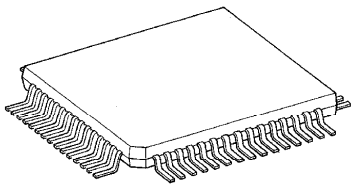
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

T7980S

T7980S CMOS 1 CHIP LSI FOR LCD ELECTRONIC CALCULATOR

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



LQFP60-P-1414-0.80

Weight : 0.66g (Typ.)

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

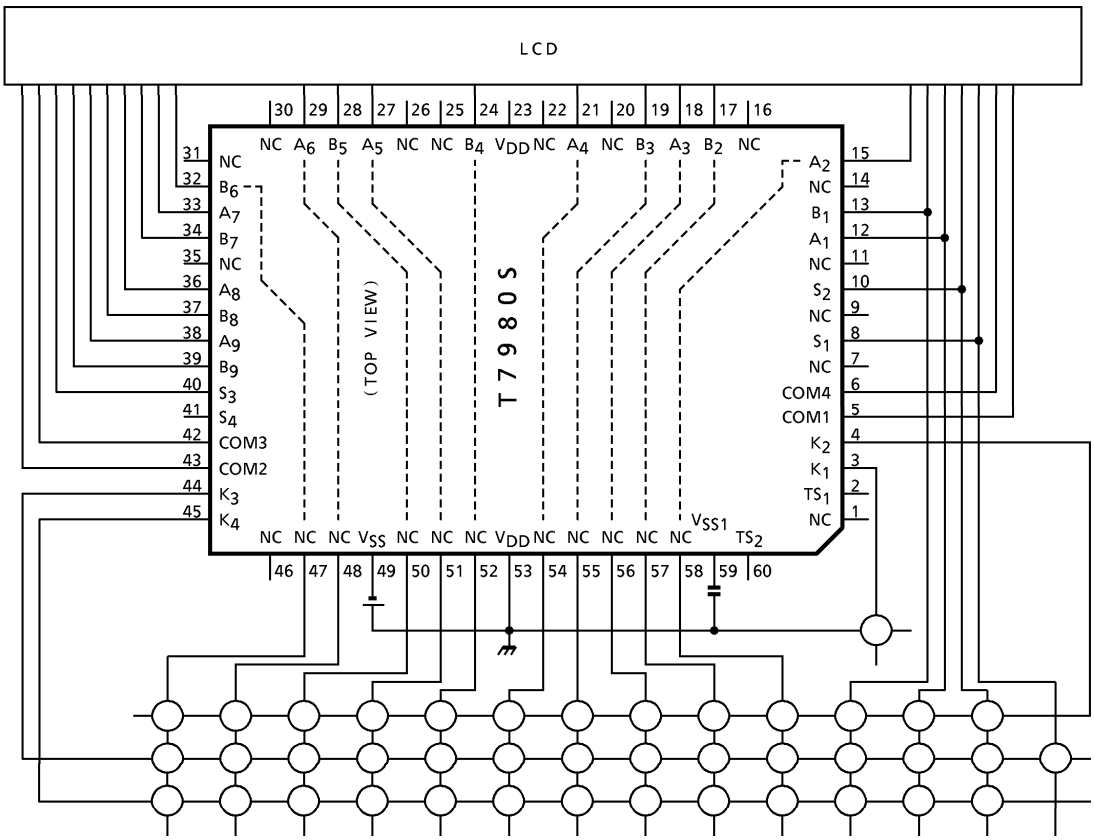
    Mantissa 8 digits plus negative code 1 digit.
- 9 kinds of special display

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 $\sqrt[X]{Y}$ 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.

- 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.

