

# T7980S

## T7980S CMOS 1 CHIP LSI FOR LCD ELECTRONIC CALCULATOR

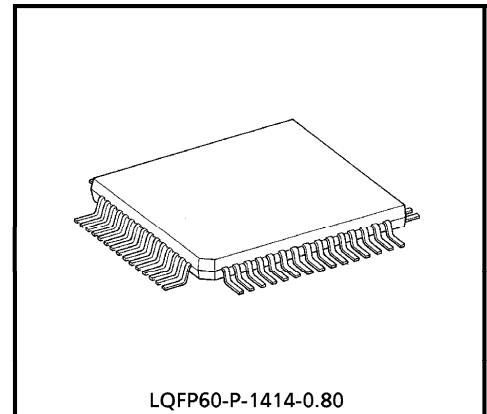
The T7980S is a 1 chip microcomputer for 8-digits + 1-digit electronic scientific calculation.

T7980S is the complete single chip CMOS LSI for electronic calculator with 8 digit, 45 function, 3 expression and hexadecimal, octal and binary, statistic calculation, and fractional number calculation with the following features.

### FEATURES

- Display 8 display digits plus 1 digits code at the right margin.
  - Scientific display.
    - Mantissa 6 digits plus exponent 2 digits plus negative code 2 digits.
  - Fractional number display.
    - 9 digits plus negative code 1 digit.
  - Other than above
    - Mantissa 8 digits plus negative code 1 digit.
- 9 kinds of special display
 

M	Memory	STAT	Statistic calculation mode
-	Mantissa and exponent Minus	DEG	Degree
E	Error	RAD	Radian
INV	Inverse	GRAD	Gradian
( )	Parenthesis calculation		
- 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. 4 pending operations are allowed and ( ) are up to continuous 15 levels.
- Fractional number calculation.
- It is possible to convert or fix the display number system by F.S key.



Weight : 0.66g (Typ.)

980910EBA2

● TOSHIBA is continually working to improve the quality and the 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 observe standards of safety, and to avoid situations in which a malfunction or failure of a TOSHIBA product 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 products specifications. Also, please keep in mind the precautions and conditions set forth in the TOSHIBA Semiconductor Reliability Handbook.

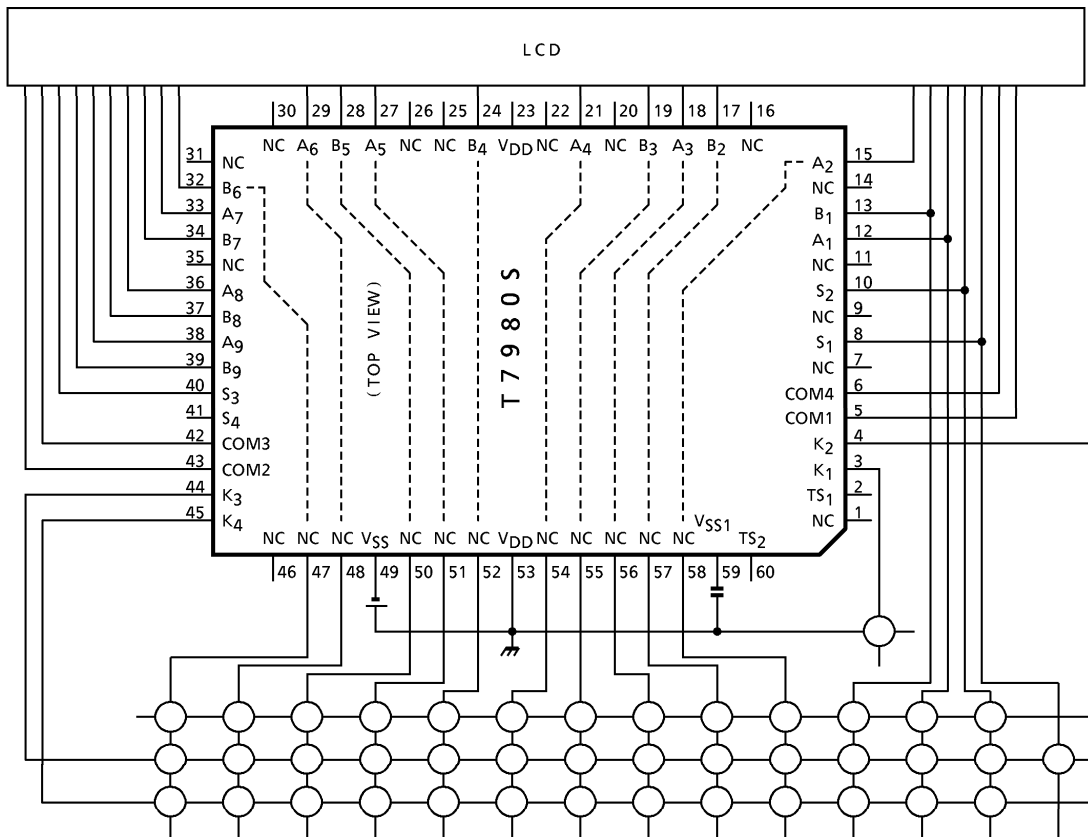
● The products described in this document are subject to the foreign exchange and foreign trade laws.

