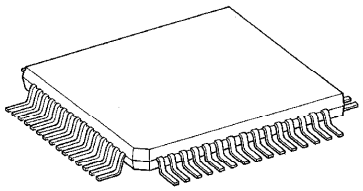
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

T6M27S

T6M27S SINGLE-CHIP CMOS LSI FOR LCD CALCULATORS

The T6M27S is single-chip microcomputer for 8-digit + 1-digit scientific caluculation.
T6M27S is the complete single chip CMOS LSI for calculator with 8 digits, 27 functions, and fractional number calculation with the following features.



LQFP60-P-1414-0.80

Weight : 0.66g (Typ.)

FEATURES

- 8-digit display plus 1-digit code at the right margin.
  - Scientific display.

    Mantissa 6 digits plus exponent 2 digits plus negative code 2 digits.
  - Fractional number display.

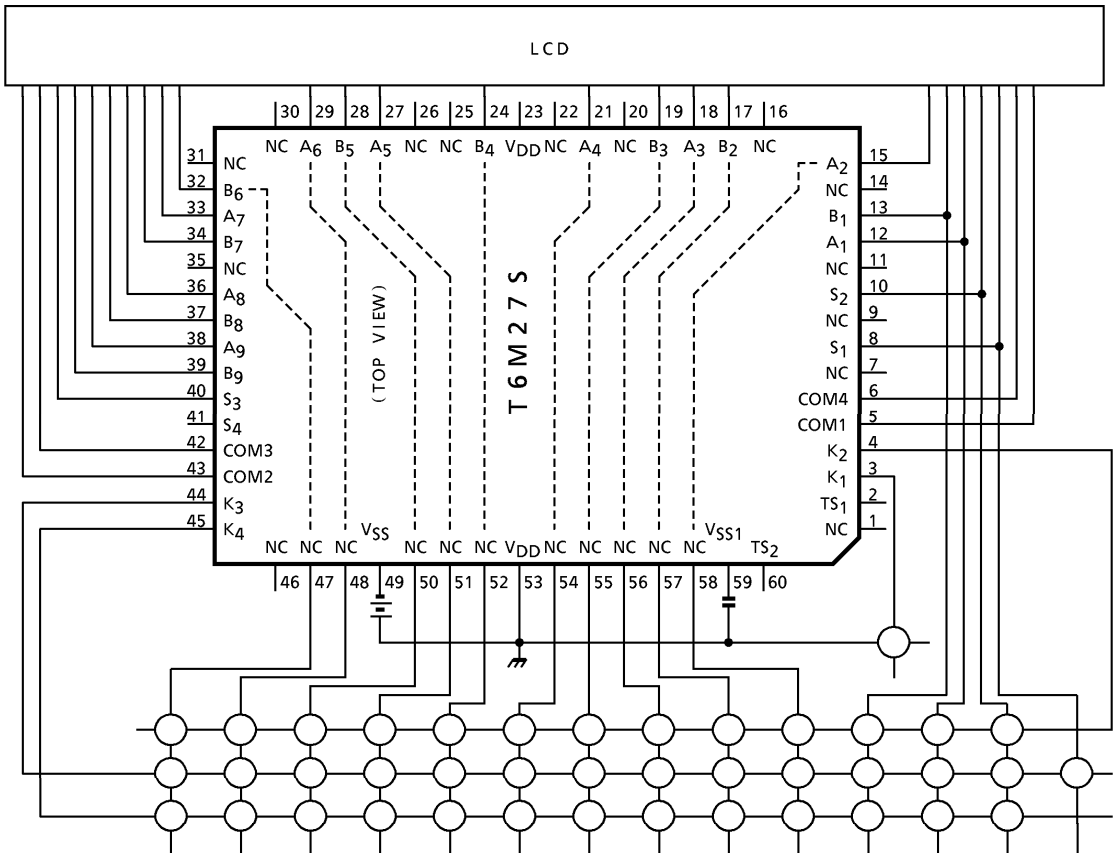
    9 digits plus negative code 1 digit.
  - Other than above

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

M	Memory	DEG	Degree
–	Minus	RAD	Radian
E	Error	GRAD	Gradian
INV	Inverse	( )	Parenthesis calculation

- The minus sign of the mantissa is floating minus.
- The arithmetic key operation in clouding Y^x has same sequence as mathematical equation. 4 pending operations are allowed and ( ) are up to continuous 15 levels.
- Fractional number calculation.
- One independent accumulating memory.
- 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.

