

INTRODUCTION

The one chip calculator circuit DL5521 is either 12-digits capacity 2-memory or 10-digits. Capacity 2-memory electronic calculator on one chip CMOS/LSI.

DL5521 can drive the liquid crystal display (LCD) with single power supply. Single power supply operation, wide operating voltage range and low power consumption make it suitable for 1.5V solar battery operated calculator. Besides DL5521 can selectable with a pin-programmable to function of Power timer and Memory hold.

The following features are included;

Operational Features:

- Display: 12-digits or 10-digits (selectable with a pin-programmable) of data, 2-digits of sign, error symbol, memory load symbol.
- Algebraic mode.
- Standard 4 functions (+, -, x, ÷)
- Memory and grand total (GT) memory calculation
- Accumulating GT memory register with count up (down) item counter.
- Automatic percentage operation with add-on, discount.
- Automatic delta percentage, mark-up and markdown operations.
- Square root.
- Constant calculation.
- Chain calculation.
- Change sign.
- Floating point or momentary mode (selectable with a switch).
- Fixed point ("0", "1", "2", "3", "4" or "6" places) or floating point (selectable with a switch).
- Adding point mode (selectable with a switch).
- Rounding switches (rounding up, down and off).
- Leading zero suppression.
- Trailing zero suppression.
- Punctuation on display, commas for thousands.
- Memory and GT memory contents indicator, turned on with non-zero in the memory and GT memory.
- Registration overflow, indicating that too many digits are entered (the most significant digit are protected).
- Result overflow, indicating during calculation (most function key are locked as it happened).
- Memory overflow indicating to flashing of memory load mark.
- Key roll over function.
- Floating minus.

Electrical Features;

- Complementary output buffer for direct driving of liquid crystal display (F.E.M LCD).
- Oscillator/clock generator internal to chip.
- Keyboard encoding internal to chip.
- Keyboard debouncing internal to chip.
- Automatic power on clear.
- Wide supply voltage range (1.2 ~ 1.8V).
- Very low power consumption (3.3 . μ W typ.).

ELECTRICAL CHARACTERISTICS**MAXIMUM RATINGS**

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V_G	-0.3~+1.8	V
Input Voltage	V_{IN}	-0.3~ V_G +0.3	V
Operating Temperature	T_{opr}	0~40	°C
Storage Temperature	T_{stg}	-55~125	°C

Selection Mode Switch Functions

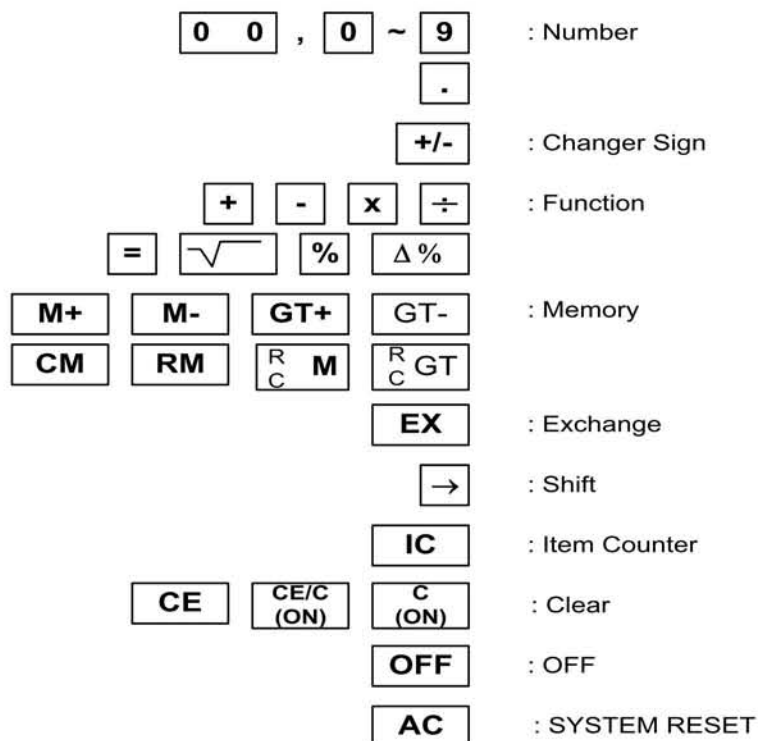
- MK: Memory Kill at Power OFF mode
- MH: Memory Hold at Power OFF mode
- GTK: GT memory Kill at Power OFF mode
- GTH: GT memory Hold at Power OFF mode
- A: Auto Power OFF and manual Power OFF
- \bar{A} : Manual Power OFF only
- 10/12: Fixed 10-digits or 12 - digits
- F: Floating decimal point mode
- 0/1/2/3/4/6: Fixed -point mode with rounding of the result to a fixed number of decimal digits
- \downarrow "CUT": Rounding to a fixed number of decimal digits with simple omission of any subsequent digits.
- \uparrow "UP": Rounding to a fixed number of decimal digits with adding "1" to the last significant bit if there are other digits to follow.
- $5\downarrow 4$ "5/4": Either "CUT" rounding if the next digit is 0...4 or "UP" rounding if the next digit is 5...9.
- ADD: Additional fixed - point mode ("+" and "-" operations with integer operands are executed in the same way as with numbers multiplied by 1/100, fractional operands are not distorted)
- $\Sigma/\bar{\Sigma}$: When "=" operation is executed "GT+" operation follows or no follows