● The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.

● The information contained herein is subject to change without notice.

- One independent accumulating memory.
- It is possible to specify decimal part digits (0~7) 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.

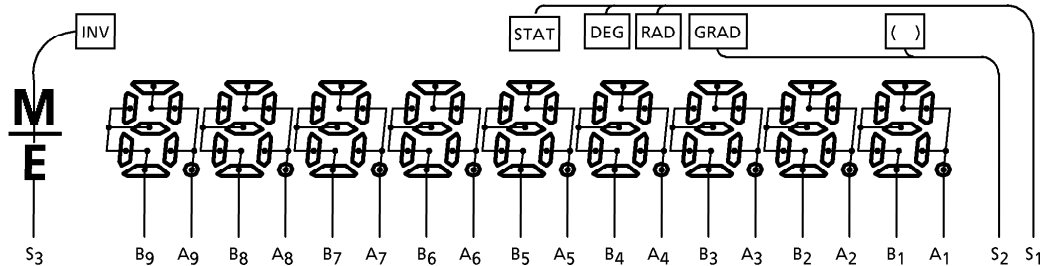
**SYSTEM BLOCK DIAGRAM**



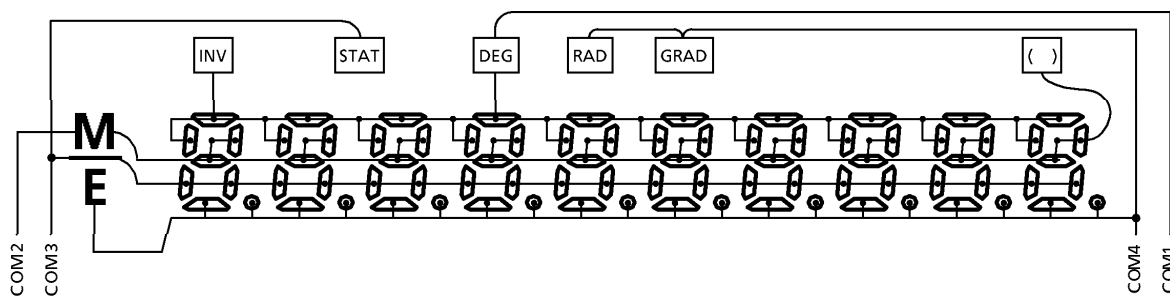
(Note) Input capacity  $\leq 300$  (pF) at  $V_{SS} = -2.6$  (V)  
 Key resistance  $\leq 1.5$  (k $\Omega$ ) at  $V_{SS} = -2.6$  (V)