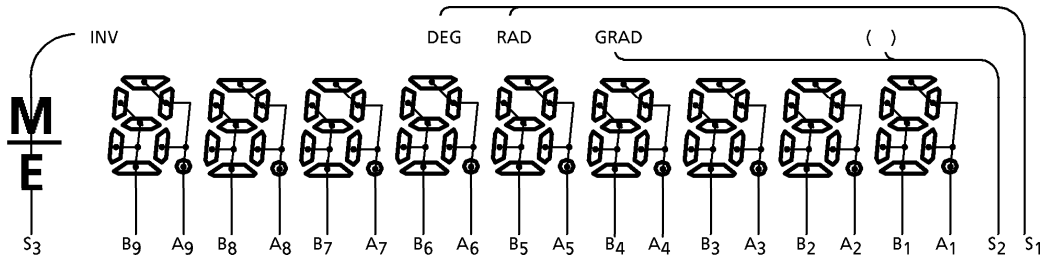
SYSTEM BLOCK DIAGRAM



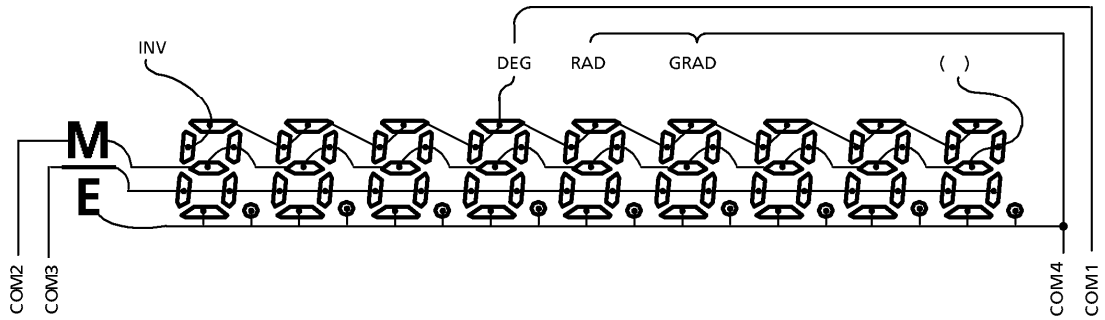
(Note) Input capacity$\leqslant$300 (pF) at V_{DD} = − 2.6 (V)
Key resistance$\leqslant$1.5 (kΩ) at V_{DD} = − 2.6 (V)