Operation Example

Calculating Speed (standard oscillating frequency $f\phi = 48$ kHz)

Numeral	11.8 ~17.7 ms
Function	1 $\boxed{+}$	25.6 ms
	1 $\boxed{+}$ 2 $\boxed{+}$	95.2 ms
Addition and Subtract	1 2 3 $\boxed{+}$ 1 $\boxed{=}$	89.1 ms
	9999999999 $\boxed{-}$ 0.000000001 $\boxed{=}$	111.8 ms
Multiply	1 2 3 $\boxed{+}$ 2 $\boxed{+}$	109.6 ms
	1 $\boxed{\times}$ 9999999999 $\boxed{=}$	207.7 ms
Device	1 2 3 $\boxed{\div}$ 3 $\boxed{=}$	147.9 ms
	9999999999 $\boxed{\div}$ 1 $\boxed{=}$	249.0 ms
Memory calculation	2 $\boxed{M+}$	143.3 ms
	9999999999 $\boxed{\div}$ 1 $\boxed{M+}$	296.2 ms
Square root	9999999999 $\boxed{\sqrt{\quad}}$	167.7 ms
	2 $\boxed{\sqrt{\quad}}$	125.0 ms

Touch Key Constitution and Operation



I. Fixed point calculations

①	Key	Display	Fixed point place	②	Key	Display	Fixed point place
	C	0.	DP = 3 (5/4)		C	0.	DP = 0 (\uparrow)
	2	2.			1	1.	
	÷	2.			.	1.	
	3	3.			2	1.2	
	=	0.667			3	1.23	
	2	2.			+	1.23	
	.	2.			1	1.	
	3	2.3			.	1.	
	+	2.3			1	1.1	
	4	4			=	3.	
	M+	6.300			9	9.	
	1	1.			√	3.	
	.	1.			x	3.	
	2	1.2			1	1.	
	M+	1.200			.	1.	
	RM	7.5			1	1.1	DP = F
					=	3.3	

II. Adding point mode calculations

Key	Display	Key	Display	Key	Display
C	0.	M+	0.02M	=	33.27M-
1	1.	3	3.M	2	2.M
23	123	.	3.M	+	0.02M
+	1.23	123	3.123	9	9.M
3	3.	M+	3.12M	.	9.M
=	1.26	RM	3.14M	$\sqrt{\quad}$	3.M
3	3.	C	0.M	=	3.02M
2	32.	1	1.M		
x	32.	23	123M		
3	3.	-	1.23M		
.	3.	3	3.M		
000	3.000	4	34.M		
=	96.000	.	34.M		
2	2.	5	34.5M		

III. Constant calculations

① Multiplication

Key	Display	Constant
k	k	
x	k	
a	a	
=	k x a	k x
b	b	k x
=	k x b	k x

② Division

Key	Display	Constant
a	a	
\div	a	
k	k	
=	a / k	\div k
b	b	\div k
=	b / k	\div k

③ Addition

Key	Display	Constant
a	a	
+	a	
k	k	
=	a + k	+k
b	b	+k
=	b + k	+k

④ Subtraction

Key	Display	Constant
a	a	
-	a	
k	k	
=	a - k	-k
b	b	-k
=	b - k	-k

5 Percentage

Key	Display	Constant
k	k	
x	k	
a	a	
%	$k \times a/100$	$k \times$
b	b	$k \times$
%	$k \times b/100$	$k \times$

