## 1.5V 10/12 DIGIT CALCULATOR CIRCUIT

DESCRIPTION

The SC3414 is a single-chip LSI CMOS calculator with 12-digits 2-memory or 10-digits 2-memory. SC3414 can drive the liquid crystal display (LCD) with single power supply. Single power supply operation, wide operating voltage and lower power consumption make it suitable for 1.5V solar battery operated calculator. Beside SC3414 can be selected as Auto Power OFF or Manual Power OFF with Lock Key. It also can be selected as Memory Hold or Clear at Power OFF.

FEATURES

* Display: 12-digit or 10-digit (selectable with a pin programmable) of data, 1-digits of sign, error, memory load symbol.
* Algebraic mode
* Standard 4 function (addition, subtraction, multiplication, division).
* Memory and Grand total 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 (selectable with a switch).
* Fixed point ("0", "1", "2", "3", "4", or "6" selectable with a switch).
* Adding point mode (selectable with a switch).
* Rounding switch (rounding up, down and off).
* Trailing zero suppression.
* Function on display, commas for thousands.
* Memory and GT memory contents indicator, turned with nonzero in the memory and GT memory.

SC3414 chip topography

* Complementary output buffer for direct driving of liquid crystal display
* Memory overflows indicating.
* Result overflow, indicating during calculation (most function key are locked as it happened).
* Keyboard encoding internal to chip.
* Automatic power on clear.
* Wide supply voltage range (1.1 to 1.8V)
* Very low power consumption.
* Floating minus.
* Key roll over function (2 keys).
* Oscillator/clock generator internal to chip.
* Registration overflow, indicating too many digits are entered (the most significant digit is protected).
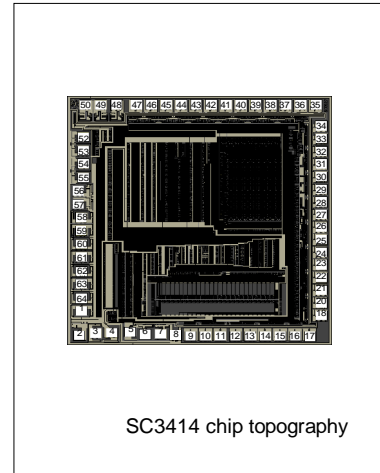
ABSOLUTE MAXIMUM RATING

Characteristics	Symbol	Value	Unit
Supply Voltage	$V_{DD} - V_{SS}$	-0.3 ~ +2.0	V
Input Voltage	V_{IN}	-0.3 ~ V_{DD} + 0.3	V
Storage temperature	T_{STG}	-55 ~ +125	°C
Operating Temperature	T_{OPT}	0 ~ + 50	°C

ELECTRICAL CHARACTERISTICS (V$_{DD}$ =1.5V±0.2V, GND=0V, T$_A$ =25°C, V$_{EE}$ =3.0±0.4V)

Characteristics	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Voltage	V$_{DD}$		1.1	1.5	1.8	V
K3~K10, RESET Input High Voltage	V$_{IH(1)}$		V$_{DD}$-0.4	--	V$_{DD}$	V
K11~K14 Input Low Voltage	V$_{IH(2)}$		V$_{EE}$-0.4-	--	V$_{EE}$	V
K3~K10, RESET Input Low Voltage	V$_{IL}$		0	--	0.4	V
SEGMENT, COM1~3 Output High Voltage	V$_{OH(1)}$		V$_{EE}$-0.2	--	V$_{EE}$	V
SEGMENT COM1~3 Output Low Voltage	V$_{OL(1)}$		0	--	0.20	V
COM1~3 Output Middle Voltage	V$_{OM}$		V$_{DD}$-0.2	--	V$_{DD}$+0.2	V
K1~K10 Output High Voltage	V$_{OH(2)}$		V$_{DD}$-0.2	--	V$_{DD}$	V
K1~K14 Output Low Voltage	V$_{OL(2)}$		0	--	0.2	V
SEGMENT, COM1~3 Output High Resistance	R$_{OH}$	V$_{OUT}$=V$_{EE}$-0.5V	--	--	70	k
SEGMENT, COM1~3 Output Low Resistance	R$_{OL}$	V$_{OUT}$=0.5V	--	--	70	k
K1~K10 Pull Down Resistance	R$_{KEYL(1)}$	V$_{OUT}$ =V$_{DD}$	240	--	650	k
K1~K10 Pull Up Resistance	R$_{KEYH(2)}$	V$_{OUT}$=0.5V	--	--	10	k
RESET Pull Up Resistance	R$_{KEYH(2)}$	V$_{OUT}$=0.5V	50	--	370	k
Oscillating (WAIT)	f$_{0\ WAIT}$	V$_{DD}$ =1.5V	10.8	18	25.2	kHZ
Frequency (OPERATE)	f$_{0\ OP}$	V$_{DD}$ =1.5V	57.6	96.0	134.4	kHZ
SEGMENT, COM1~3 Frame Frequency	f$_F$	V$_{DD}$ =1.5V	56.3	93.8	131	HZ
Supply Current	I$_{DDWAIT}$	(WAIT)	--	2.2	3.4	μA
	I$_{DDOP}$	(OPERATE)	--	7.0	11.0	μA
	I$_{DDOFF}$	(OFF)	--	--	1.0	μA
Power off Timer Times	T	V$_{DD}$ =1.5V	429	600	1001	SEC