CONNECTION OF LCD

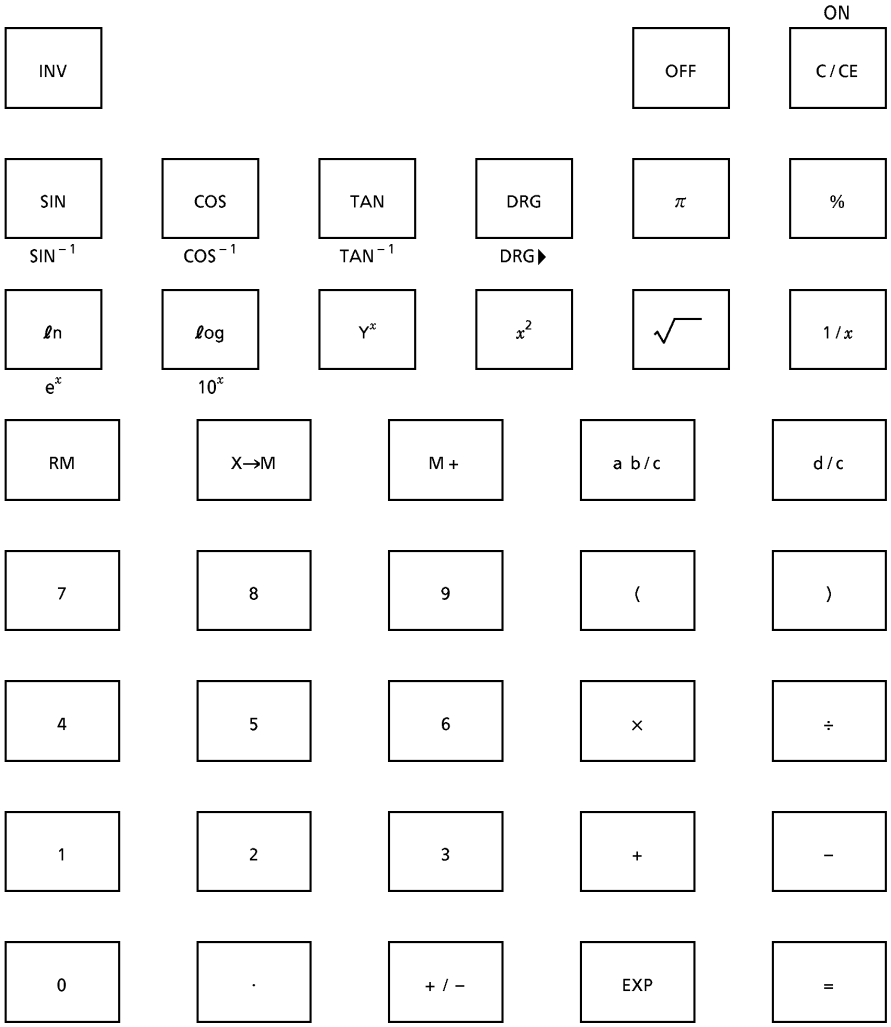
SEGMENT



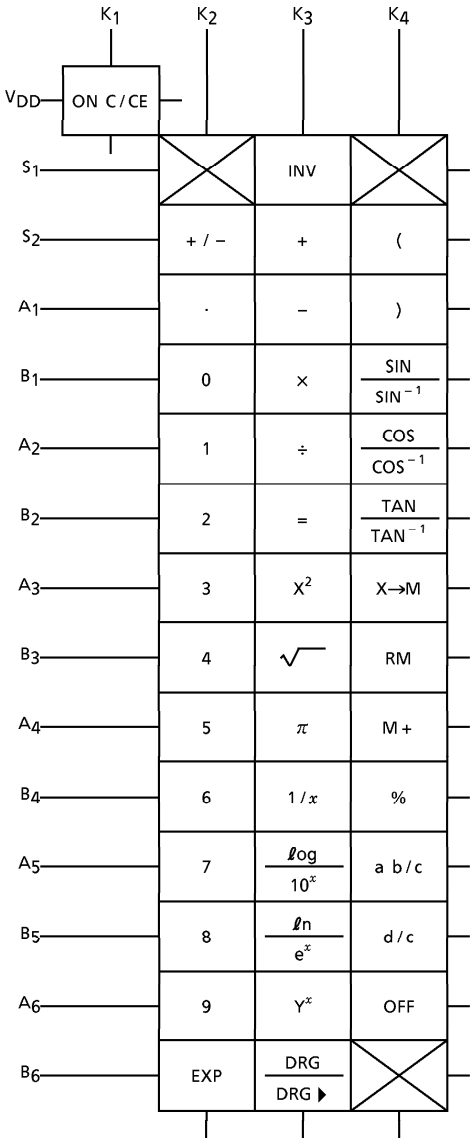
COMMON



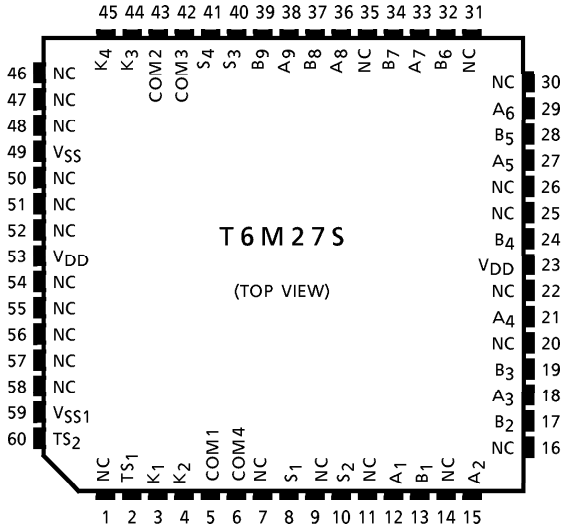
SET KEY LAYOUT (Example)



KEY CONNECTION



PIN ASSIGNMENT



OPERATION EXAMPLE

CALCULATION EXAMPLE	KEY OPERATION	DISPLAY		
		MANTISSA	SIGN	EXPONENT
	Addition, Subtraction			
• $123 + 654 = 777$	123 [+] 654 [=]	777		
• $19 + 19 + 19 + 19 = 76$	19 [+] [=] [=] [=]	76		
• $2.34 - 3.45 = -1.11$	2.34 [−] 3.45 [=]	−1.11		
	Multiplication, Division			
• $98765 \times (-4321) = -4.26763 \times 10^8$	98765 [×] 4321 [+ / −] [=]	−4.26763		08
• $(4.5 \times 10^6) \div 7.8 = 576923.08$	4.5 [EXP] 6 [÷] 7.8 [=]	576923.08		
	Parenthesis			
• $\frac{11 - 13}{15 + 17} = -0.0625$	[(] 11 [−] 13 [)] [÷] [(] 15 [+] 17 [=]	−0.0625		
• $98 \div [(7 + 4) \times (5 - 6)] = -8.9090909$	98 [÷] [(] [(] 7 [+] 4 [)] [×] [(] 5 [−] 6 [=]	−8.9090909		

CALCULATION EXAMPLE	KEY OPERATION	DISPLAY		
		MANTISSA	SIGN	EXPONENT
Constant Calculation				
• $0.12 + \underline{0.78} = 0.9$	0.12 [+] 0.78 [=]	0.9		
$0.34 + \underline{0.78} = 1.12$	0.34 [=]	1.12		
$0.56 + \underline{0.78} = 1.34$	0.56 [=]	1.34		
• $987 - \underline{100} = 887$	987 [−] 100 [=]	887		
$654 - \underline{100} = 554$	654 [=]	554		