6 Percentage

Key	Display	Constant
a	a	
÷	a	
k	k	
%	$100 \times a/k$	$\div k$
b	b	$\div k$
%	$100 \times b/k$	$\div k$

7 Add-on

Key	Display	Constant
k	k	
+	k	
a	a	
%	$k \times (1+a/100)$	$k +$
b	b	$k +$
%	$k \times (1+b/100)$	$k +$

8 Discount

Key	Display	Constant
a	a	
-	a	
k	k	
%	$k \times (1-a/100)$	$k -$
b	b	$k -$
%	$k \times (1-b/100)$	$k -$

IV. Δ % calculations

1 Key Display

a	a
+	a
b	b
Δ %	$100 \times (a+b)/b$

2 Key Display

a	a
-	a
b	b
Δ %	$100 \times (a-b)/b$

V. Mark-up, mark-down calculations

1 Mark-up

Key	Display
a	a
÷	a
b	b
Δ %	$a/(1-b/100)$
Δ %	$ a/(1-b/100) $

2 Mark-down

Key	Display
a	a
÷	a
b	b
+/-	- b
Δ %	$a/(1+b/100)$
Δ %	$ a/(1+b/100)-a $

VI. Add-on, discount calculations

Add-on

①	Key	Display
	a	a
	x	a
	b	b
	%	$a \times b/100$
	+	$a \times b/100$
	=	$a \times (1+b/100)$

③	Key	Display
	a	a
	+	a
	b	b
	%	$a \times (1+b/100)$

⑤	Key	Display
	a	a
	x	a
	b	b
	Δ %	$a \times (1+b/100)$

Discount

②	Key	Display
	a	a
	x	a
	b	b
	%	$a \times b/100$
	-	$a \times b/100$
	=	$a \times (1-b/100)$

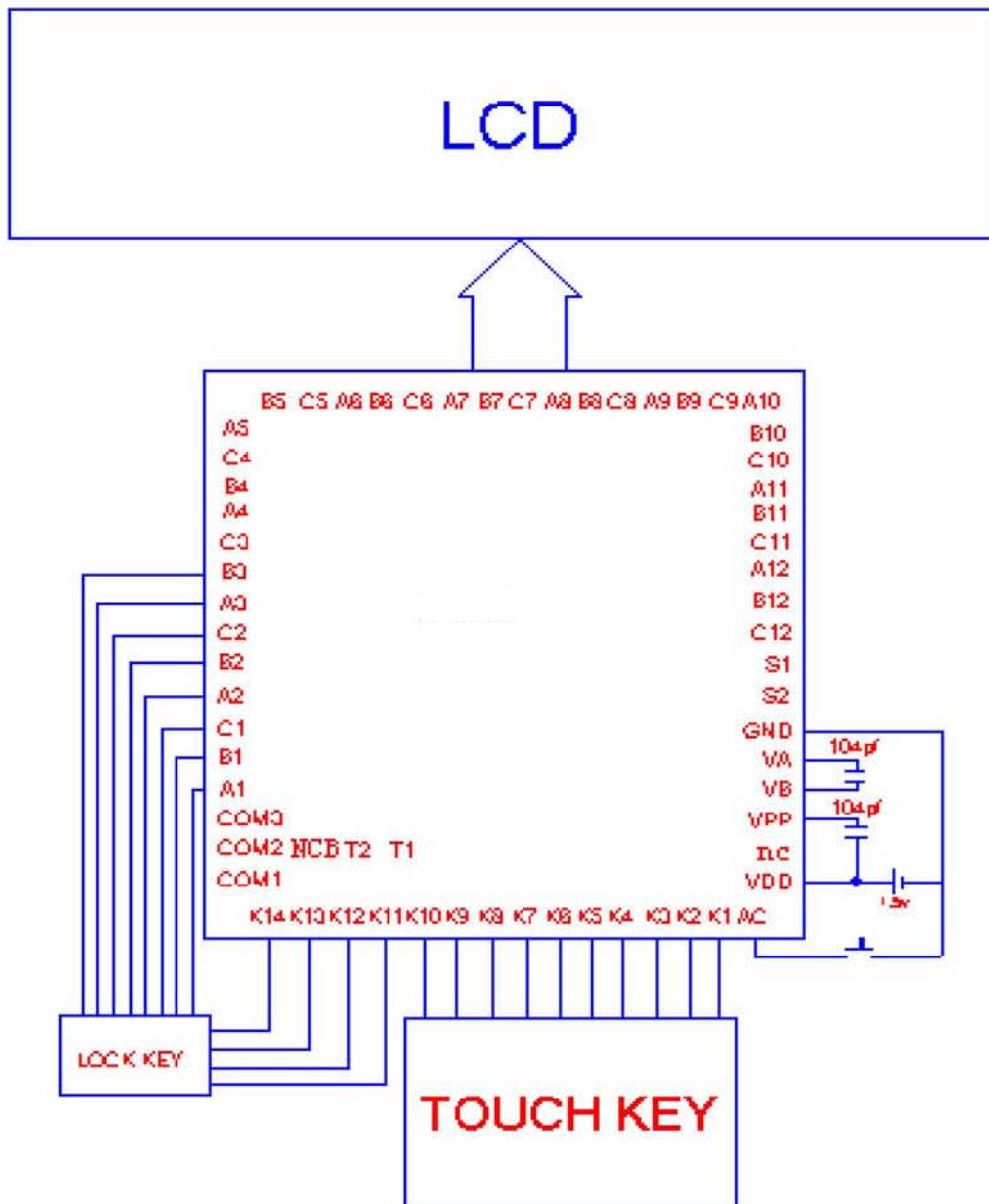
④	Key	Display
	a	a
	-	a
	b	b
	%	$b \times (1-b/100)$