CONNECTION OF LCD

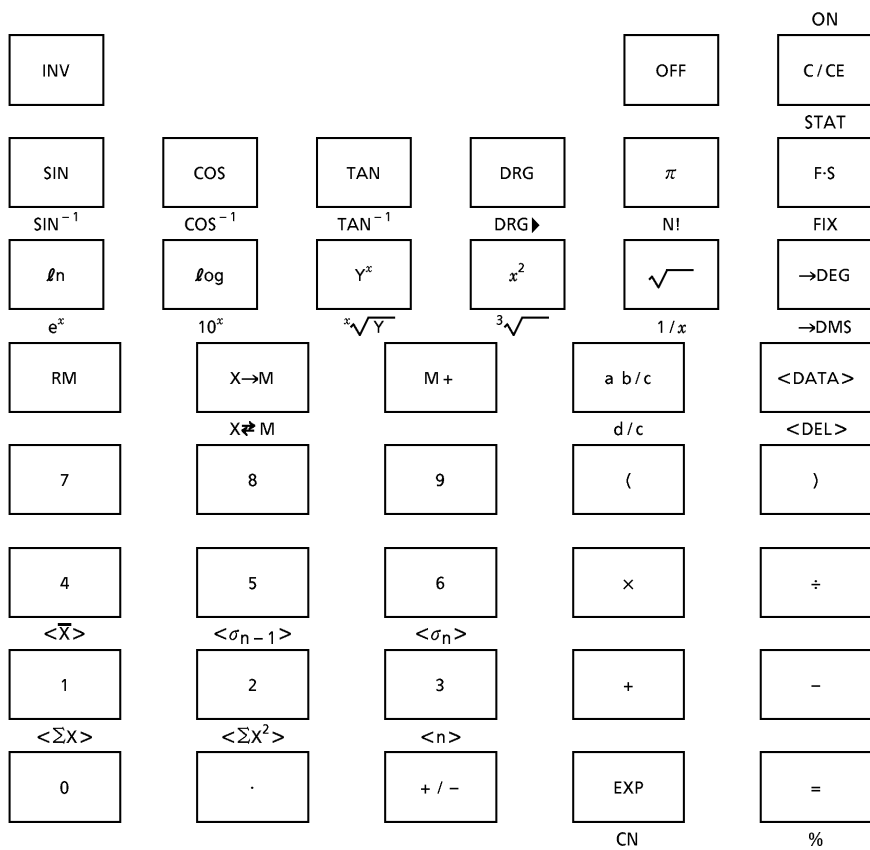
SEGMENT



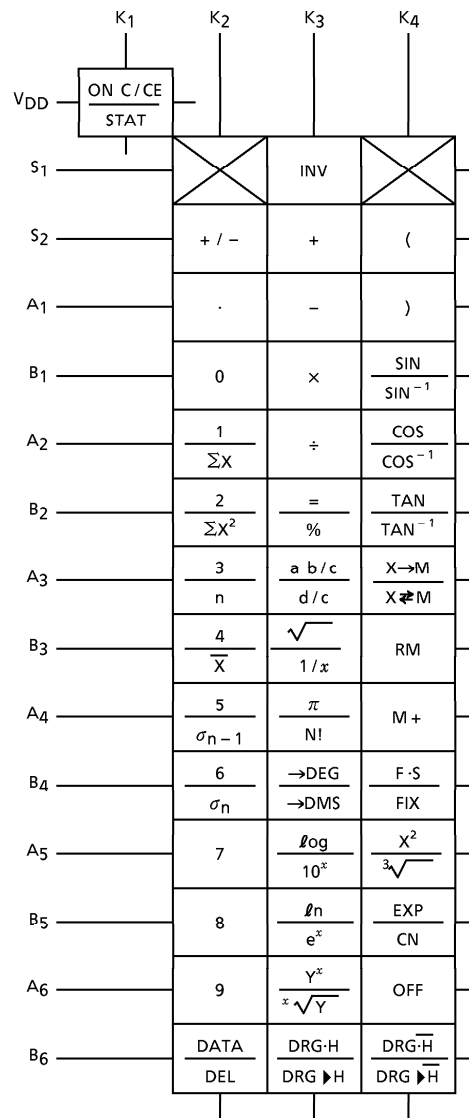
COMMON



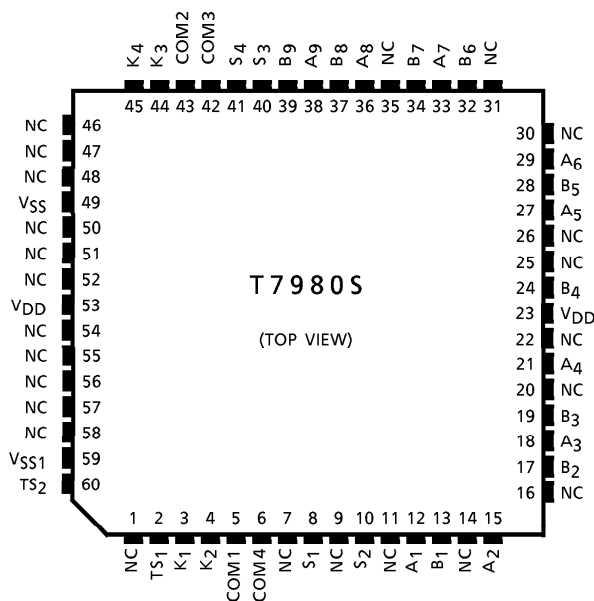
SET KEY LAYOUT (Example)



KEY LAYOUT



PIN LAYOUT



SPECIFICATION OF CALCULATOR

Speed of Calculator

Key on 5.8ms

Key off 82ms

$f_{\phi\text{WAIT}} = 30\text{kHz}$ ,  $f_{\phi\text{op}} = 70\text{kHz}$

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

Item	Operation			Calculation speed (ms)
Number	DEC		5	12
			5	12
Function	DEC		5 +	40
			5 ×	41
4-operation	DEC		1 + 2	60
			1 0 0 0 0 0 0 - 1	70
			5 × 9	83
			5 5 5 5 5 × 9 9 9 9 9	91
			5 ÷ 9	41
			5 5 5 5 5 ÷ 9 9 9 9 9	128
$Y^x, x\sqrt{Y}$		3 Y <sup>x</sup> 4	=	605
		3 <sup>x</sup> √Y 4	=	636
SIN	DEG	3 0	SIN	643
	RAD	$\pi \div 6 =$	SIN	803
	GRAD	1 0 0 ÷ 3 =	SIN	686
COS	DEG	6 0	COS	648
	RAD	$\pi \div 3 =$	COS	757
	GRAD	2 0 0 ÷ 3 =	COS	695

Item	Operation			Calculation speed (ms)	
TAN	DEG	4 5	TAN	242	
	RAD	$\pi \div 4 =$	TAN	306	
	GRAD	5 0	TAN	242	
SIN <sup>-1</sup>	DEG	0. 5	SIN <sup>-1</sup>	556	
	RAD	0. 5	SIN <sup>-1</sup>	462	