$321 - \underline{100} = 221$	321 [=]	221		
• $1.1 \times \underline{4.4} = 4.84$	1.1 [×] 4.4 [=]	4.84		
$2.2 \times \underline{4.4} = 9.68$	2.2 [=]	9.68		
$3.3 \times \underline{4.4} = 14.52$	3.3 [=]	14.52		
• $500 \div \underline{4} = 125$	500 [÷] 4 [=]	125		
$600 \div \underline{4} = 150$	600 [=]	150		
$700 \div \underline{4} = 175$	700 [=]	175		
• $2\underline{^5} = 32$	2 [y^2] 5 [=]	32		
$3\underline{^5} = 243$	3 [=]	243		
$4\underline{^5} = 1024$	4 [=]	1024		
• $12.3 + \underline{4 \times 5.6} = 34.7$	12.3 [+] 4 [×] 5.6 [=]	34.7		
$23.4 + \underline{4 \times 5.6} = 45.8$	23.4 [=]	45.8		
$34.5 + \underline{4 \times 5.6} = 56.9$	34.5 [=]	56.9		
Memory Calculation				
(Total calculation)				
$9 \times 8 = 72$	[C·CE] [X→M] 9 [×] 8 [=] [M+]	72		
$7 \times 6 = 42$	7 [×] 6 [=] [M+]	42		
$+) \underline{5 \times 4 = 20}$	5 [×] 4 [=] [M+] [RM]	20		
134		134		
Fractional Calculation				
• $\frac{1}{2} + \frac{1}{3} + \frac{1}{4} = 1\frac{1}{12}$	1 [ab/c] 2 [+] 1 [ab/c] 3 [+] 1 [ab/c] 4 [=]	1⌴1⌟12		
	[d/c]	13⌟12		
	[ab/c]	1.0833333		
	[ab/c]	1⌴1⌟12		
• $5\frac{1}{6} - 7\frac{1}{8} = -1\frac{23}{24}$	5 [ab/c] 1 [ab/c] 6 [−] 7 [ab/c] 1 [ab/c] 8 [=]	−1⌴23⌟24		
	[d/c]	−47⌟24		
	[ab/c]	−1.9583333		