⑥	Key	Display
	a	a
	x	a
	b	b
	+/-	-b
	Δ %	$a \times (1-b/100)$

VII. Average operation use of the item counter

Key	Display	Item Counter	Key	Display	Item Counter
a	a	0	-	a+b+c+d	2
+	a	1	d	d	2
b	b	1	+	a+b+c	3
+	a+b	2	e	e	3
c	c	2	=	a+b+c+e	4
+	a+b+c	3	÷	a+b+c+e	4
d	d	3	IC	4	4
+	a+b+c+d	4	=	$(a+b+c+e)/4$	5

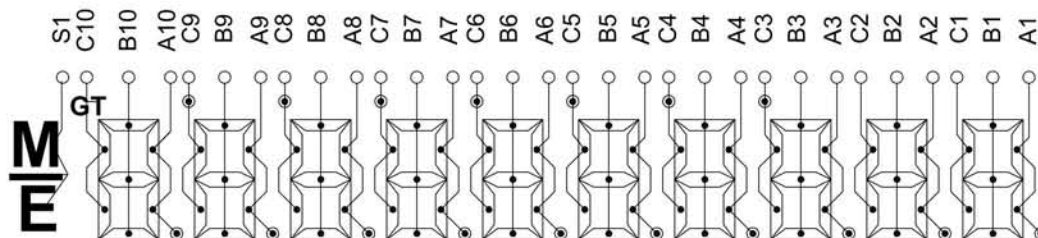
APPLICATION CIRCUIT



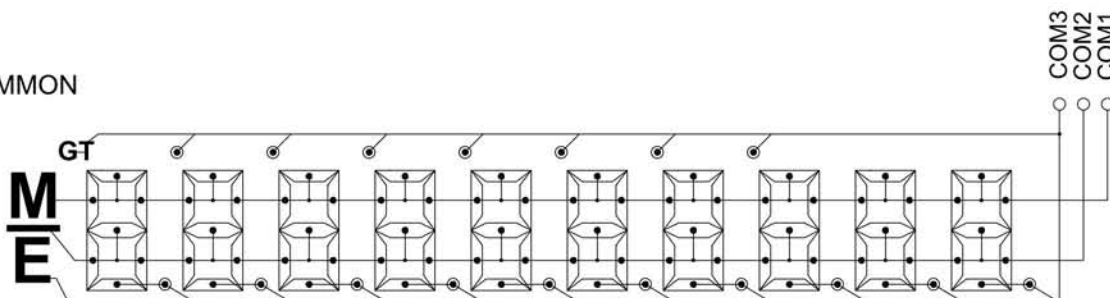
CONNECTION OF LCD

Select of 10 – digits

SEGMENT

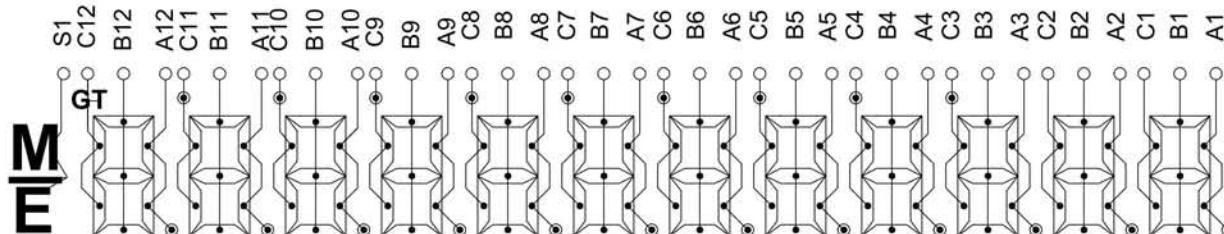


COMMON

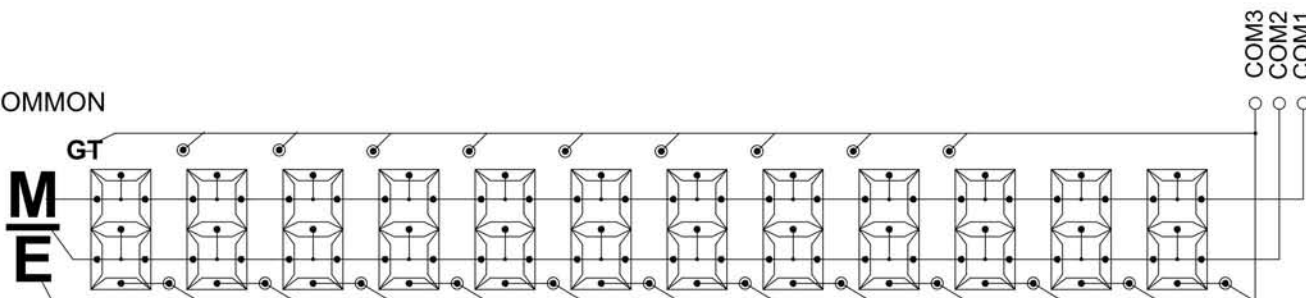


Select of 12 – digits

SEGMENT