	GRAD	0. 5	SIN <sup>-1</sup>	547	
COS <sup>-1</sup>	DEG	0. 5	COS <sup>-1</sup>	647	
	RAD	0. 5	COS <sup>-1</sup>	527	
	GRAD	0. 5	COS <sup>-1</sup>	639	
TAN <sup>-1</sup>	DEG	1	TAN <sup>-1</sup>	230	
	RAD	1	TAN <sup>-1</sup>	154	
	GRAD	1	TAN <sup>-1</sup>	225	
Ln		2 0	ln	192	
Log		2 0	log	236	
e <sup>x</sup>		2 0	e <sup>x</sup>	234	
10 <sup>x</sup>		1. 2 3	10 <sup>x</sup>	290	
		1 0	10 <sup>x</sup>	105	
X!		6 9	N!	698	
X <sup>2</sup>		2 0	X <sup>2</sup>	57	
$\sqrt{\quad}$		2 0	$\sqrt{\quad}$	184	
1/X		2 0	1/X	72	
$\sqrt[3]{\quad}$		2 0	$\sqrt[3]{\quad}$	535	
→DEG		1. 2 3 4 5	→DEG	175	
→DMS		1. 2 3 4 5	→DMS	173	
→RAD	DEG	3 6 0	DRG▶	131	
→GRAD	RAD	2 × $\pi =$	DRG▶	104	
→DEG	GRAD	4 0 0	DRG▶	59	
Memory		1 2 3	X→M	33	
		1 2 3 X → M	M+	36	
		1 2 3 X → M	RM	27	
		1 2 3 X → M	X⇌M	33	
%		1 2 3 + 4 5 6	%	65	
		1 2 3 - 4 5 6	%	65	
		1 2 3 × 4 5 6	%	34	
		1 2 3 ÷ 4 5 6	%	34	
Statistic Calculation	1 DATA 2 DATA 3 DATA ..... 8 DATA 9			DATA	228
	The above-mentioned data			n	32
				$\bar{X}$	70
				$\Sigma X$	31
				$\Sigma X^2$	30
				$\sigma_{n-1}$	318
	$\sigma_n$	378			