CALCULATION EXAMPLE	KEY OPERATION	DISPLAY		
		MANTISSA	MODE	EXPONENT
Functional Calculation				
(Trigonometry)				
• $\sin 30° = 0.5$ [DEG]	DRG [DEG] 30 SIN	0.5	[DEG]	
• $\cos\frac{2}{3}\pi$ [RAD] $= -0.5$	DRG [RAD] (2 ÷ 3 × π) COS	−0.5	[RAD]	
• $\tan 150^g = -1$ [GRAD]	DRG [GRAD] 150 TAN	−1	[GRAD]	
• $1 - \cos^2 60° = 0.75$ [DEG]	DRG [DEG] 1 − 60 COS x^2 =	0.75	[DEG]	
(Inverse trigonometry)				
• $\sin^{-1} -0.5 = -30°$ [DEG]	DRG [DEG] 0.5 + / − SIN^{-1}	−30	[DEG]	
• $\cos^{-1} -1$ $= 3.1415927$ [RAD]	DRG [RAD] 1 + / − COS^{-1}	3.1415927	[RAD]	
• $\tan^{-1} 1 = 50^g$ [GRAD]	DRG [GRAD] 1 TAN^{-1}	50	[GRAD]	
(Exponential)				
• $e^1 = 2.7182818$	1 e^x	2.7182818		
• $e^{1.5} \times 10^{2.5} = 1417.2345$	1.5 e^x × 2.5 10^x =	1417.2345		
(Natural logarithm)				
• $\ln 30 = 3.4011974$	30 LN	3.4011974		
(Common logarithm)				
• $\log 100 = 2$	100 LOG	2		
• $\log\sqrt{3} + \log\sqrt{5}$ $= 0.5880456$	3 √ LOG + 5 √ LOG =	0.5880456		
(Square root)				
• $\sqrt{2} = 1.4142136$	2 √	1.4142136		
• $\sqrt{5} \times \sqrt{7} = 5.9160798$	5 √ × 7 √ =	5.9160798		
(Square)				
• $3^2 + 4^2 = 25$	3 x^2 + 4 x^2 =	25		
• $(2.34 \times 10^5)^2$ $= 5.4756 \times 10^{10}$	2.34 EXP 5 x^2	5.4756		10
(Power)				
• $2^{10} = 1024$	2 y^2 10 =	1024		
• $3^{-19} = 8.60391 \times 10^{-10}$	3 y^2 19 + / − =	8.60391		−10
• $\sqrt[3]{8}\,(= 8^{1/3}) = 2$	8 y^2 3 1 / x =	2		
• $\sqrt[4]{81} = 3$	81 √ √	3		
(Reciprocal)				
• $\frac{1}{3} + \frac{1}{5} = 0.5333333$	3 1 / x + 5 1 / x =	0.5333333		
• $\frac{1}{1.23 \times 10^{17}}$ $= 8.13008 \times 10^{-18}$	1.23 EXP 17 1 / x	8.13008		−18
Pi Calculation				
• $5 \times \pi = 15.707963$	5 × π =	15.707963		

CALCULATION EXAMPLE	KEY OPERATION	DISPLAY		
		MANTISSA	SIGN	EXPONENT
Percent Calculation				
• What is 15% of 400? $400 \times \frac{15}{100} = 60$	400 × 15 % =	60		
• 3 equals what percent of 24? $\frac{3}{24} \times 100 = 12.5$	3 ÷ 24 % =	12.5		
• A 25% add on to 800 $800 + 800 \times \frac{25}{100} = 1000$	800 + 25 % =	1000		
• A 18% deduction on 700 $700 - 700 \times \frac{18}{100} = 574$	700 − 18 % =	574		