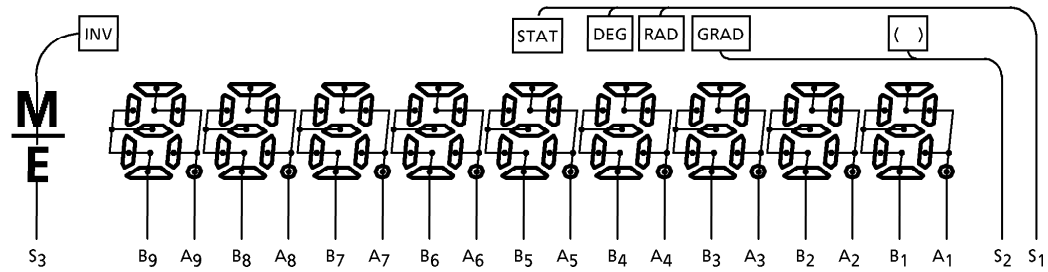
SYSTEM BLOCK DIAGRAM



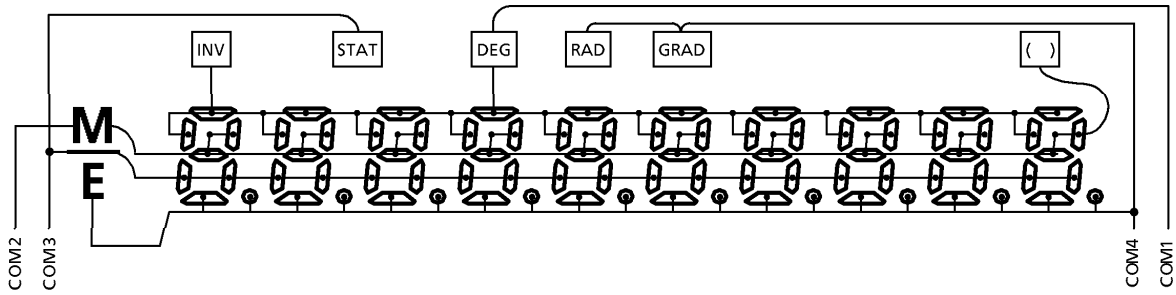
(Note) Input capacity≤300 (pF) at V_{SS} = −2.6 (V)
Key resistance≤1.5 (kΩ) at V_{SS} = −2.6 (V)