Item	Operation			Calculation speed (ms)
Fractional number Calculation	Function	$2 \text{ ab/c } 3 \text{ 6 ab/c } 2 \text{ 3 } 4$	—	116
		$2 \text{ ab/c } 3 \text{ 6 ab/c } 2 \text{ 3 } 4$	÷	117
	4-operation	$2 \text{ _ } 36 \text{ J } 234 + 3 \text{ _ } 45 \text{ J } 345$	=	271
		$2 \text{ _ } 36 \text{ J } 234 - 3 \text{ _ } 45 \text{ J } 345$	=	261
		$2 \text{ _ } 36 \text{ J } 234 \times 3 \text{ _ } 45 \text{ J } 345$	=	231
		$2 \text{ _ } 36 \text{ J } 234 \div 3 \text{ _ } 45 \text{ J } 345$	=	197

**OPERATION RANGE AND ACCURACY**

Function	Angle Unit	Operation range	Under flow area	Normal accuracy
SIN X	DEG	$0 \leq  X  \leq 4.4999999 \times 10^{09}$	$0 \leq  X  \leq 5.7295779 \times 10^{-98}$	8 digits ± 1
	RAD	$0 \leq  X  \leq 78539816.$	$0 \leq  X  \leq 1.0000000 \times 10^{-99}$	
	GRAD	$0 \leq  X  \leq 4.9999999 \times 10^{09}$	$0 \leq  X  \leq 6.3661977 \times 10^{-98}$	
COS X	DEG	$0 \leq  X  \leq 4.5000000 \times 10^{09}$	—	
	RAD	$0 \leq  X  \leq 78539817.$	—	
	GRAD	$0 \leq  X  \leq 5.0000000 \times 10^{09}$	—	
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 <sup>-1</sup> X	DEG	$0 \leq  X  \leq 1$	$0 \leq  X  \leq 1.5707963 \times 10^{-99}$	
	RAD	$0 \leq  X  \leq 1$	—	
	GRAD	$0 \leq  X  \leq 1$	$0 \leq  X  \leq 1.5707963 \times 10^{-99}$	
COS <sup>-1</sup> X	DEG	SAME AS SIN <sup>-1</sup> X	—	
	RAD	SAME AS SIN <sup>-1</sup> X	—	
	GRAD	SAME AS SIN <sup>-1</sup> X	—	
TAN <sup>-1</sup> X	DEG	$0 \leq  X  \leq 9.9999999 \times 10^{99}$	SAME AS SIN <sup>-1</sup> X	
	RAD	$0 \leq  X  \leq 9.9999999 \times 10^{99}$	—	
	GRAD	$0 \leq  X  \leq 9.9999999 \times 10^{99}$	SAME AS SIN <sup>-1</sup> X	

Function	Operation range	Under flow area	Normal accuracy
LN X	$0 < X$	—	8 digits ± 1
LOG X	$0 < X$	—	
e <sup>x</sup>	$- 9.9999999 \times 10^{99} \leq X \leq 230.25850$	$- 9.9999999 \times 10^{99} \leq X \leq - 227.95593$	
10 <sup>x</sup>	$- 9.9999999 \times 10^{99} \leq X \leq 99.999999$	$- 9.9999999 \times 10^{99} \leq X \leq - 99.000001$	