PAD ASSIGNMENT
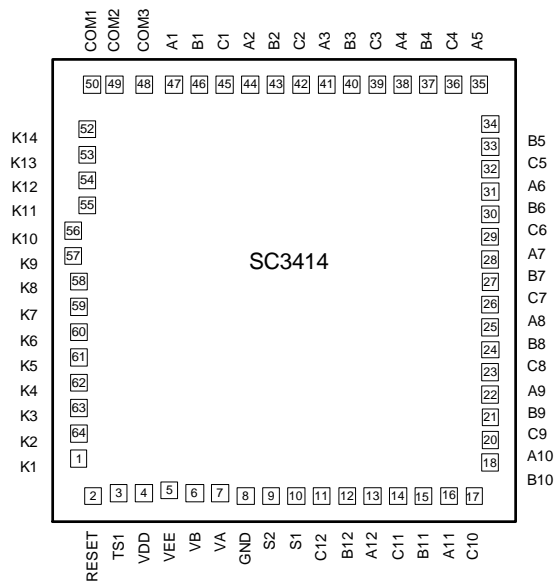
Note: The IC substrate should be connected to GND in the PCB layout artwork.

PIN DESCRIPTION

Pin No.	Symbol	Description
1	K1	Key output strobe signal to key
2	RESET	System reset
3	TS1	Test pin
4	V_{DD}	Power supply
5	V_{EE}	Connected to capacitor
6	VB	Connected as voltage doubler
7	VA	Connected as voltage doubler
8	GND	Ground
9	S2	Output Signal to LCD
10	S1	Output Signal to LCD
11	C12	Output Signal to LCD
12	B12	Output Signal to LCD
13	A12	Output Signal to LCD
14	C11	Output Signal to LCD
15	B11	Output Signal to LCD
16	A11	Output Signal to LCD
17	C10	Output Signal to LCD
18	B10	Output Signal to LCD
20	A10	Output Signal to LCD
21	C9	Output Signal to LCD
22	B9	Output Signal to LCD
23	A9	Output Signal to LCD
24	C8	Output Signal to LCD
25	B8	Output Signal to LCD
26	A8	Output Signal to LCD
27	C7	Output Signal to LCD
28	B7	Output Signal to LCD
29	A7	Output Signal to LCD
30	C6	Output Signal to LCD
31	B6	Output Signal to LCD
32	A6	Output Signal to LCD
33	C5	Output Signal to LCD
34	B5	Output Signal to LCD
35	A5	Output Signal to LCD
36	C4	Output Signal to LCD
37	B4	Output Signal to LCD
38	A4	Output Signal to LCD and Output strobe to lock key
39	C3	Output Signal to LCD and Output strobe to lock key
40	B3	Output Signal to LCD and Output strobe to lock key

(To be continued)

(Continued)

Pin No.	Symbol	Description
41	A3	Output Signal to LCD and Output strobe to lock key
42	C2	Output Signal to LCD and Output strobe to lock key
43	B2	Output Signal to LCD and Output strobe to lock key
44	A2	Output Signal to LCD and Output strobe to lock key
45	C1	Output Signal to LCD and Output strobe to lock key
46	B1	Output Signal to LCD and Output strobe to lock key
47	A1	Output Signal to LCD and Output strobe to lock key
48	COM3	Common 3 to LCD
49	COM2	Common 2 to LCD
50	COM1	Common 1 to LCD
52	K14	Key input signal
53	K13	Key input signal
54	K12	Key input signal
55	K11	Key input signal
56	K10	Key input signal
57	K9	Key input signal
58	K8	Key output strobe signal and key input signal
59	K7	Key output strobe signal and key input signal
60	K6	Key output strobe signal and key input signal
61	K5	Key output strobe signal and key input signal
62	K4	Key output strobe signal and key input signal
63	K3	Key output strobe signal and key input signal
64	K2	Key output strobe signal to key