MAXIMUM RATINGS

CHARACTERISTICS	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)

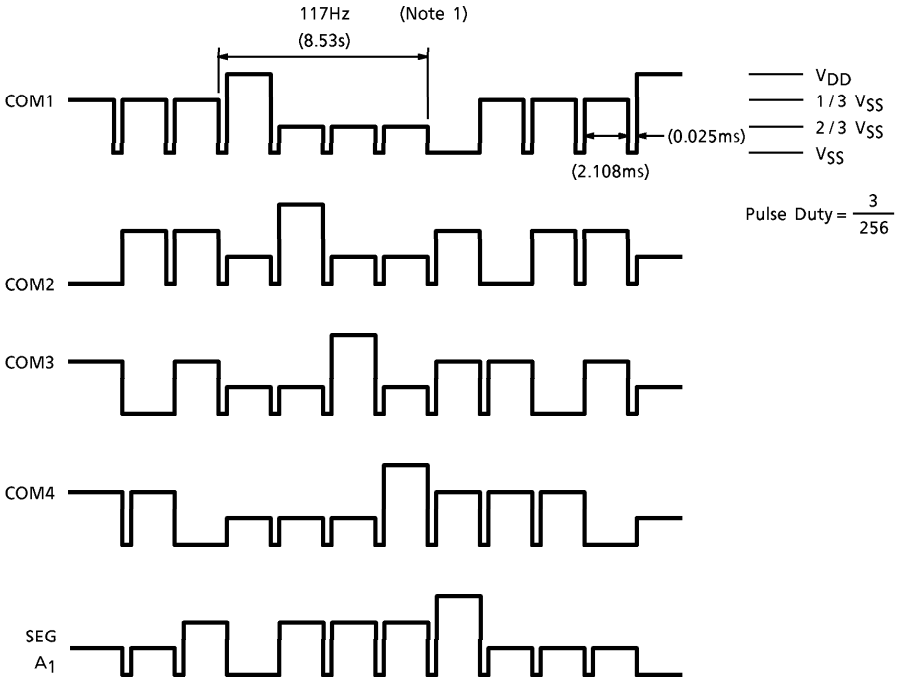
CHARACTERISTICS	SYMBOL	TEST CIR-CUIT	PIN NAME	TEST CONDITION	MIN	TYP.	MAX	UNIT
Operating Voltage	—	—	—	—	−2.5	−3.0	−3.4	V
Supply Current	I_{DD} WAIT	—	—	V_{SS} = −3.0V, wait	—	26	—	μA
Supply Current	I_{DD} OP	—	—	V_{SS} = −3.0V, operate	—	52	78	μA
Supply Current	I_{DD} OFF	—	—	V_{SS} = −3.0V, off	—	1	3	μA
Oscillating Frequency	fϕ WAIT	—	—	V_{SS} = −3.0V, wait	18	30	42	kHz
Oscillating Frequency	fϕ OP	—	—	V_{SS} = −3.0V, operate	42	70	98	kHz
Frame Frequency	fF	—	—	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

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

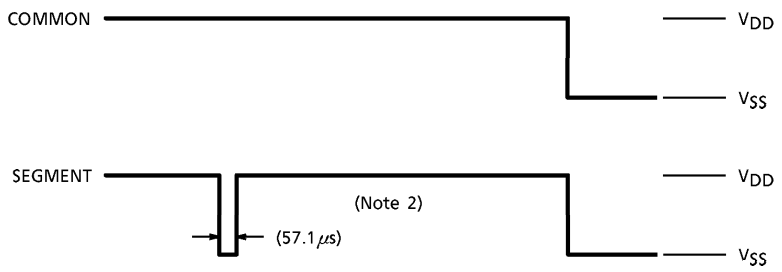
(Note 1) The key buffer is high impedance at $\overline{\text{keystroke}}$.