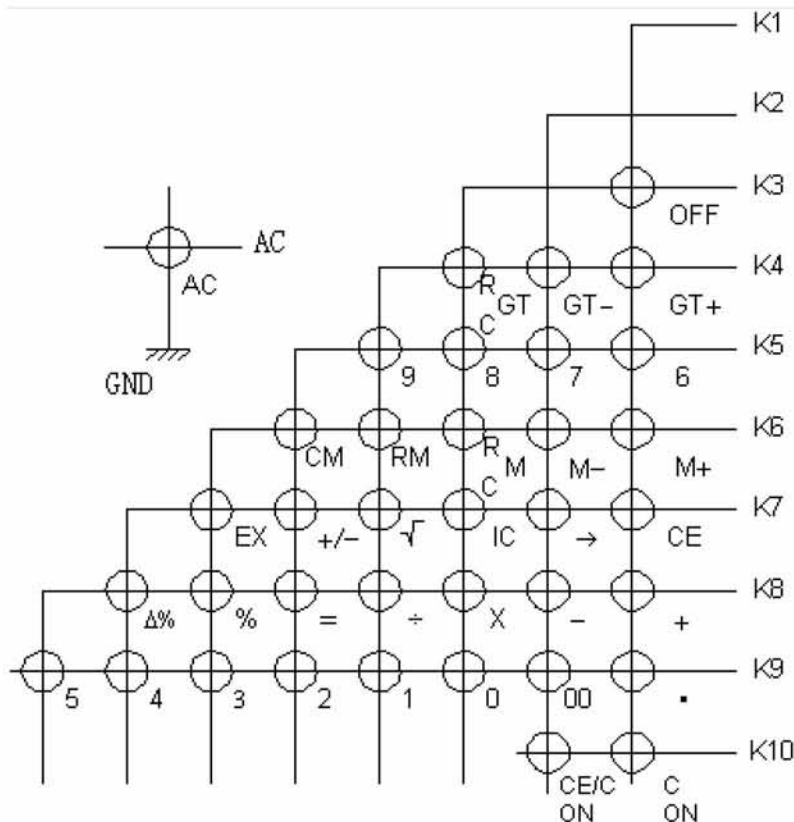


COMMON

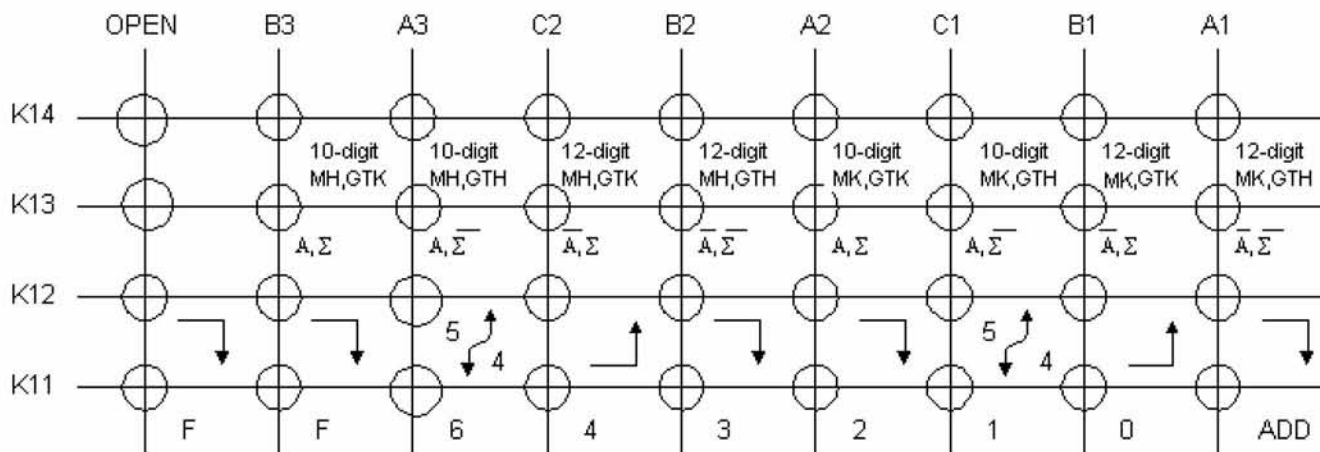


KEY CONNECTION

• Touch Key

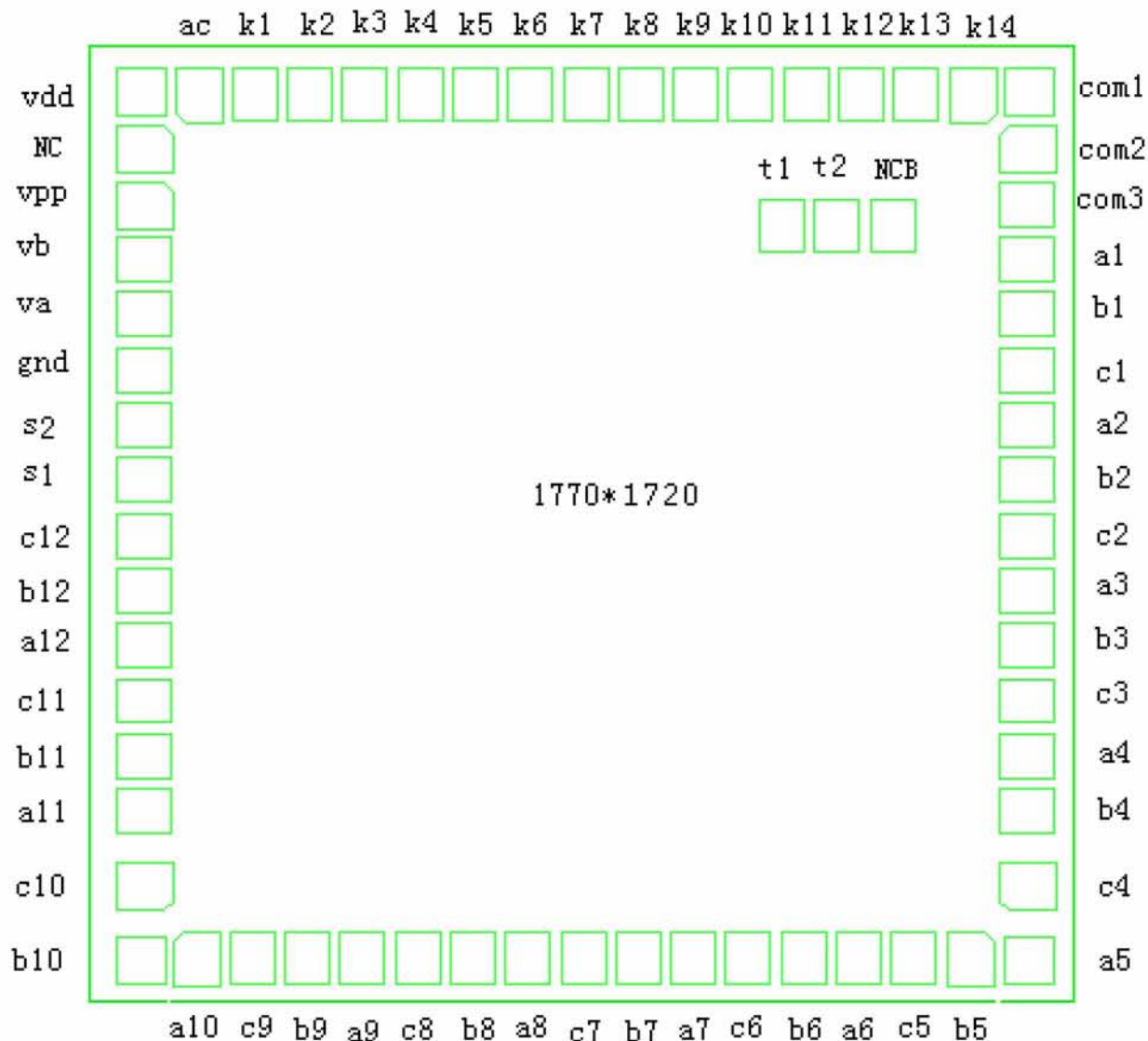


• Lock Key



- K14... Selectable with Calculated Digits and Memory Hold Status.
MH (Memory Hold), MK (Memory Kill), GTH (GT memory Hold) and GTK (GT memory Kill) at Auto Power OFF or OFF Key.
- K13... Selectable with Auto Power OFF mode and Total Switch.
- K12... Rounding switches.
- K11... Selectable with Fixed point or Floating mode.

PAD DIAGRAM



Pad location

Name	X(μm)	Y(μm)	Name	X(μm)	Y(μm)
AC	85.00	185.00	A6	1585.00	1385.00