FUNCTIONAL DESCRIPTION

A). Operation Characteristics

a).Constant Operation

The SC3414 has implied constant mode on +, -, X,÷ & % operations. The constant is performed automatically

by the "=" key, "%" key, or "%" key without a constant for addition, subtraction and division while the first operand is the constant for multiplication.

b).Number Entry

Numbericals can be entered up to 12-digit.

c).Memory Protection

In any error detection, the memory contents present before the error detection are protected.
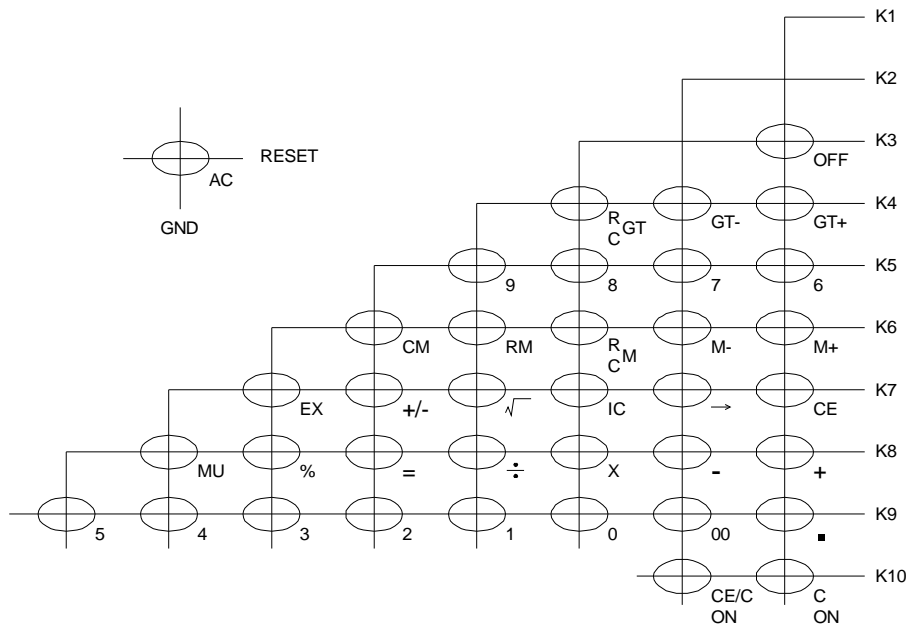
d).Memory Indication

If the memory contents are a number other than zero, "M" is indicated in the sign-digit position.
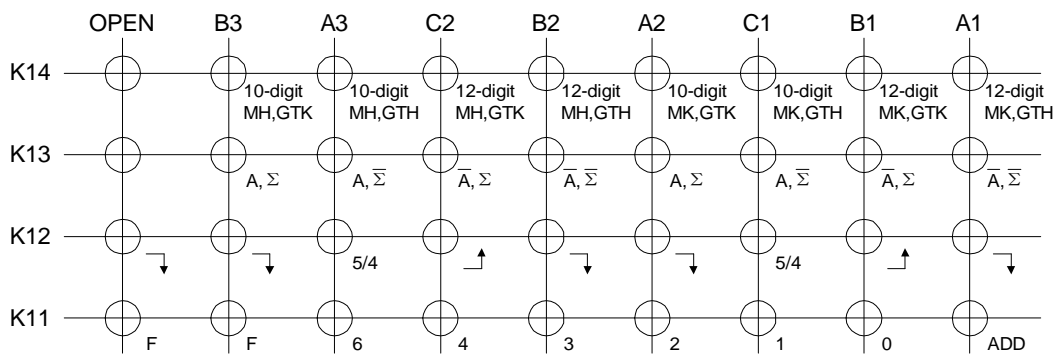
e).Auto Power Off

   If no key is depressed for a specific period of time, the power supply will automatically turn off (pin option). This time interval up to power-off is 600 sec.

f).Key Definition

   i).Touch Key Constitution

   ii).Lock Key Constitution

K14: Select with Calculated Digits and Memory Hold Status, MH (Memory Hold), MK (Memory Kill), GTH (GT Memory Hold) and GTX (GT Memory Kill) at Auto Power OFF or OFF key.

K13: Select with Auto Power OFF mode and Total switch.

K12: Rounding switches.

K11: Select with Fixed point or Floating mode.

