental factors which could conceivably adversely affect their proper performance.

10. Handling criteria

The user should find the following suggested precautions helpful when handling chips.
In any event, because of the extremely small size and the fragile nature of chips, care should be taken when handling these devices.

10.1 Grounding

a) Bonders, pellet pick-up tools, table tops, trimming and forming tools, sealing equipment and any other equipment used in chip handling should be properly grounded.

b) The operator should be properly grounded.

10.2 In-process handling

a) Assemblies or sub-assemblies of chips should be transported and stored in conductive carriers.

b) All external leads on the assemblies or sub-assemblies should be shorted together.

11. Visual Inspection Criteria

11.1 Visual inspection magnification shall be 40×

11.2 Defects defined:

11.2.1 Thickness

See individual specifications in the technical data sheets.

11.2.2 Chips and cracks

A die shall be rejected if:

Any crack or chip extends for more than a length of 35 μm inside the scribe line (see Figure 1).

11.2.3 Metallization

A die shall be rejected if:

a) more than 25% of the metallization of any bonding pad is missing.

b) there is a short or break which affects electrical characteristics in any lead pattern (see Figure 2).

11.2.4 Glass protection coat

A die shall be rejected if:

The glass protection coat covers more than 25% of any bonding pad.

11.2.5 Attached foreign material

A die shall be rejected if:

a) a die is covered by stains or attached foreign material the area of which is greater than five times the bonding pad area.

b) it exhibits residual ink, stains or attached foreign material which cover more than 20% of any active bonding pad (see Figure 3).

11.2.6 Others

A die shall be rejected if:

a) there are no probe needle scratches on any of the bonding pads.

b) if it has been marked with ink.