Function	Operation range	Under flow area	Normal accuracy
X!	$0 \leq X \leq 69$ (INTEGER)	—	8 digits $\pm 1$
$\frac{1}{X}$	$1 \times 10^{-99}$ $\leq  X  \leq 9.9999999 \times 10^{99}$ ( $X \neq 0$ )	$1.0000001 \times 10^{99}$ $\leq  X  \leq 9.9999999 \times 10^{99}$	
$X^2$	$0 \leq  X  \leq 9.9999999 \times 10^{49}$	$0 \leq  X  \leq 3.1622776 \times 10^{-50}$	
$\sqrt{X}$	$0 \leq X \leq 9.9999999 \times 10^{99}$	—	
$\sqrt[3]{X}$	$0 \leq  X  \leq 9.9999999 \times 10^{99}$	—	
DMS→DEG	$0 \leq  X  \leq 9.9999999 \times 10^7$	—	
DEG→DMS	$0 \leq  X  \leq 9.9999999 \times 10^7$	$0 \leq  X  \leq 1.3888888 \times 10^{-6}$	lowest digits $\pm 1$
DEG→RAD	$0 \leq  X  \leq 9.9999999 \times 10^{99}$	$0 \leq  X  \leq 5.7295779 \times 10^{-98}$	8 digits $\pm 1$
RAD→GRAD	$0 \leq  X  \leq 1.5707963 \times 10^{98}$	—	
GRAD→DEG	$0 \leq  X  \leq 9.9999999 \times 10^{99}$	$0 \leq  X  \leq 1.1111111 \times 10^{-99}$	
$Y^X$	$-9.9999999 \times 10^{99}$ $\leq X \cdot \text{LN }  Y  \leq 230.25850$ (1) $Y > 0 \cdots$ The above-mentioned operation range. (2) $Y < 0 \cdots X$ (Integer) or $1/X$ (Odd, $X \neq 0$ ) $\cdots$ The above-mentioned operation range. (3) $Y = 0 \cdots 0 < X$	$-9.9999999 \times 10^{99}$ $\leq X \cdot \text{LN }  Y  \leq -227.95593$	
$\sqrt[X]{Y}$	$-9.9999999 \times 10^{99}$ $\leq \frac{1}{X} \cdot \text{LN }  Y  \leq 230.25850$ (1) $Y > 0 \cdots$ The above-mentioned operation range. (2) $Y < 0 \cdots X$ (Odd) or $1/X$ (Integer, $X \neq 0$ ) $\cdots$ The above-mentioned operation range. (3) $Y = 0 \cdots 0 < X$	$-9.9999999 \times 10^{99}$ $\leq \frac{1}{X} \cdot \text{LN }  Y  \leq -227.95593$	8 digits $\pm 1$
Statistic	DATA DEL	Operation range $ x  \leq 9.9999999 \times 10^{49}$ $ \sum X  \leq 9.9999999 \times 10^{99}$ $\sum X^2 \leq 9.9999999 \times 10^{99}$ $0 \leq n \leq 99999999$ . n = Integer	
	$\bar{x}$	n $\neq 0$	
	$\sigma_{n-1}$	n $\neq 1$ , n $\neq 0$ $0 \leq \frac{\sum X^2 - \{(\sum X)^2 / n\}}{n-1} \leq 9.9999999 \times 10^{99}$	
	$\sigma_n$	n $\neq 0$ $0 \leq \frac{\sum X^2 - \{(\sum X)^2 / n\}}{n} \leq 9.9999999 \times 10^{99}$	