K1	85.00	285.00	B6	1585.00	1285.00
K2	85.00	385.00	C6	1585.00	1185.00
K3	85.00	485.00	A7	1585.00	1085.00
K4	85.00	585.00	B7	1585.00	985.00
K5	85.00	685.00	C7	1585.00	885.00
K6	85.00	785.00	A8	1585.00	785.00
K7	85.00	885.00	B8	1585.00	685.00
K8	85.00	985.00	C8	1585.00	585.00
K9	85.00	1085.00	A9	1585.00	485.00
K10	85.00	1185.00	B9	1585.00	385.00
K11	85.00	1285.00	C9	1585.00	285.00
K12	85.00	1385.00	A10	1585.00	185.00
K13	85.00	1485.00	B10	1588.75	81.25
K14	85.00	1585.00	C10	1484.95	85.00
COM1	81.25	1688.75	A11	1385.00	85.00
COM2	185.00	1685.00	B11	1285.00	85.00
COM3	285.00	1685.00	C11	1185.00	85.00
A1	385.00	1685.00	A12	1085.00	85.00
B1	485.00	1685.00	B12	985.00	85.00
C1	585.00	1685.00	C12	885.00	85.00
A2	685.00	1685.00	S1	785.00	85.00
B2	785.00	1685.00	S2	685.00	85.00
C2	885.00	1685.00	GND	585.00	85.00
A3	985.00	1685.00	VA	485.00	85.00
B3	1085.00	1685.00	VB	385.00	85.00
C3	1185.00	1685.00	VPP	285.00	85.00
A4	1285.00	1685.00	NC	185.00	85.00
B4	1385.00	1685.00	VDD	81.25	81.25
C4	1485.00	1685.00	T1	324.10	1241.10
A5	1588.75	1688.75	T2	324.10	1341.10
B5	1585.00	1585.00	NCB	324.10	1441.10
C5	1585.00	1485.00			

Chip Size: 1770×1720 μm

Note: For PCB layout, IC substrate must be connected to GND