11.3 Parameter limits for samples should be applied as necessary

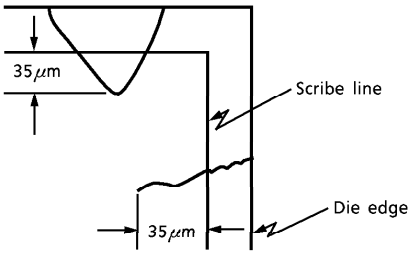


Figure 1

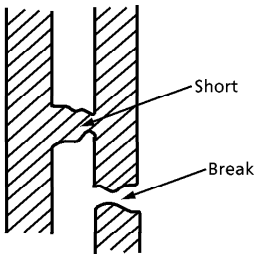


Figure 2 Lead pattern

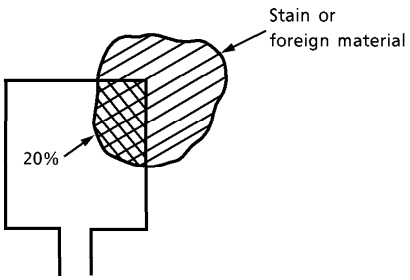
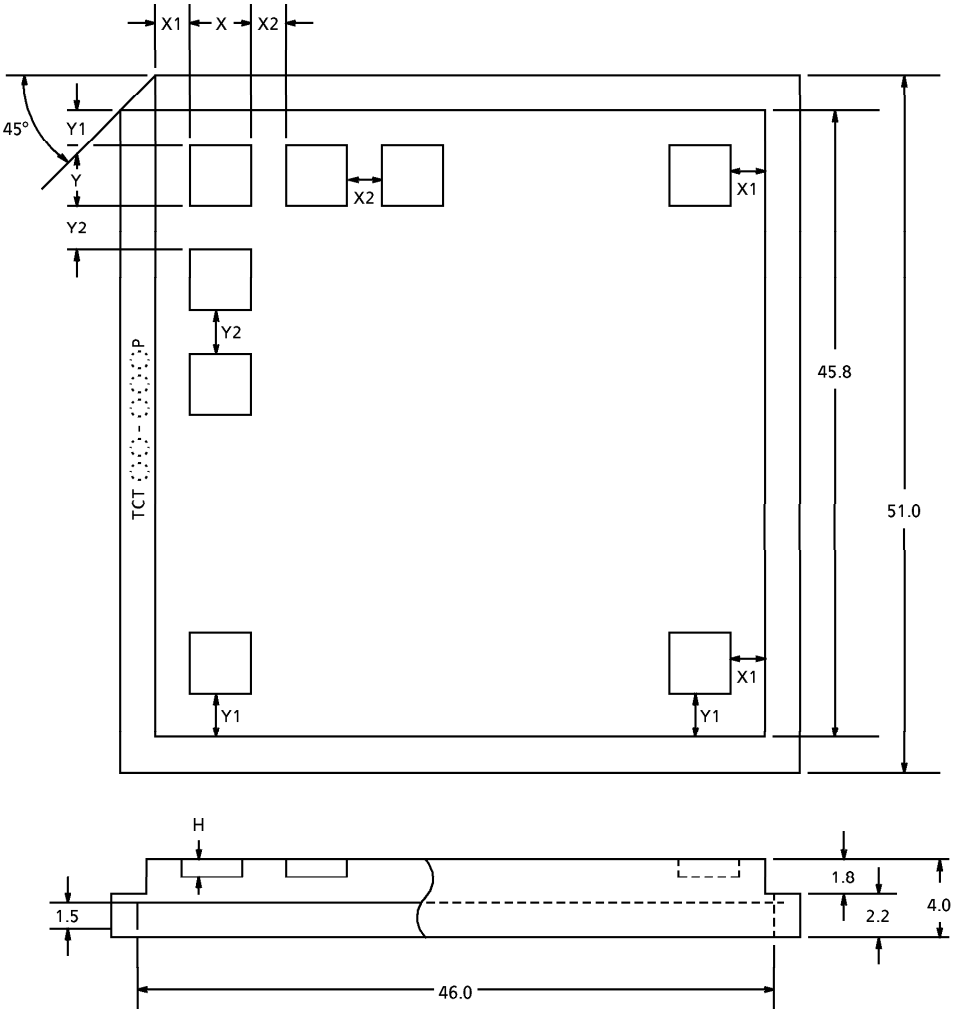


Figure 3

External Dimensions of Chip Tray



Please select a tray name from the table according to the chip size:

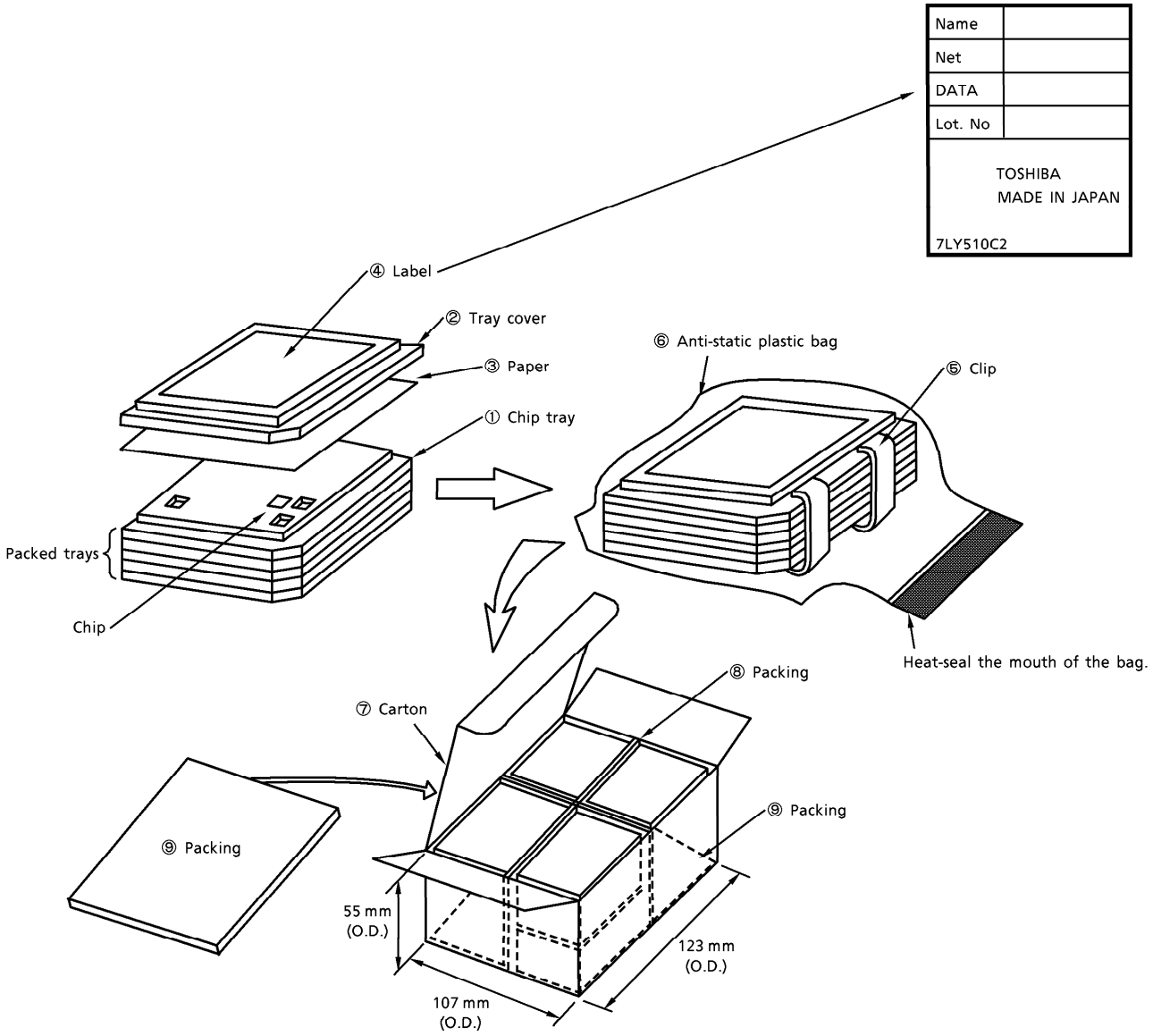
Unit: mm

Tray name	X	Y	H	No. of pockets (pcs)	X1	X2	Y1	Y2
TCT28-060P	2.80	2.80	0.60	10×10 (100)	1.700	1.800	1.700	1.600
TCT33-060P	3.30	3.30	0.60	10×10 (100)	1.900	1.000	1.900	1.000
TCT38-060P	3.80	3.80	0.60	10×10 (100)	1.200	0.600	1.200	0.600
TCT45-060P	4.50	4.50	0.60	7×7 (49)	2.050	1.700	2.050	1.700
TCT53-060P	5.30	5.30	0.60	7×7 (49)	1.350	1.000	1.350	1.000

Tray material:

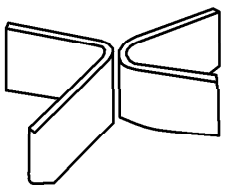
Carbon-bearing polypropylene

Packing Method 1



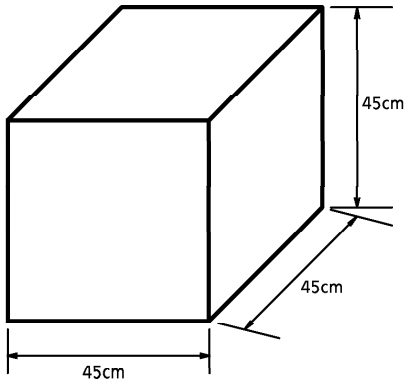
Place eight bags of chip trays in each carton ⑦. Lay one sheet of packing (7UF44F) ⑨ on top before closing the lid of the carton (see the diagram above).

Prepare the packing ⑧ by cutting a sheet of 7UF44F into halves and folding each half in half as shown below; use these halves as inner partitions.



Packing Method 2

Shipping box



- Inner box : Containing 20 boxes
- Weight : Approx. 15 kg (including packing material)
- Material : Corrugated cardboard
- IC contents : 36 × 5 × 8 × 20 = 28.800 pcs