CONNECTION OF LCD

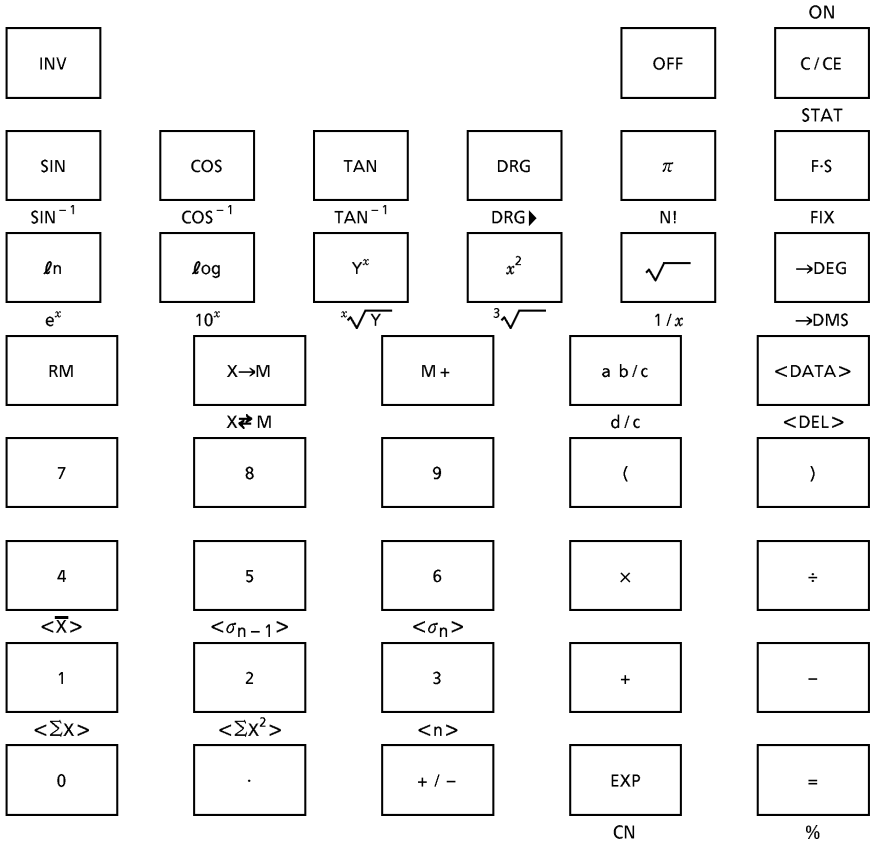
SEGMENT



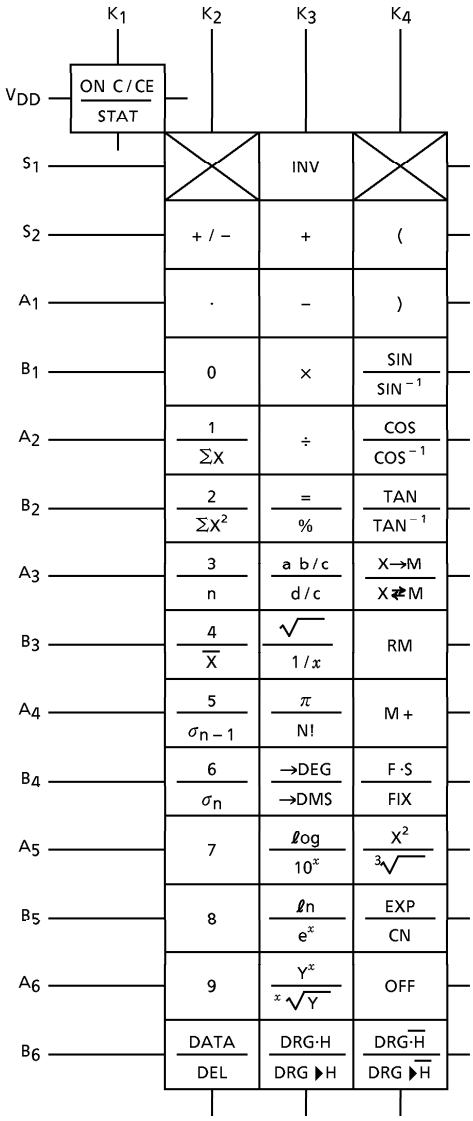
COMMON



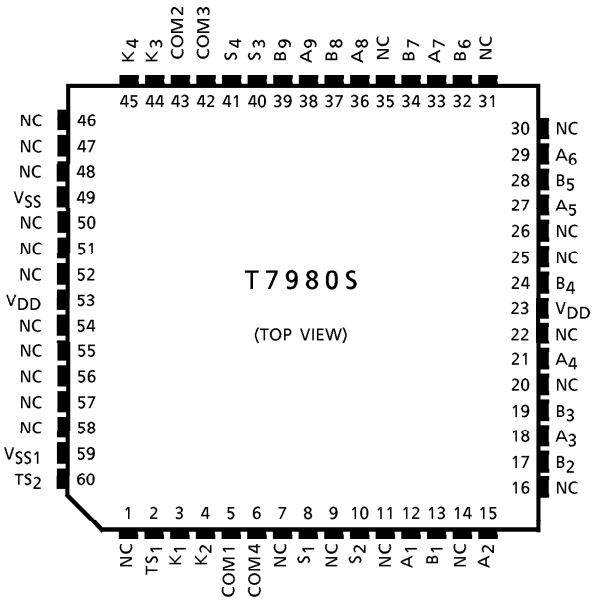
SET KEY LAYOUT (Example)



KEY LAYOUT


K1
K2
K3
K4
VDD
ON C/CE
STAT
S1
S2
A1
B1
A2
B2
A3
B3
A4
B4
A5
B5
A6
B6
INV
+ / −
+
(
·
−
)
0
×
SIN
SIN−1
1
ΣX
÷
COS
COS−1
2
ΣX2
=
%
TAN
TAN−1
3
n
a b/c
d/c
X→M
X⇄M
4
X̄
1/x
RM
5
σn−1
π
N!
M+
6
σn
→DEG
→DMS
F·S
FIX
7
log
10x
X2
EXP
8
ln
ex
CN
9
Yx
x√Y
OFF
DATA
DEL
DRG·H
DRG▶H
DRG·H̄
DRG▶H̄