## MAXIMUM RATINGS

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

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

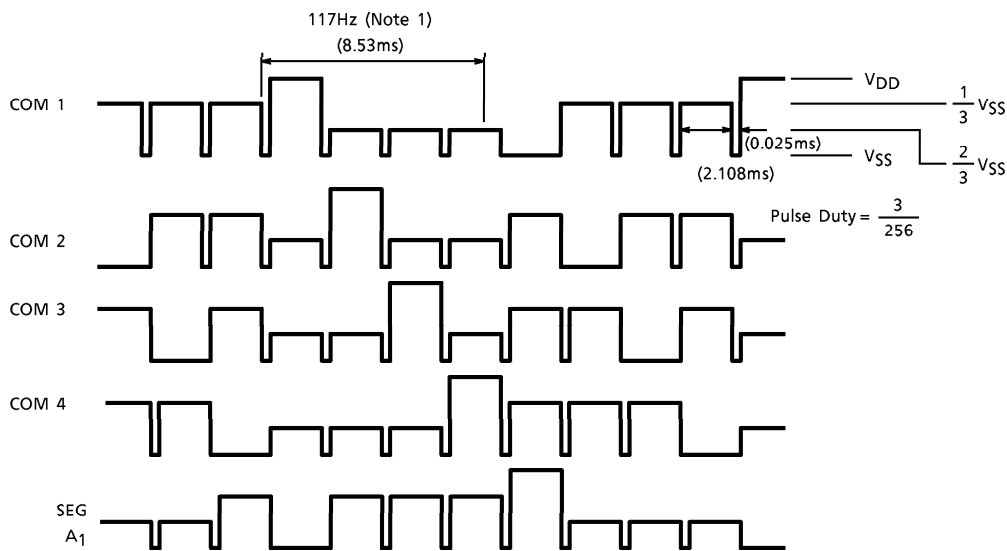
PARAMETER	SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	—	—	—	—	-2.5	-3.0	-3.4	V
Supply Current	$I_{DD}$ WAIT	—	—	$V_{SS} = -3.0V$ , wait	—	26	46	$\mu A$
Supply Current	$I_{DD}$ OP	—	—	$V_{SS} = -3.0V$ , operate	—	52	78	$\mu A$
Supply Current	$I_{DD}$ OFF	—	—	$V_{SS} = -3.0V$ , off	—	1	3	$\mu A$
Oscillating Frequency	$f\phi$ WAIT	—	—	$V_{SS} = -3.0V$ , wait	18	30	42	kHz
Oscillating Frequency	$f\phi$ OP	—	—	$V_{SS} = -3.0V$ , operate	42	70	98	kHz
Frame Frequency	$f_F$	—	—	$V_{SS} = -3.0V$ , wait	70	117	164	Hz
Timer	T timer	—	—	$V_{SS} = -3.0V$	428	600	1000	s
"1" Input Voltage	$V_{IH}$	—	$K_1 \sim K_4$	—	$V_{SS} + 0.5$	—	$V_{SS}$	V
"0" Input Voltage	$V_{IL}$	—	$K_1 \sim K_4$	—	$V_{DD}$	—	-0.5	V
"1" Output Resistance	$R_{KEY}$	—	SEG	$V_{OUT} = V_{SS} + 0.5V$ : KEY STROBE	—	—	2	$k\Omega$
"0" Output Resistance	$R_{SEG} (L)$	—	SEG	$V_{OUT} = V_{DD} - 0.5V$	—	—	90	$k\Omega$
"1" Output Resistance	$R_{SEG} (H)$	—	SEG	$V_{OUT} = V_{SS} + 0.5V$ : KEY STROBE	—	—	90	$k\Omega$
"0" Output Resistance	$R_{COM} (L)$	—	COM	$V_{OUT} = V_{DD} - 0.5V$	—	—	25	$k\Omega$
"1" Output Resistance	$R_{COM} (H)$	—	COM	$V_{OUT} = V_{SS} + 0.5V$	—	—	25	$k\Omega$
KEY Pull Up Resistance	$R_{PULL UP}$	—	$K_1$	$V_{OUT} = 0V$	27	45	63	$k\Omega$
KEY Pull Down Resistance	$R_{PULL DOWN}$	—	$K_2 \sim K_4$	$V_{OUT} = V_{SS}$	27	45	63	$k\Omega$
"M" Output Resistance	$R_{OM}$	—	SEG	$V_{OUT} = \frac{1}{3} V_{SS} - 0.5V$	—	100	—	$k\Omega$
"M" Output Resistance	$R_{OM}$	—	SEG	$V_{OUT} = \frac{2}{3} V_{SS} + 0.5V$	—	100	—	$k\Omega$
"M" Output Resistance	$R_{OM}$	—	COM	$V_{OUT} = \frac{1}{3} V_{SS} - 0.5V$	—	77	—	$k\Omega$
"M" Output Resistance	$R_{OM}$	—	COM	$V_{OUT} = \frac{2}{3} V_{SS} + 0.5V$	—	77	—	$k\Omega$

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

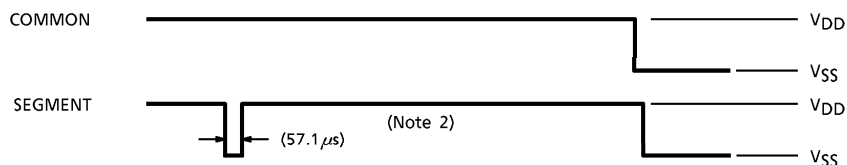
(Note 1) The key buffer is high impedance at  $\overline{\text{keystrobe}}$ .