WAVEFORMS FOR DISPLAY

Display



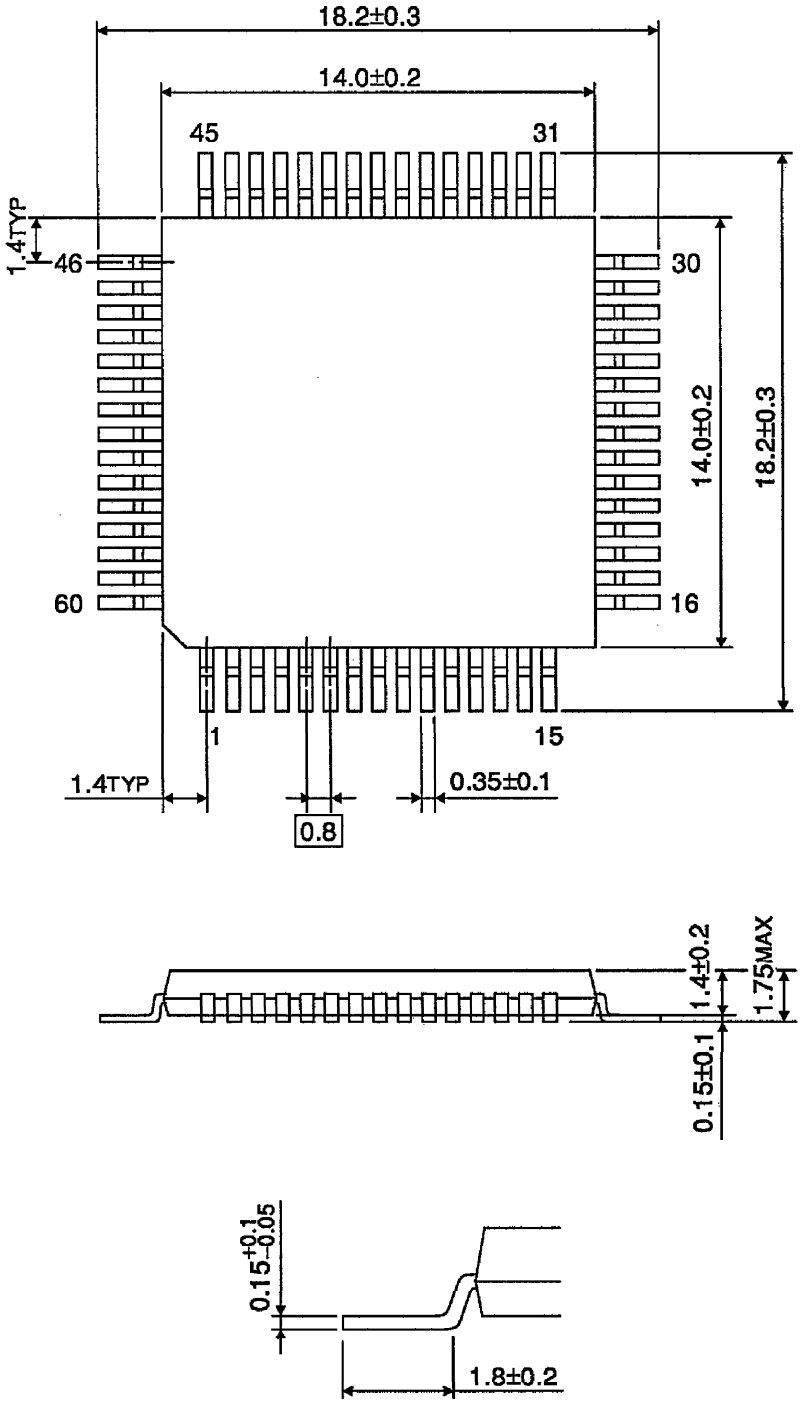
Key pulse output



(Note 1) Fϕ WAIT = 30kHz
(Note 2) Fϕ OP = 70kHz

PACKAGE DIMENSIONS

LQFP60-P-1414-0.80 Unit : mm



Weight : 0.66g (Typ.)