PIN LAYOUT



SPECIFICATION OF CALCULATOR

Speed of Calculator

Key on 5.8ms Key off 82ms $f\phi WAIT = 30kHz$, $f\phi op = 70kHz$

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

Item	Operation			Calculation speed (ms)
Number	DEC		5	12
		5	5	12
Function	DEC	5	+	40
		5	×	41
4-operation	DEC	1 + 2	+	60
		1 0 0 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, $\sqrt[x]{Y}$		3 Y^x 4	=	605
		3 $\sqrt[x]{Y}$ 4	=	636
SIN	DEG	3 0	SIN	643
	RAD	π ÷ 6 =	SIN	803
	GRAD	1 0 0 ÷ 3 =	SIN	686
COS	DEG	6 0	COS	648
	RAD	π ÷ 3 =	COS	757
	GRAD	2 0 0 ÷ 3 =	COS	695

Item	Operation			Calculation speed (ms)
TAN	DEG	4 5	TAN	242
	RAD	π ÷ 4 =	TAN	306
	GRAD	5 0	TAN	242
SIN^{-1}	DEG	0 . 5	SIN^{-1}	556
	RAD	0 . 5	SIN^{-1}	462
	GRAD	0 . 5	SIN^{-1}	547
COS^{-1}	DEG	0 . 5	COS^{-1}	647
	RAD	0 . 5	COS^{-1}	527
	GRAD	0 . 5	COS^{-1}	639
TAN^{-1}	DEG	1	TAN^{-1}	230
	RAD	1	TAN^{-1}	154
	GRAD	1	TAN^{-1}	225
Ln	2 0		ln	192
Log	2 0		ℓog	236
e^x	2 0		e^x	234
10^x	1 . 2 3		10^x	290
	1 0		10^x	105
X!	6 9		N!	698
X^2	2 0		X^2	57
$\sqrt{}$	2 0		$\sqrt{}$	184
1/X	2 0		1/X	72
$\sqrt[3]{}$	2 0		$\sqrt[3]{}$	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 × π =	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
			$\overline{X}$	70
			ΣX	31
			ΣX^2	30
			σ_{n-1}	318
			σ_n	378

Item	Operation			Calculation speed (ms)
Fractional number Calculation	Function	2 ab/c 3 6 ab/c 2 3 4	−	116
		2 ab/c 3 6 ab/c 2 3 4	÷	117
	4-operation	2 _ 36」 234 + 3 _ 45 」 345	=	271
		2 _ 36」 234 − 3 _ 45 」 345	=	261
		2 _ 36」 234 × 3 _ 45 」 345	=	231
		2 _ 36」 234 ÷ 3 _ 45 」 345	=	197