WAVEFORMS FOR DISPLAY

Display



Key pulse output

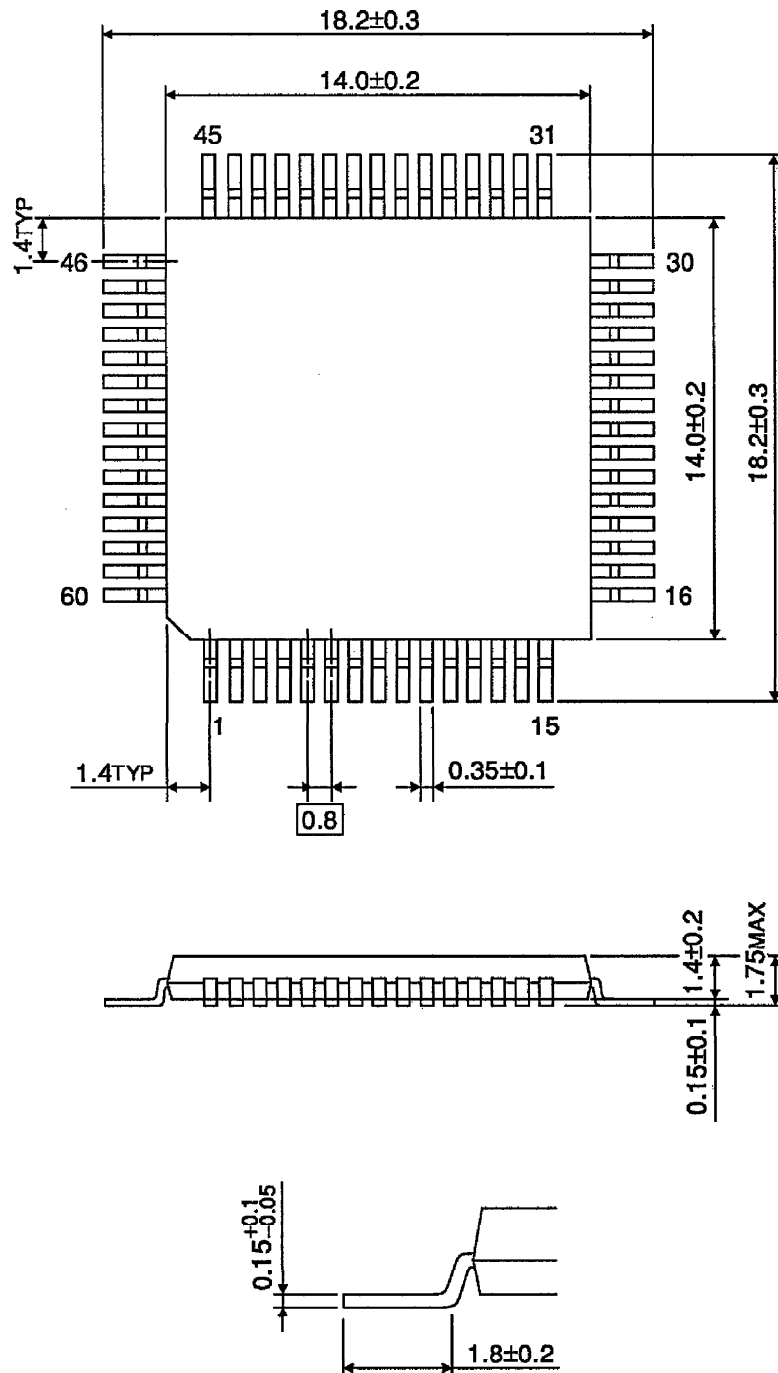


(Note 1) F<sub>φ</sub>WAIT = 30kHz

(Note 2) F<sub>φ</sub>OP = 70kHz

OUTLINE DRAWING  
LQFP60-P-1414-0.80

Unit : mm



Weight : 0.66g (Typ.)