OPERATION RANGE AND ACCURACY

Function	Angle Unit	Operation range	Under flow area	Normal accuracy
SIN X	DEG	$0 \leqq \lvert X \rvert \leqq 4.4999999 \times 10^{09}$	$0 \leqq \lvert X \rvert \leqq 5.7295779 \times 10^{-98}$	8 digits ± 1
	RAD	$0 \leqq \lvert X \rvert \leqq 78539816.$	$0 \leqq \lvert X \rvert \leqq 1.0000000 \times 10^{-99}$	
	GRAD	$0 \leqq \lvert X \rvert \leqq 4.9999999 \times 10^{09}$	$0 \leqq \lvert X \rvert \leqq 6.3661977 \times 10^{-98}$	
COS X	DEG	$0 \leqq \lvert X \rvert \leqq 4.5000000 \times 10^{09}$	—	
	RAD	$0 \leqq \lvert X \rvert \leqq 78539817.$	—	
	GRAD	$0 \leqq \lvert X \rvert \leqq 5.0000000 \times 10^{09}$	—	
TAN X	DEG	SAME AS SIN X except for $\lvert X \rvert = (2n-1) \cdot 90$	SAME AS SIN X	
	RAD	SAME AS SIN X except for $\lvert X \rvert = (2n-1) \cdot \pi / 2$	SAME AS SIN X	
	GRAD	SAME AS SIN X except for $\lvert X \rvert = (2n-1) \cdot 100$	SAME AS SIN X	
$SIN^{-1}X$	DEG	$0 \leqq \lvert X \rvert \leqq 1$	$0 \leqq \lvert X \rvert \leqq 1.5707963 \times 10^{-99}$	
	RAD	$0 \leqq \lvert X \rvert \leqq 1$	—	
	GRAD	$0 \leqq \lvert X \rvert \leqq 1$	$0 \leqq \lvert X \rvert \leqq 1.5707963 \times 10^{-99}$	
$COS^{-1}X$	DEG	SAME AS $SIN^{-1}X$	—	
	RAD	SAME AS $SIN^{-1}X$	—	
	GRAD	SAME AS $SIN^{-1}X$	—	
$TAN^{-1}X$	DEG	$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$	SAME AS $SIN^{-1}X$	
	RAD	$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$	—	
	GRAD	$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$	SAME AS $SIN^{-1}X$	

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

Function		Operation range	Under flow area	Normal accuracy
$X!$		$0 \leqq X \leqq 69$ (INTEGER)	—	8 digits ± 1
$\frac{1}{X}$		$1 \times 10^{-99} \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$ $(X \neq 0)$	$1.0000001 \times 10^{99} \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$	
X^2		$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{49}$	$0 \leqq \lvert X \rvert \leqq 3.1622776 \times 10^{-50}$	
$\sqrt{X}$		$0 \leqq X \leqq 9.9999999 \times 10^{99}$	—	
$\sqrt[3]{X}$		$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$	—	
DMS→DEG		$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{7}$	—	
DEG→DMS		$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{7}$	$0 \leqq \lvert X \rvert \leqq 1.3888888 \times 10^{-6}$	lowest digits ± 1
DEG→RAD		$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$	$0 \leqq \lvert X \rvert \leqq 5.7295779 \times 10^{-98}$	8 digits ± 1
RAD→GRAD		$0 \leqq \lvert X \rvert \leqq 1.5707963 \times 10^{98}$	—	
GRAD→DEG		$0 \leqq \lvert X \rvert \leqq 9.9999999 \times 10^{99}$	$0 \leqq \lvert X \rvert \leqq 1.1111111 \times 10^{-99}$	
Y^X		$-9.9999999 \times 10^{99} \leqq X \cdot LN \lvert Y \rvert \leqq 230.25850$	$-9.9999999 \times 10^{99} \leqq X \cdot LN \lvert Y \rvert \leqq -227.95593$	
		(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) $Y = 0 \cdots 0 < X$		
$\sqrt[X]{Y}$		$-9.9999999 \times 10^{99} \leqq \frac{1}{X} \cdot LN \lvert Y \rvert \leqq 230.25850$	$-9.9999999 \times 10^{99} \leqq \frac{1}{X} \cdot LN \lvert Y \rvert \leqq -227.95593$	8 digits ± 1
		(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) $Y = 0 \cdots 0 < X$		
Statistic	DATA DEL	Operation range		8 digits ± 1
		$\lvert x \rvert \leqq 9.9999999 \times 10^{49}$ $\lvert \Sigma X \rvert \leqq 9.9999999 \times 10^{99}$ $\Sigma X^2 \leqq 9.9999999 \times 10^{99}$ $0 \leqq n \leqq 99999999.$ n = Integer		
	$\bar{x}$	$n \neq 0$		
	$\sigma n-1$	$n \neq 1$, $n \neq 0$ $0 \leqq \frac{\Sigma X^2 - \{(\Sigma X)^2 / n\}}{n-1} \leqq 9.9999999 \times 10^{99}$		
	σn	$n \neq 0$ $0 \leqq \frac{\Sigma X^2 - \{(\Sigma X)^2 / n\}}{n} \leqq 9.9999999 \times 10^{99}$		

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±0.2V, V_{DD} = 0V, Ta = 25±1.5°C)

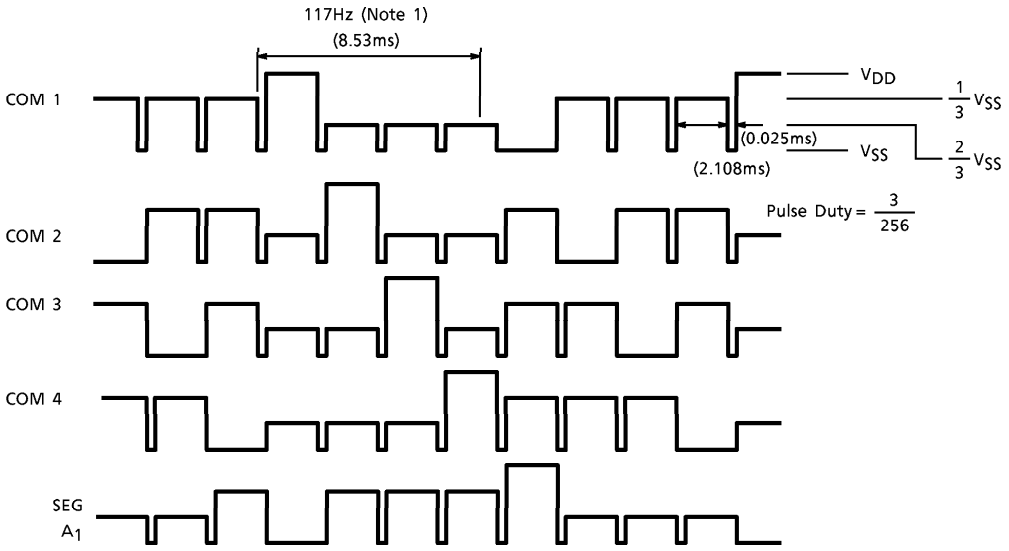
PARAMETER	SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	—	—	—	—	−2.5	−3.0	−3.4	V
Supply Current	I_{DD} WAIT	—	—	V_{SS} = −3.0V, wait	—	26	46	μA
Supply Current	I_{DD} OP	—	—	V_{SS} = −3.0V, operate	—	52	78	μA
Supply Current	I_{DD} OFF	—	—	V_{SS} = −3.0V, off	—	1	3	μA
Oscillating Frequency	f_ϕ WAIT	—	—	V_{SS} = −3.0V, wait	18	30	42	kHz
Oscillating Frequency	f_ϕ 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~K_4	—	V_{SS}+0.5	—	V_{SS}	V
"0" Input Voltage	V_{IL}	—	K_1~K_4	—	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	27	45	63	kΩ
KEY Pull Down Resistance	$R_{PULL\ DOWN}$	—	K_2~K_4	V_{OUT} = V_{SS}	27	45	63	kΩ
"M" Output Resistance	R_{OM}	—	SEG	$V_{OUT} = \frac{1}{3}V_{SS} - 0.5V$	—	100	—	kΩ
"M" Output Resistance	R_{OM}	—	SEG	$V_{OUT} = \frac{2}{3}V_{SS} + 0.5V$	—	100	—	kΩ
"M" Output Resistance	R_{OM}	—	COM	$V_{OUT} = \frac{1}{3}V_{SS} - 0.5V$	—	77	—	kΩ
"M" Output Resistance	R_{OM}	—	COM	$V_{OUT} = \frac{2}{3}V_{SS} + 0.5V$	—	77	—	kΩ

PARAMETER	SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
"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

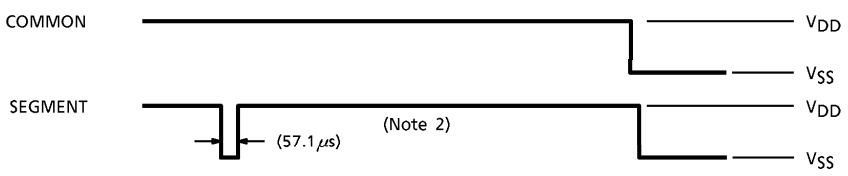
(Note 1) The key buffer is high impedance at $\overline{\text{keystrobe}}$.

WAVEFORMS FOR DISPLAY

Display



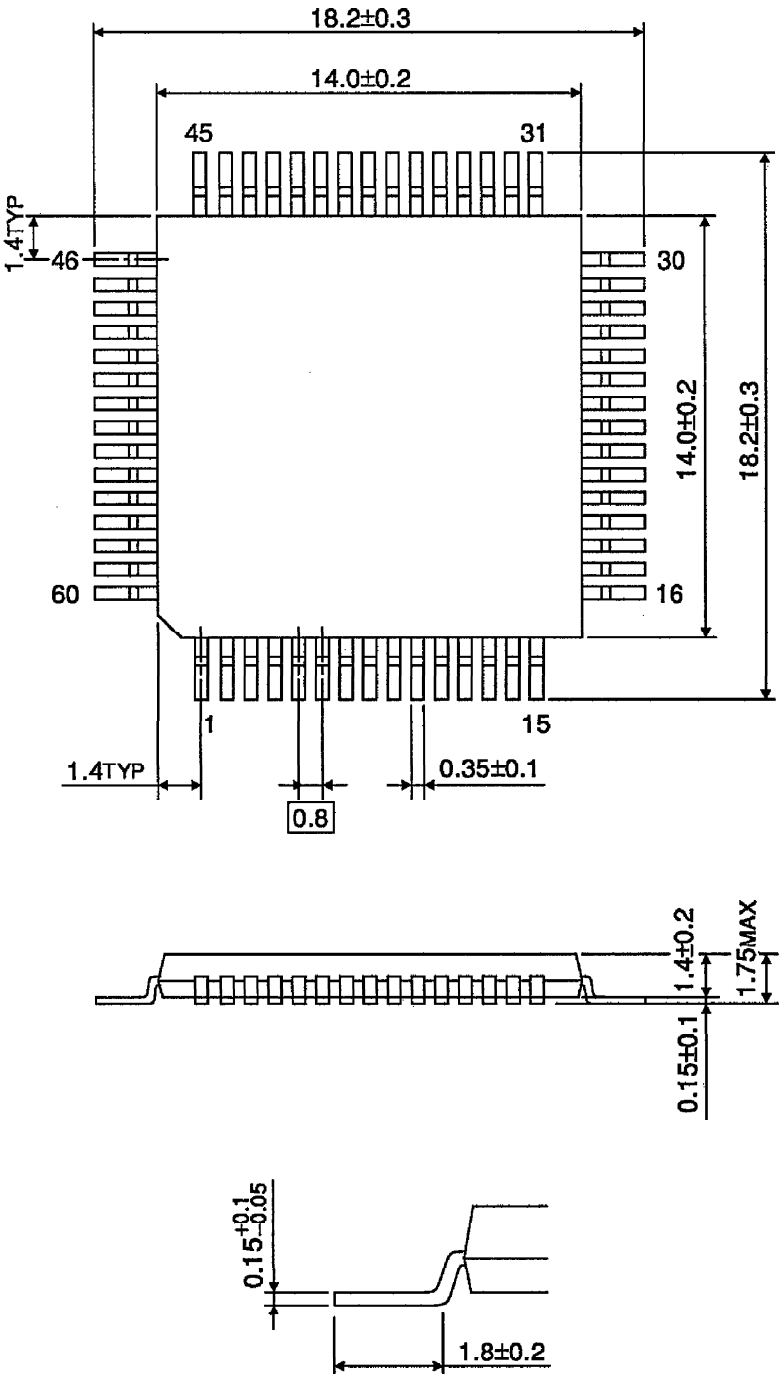
Key pulse output



(Note 1) $F\phi WAIT = 30kHz$
(Note 2) $F\phi OP = 70kHz$

OUTLINE DRAWING

LQFP60-P-1414-0.80 Unit : mm



Weight : 0.66g (Typ.)