B). Keyboard Description

a).Equal Key (=)

i).Performs Keyed-in operation and maintains that operation for possible use.

ii).Establishes power/reciprocation calculation.

b).Multiplication Key (×)

i).Enters multiplicand.

ii).Performs previous operation and displays result.

c).Division Key (÷)

i).Enters dividend.

ii).Performs previous operation and displays result.

d).Addition Key (+)

i).Conditions machine for an addition.

ii).Performs previous operation and displays result.

e).Subtraction Key (-)

i).Conditions machine for a subtraction.

ii).Performs previous operation and displays result.

f).Percent Key (%)

The purpose of the percent key is to allow for calculation of add-on and discount. Determination of add-on requires the principal amount to be the first entry followed by the "+" or "X" key, with the percentage being the second entry. Depression of the percent key yields the amount to add on, such as tax or interest. Depression of the "=" key adds this amount to the principal.

g).Change Sign Key (+/-)

Pushing the "+/-" key twice in succession causes the corresponding sign to appear and disappear. During digit entry, this function changes he sign of the entered factor.

h).Power On/All Clear Key (ON/AC)

i).First push power-on displays "0".

ii).In the middle of a digit entry, a second push will clear all operating register).

i)Clear Entry/Clear Key (CE/C)

i).During the digit entry, the first depression will clear the entry register. And display the previous enter number

again.

ii).The second push will clear all registers.

j).Clear Entry Key (CE)

During the digit entry will clear the entry register and display number "0".

k).Square Root Key (Ö)

Extracts the square root of a positive number displayed in the entry register.

l).Memory Plus Key (M+)

i). Adds the current display to the contents of memory.

ii). It will terminate a number entry.

m).Memory Minus Key (M-)

i).Subtracts the current display from the contents of memory

ii).It will terminate a number entry.

n).memory Recall and Clear Key (RCM)

i).First push, as RM key, transfers the contents of the memory register into the display register.

ii).Second push, as CM key, clears the memory.

o).Number, Decimal Key ("00", "0 - 9", "•")

The first number key in a sequence will clear the display and enter the digit in the display. Successive entries will shift the display left and enters the data in display register. The first decimal point entered is effective. An attempted entry of more than 12 digits or 11decimal places will be ignored.

p).GT Memory Recall and Clear Key (RC GT)

i).First push, as RGT key, transfers the contents of the GT memory register into the display register.

ii).Second push, as CGT key, clears the GT memory.

q).Exchange Key (EX)

Exchange two operand between the operator. For example, key in "a-b", and then key in "EX" will exchange a and b to "b-a".

r).Shift Key (→)

Delete the rightest digit and others will shift to right.

s).Item Counter Key (IC)

i).The "+" and "=" key will increase the counter's contents by one.

ii).The "-" will decrease it by two.

iii).The others operator key and number key will not change it.

t).Grand Total Plus (GT+)

Ands the current display to the content of grand total memory.

u).Grand Total Minus (GT-)

Subtracts the current display from the content of grand total memory.

GT- will terminate a number entry.

C). Error Conditions

a).Error Detection

System errors occur when:

i).The integral part of any calculation result exceeds 12 digits.

ii).The integral part of any memory calculation result exceeds 12-digit or when the integral part of any addend or subtrahend to memory exceeds 12-digit.

iii).The integral part of a mark-up and mark-down calculation result exceeds 12-digit.

v).A division by zero is attempted.

iv).An extraction of the square root of a negative number is attempted.

b).Error Indication

   i).System error :

   a)."0" is indicated in the first-digit position and "E" in the sign-digit position.

   b).The high-order 12-digit of a calculation result is indicated together with "E". The location of the decimal point corresponds to the result of calculation times le-12, and no zero shift is performed.
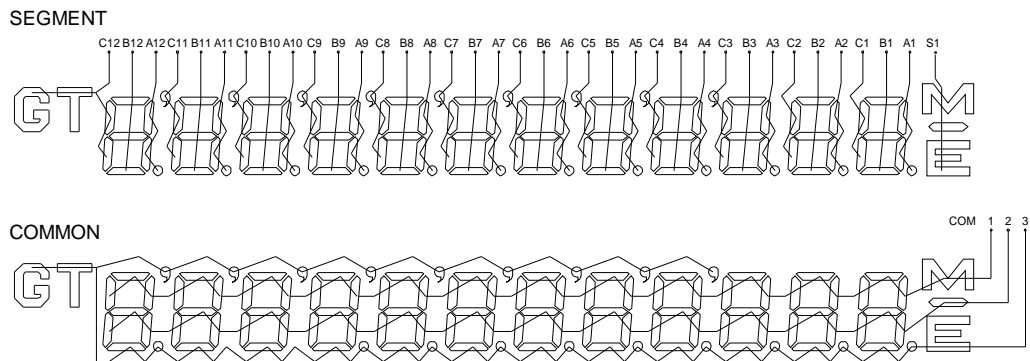
c).Error Release

   i).System error:

   A system error can be released by depressing ON/AC key or CE/C key. However the calculation result is not cleared by CE/C key but is retained.
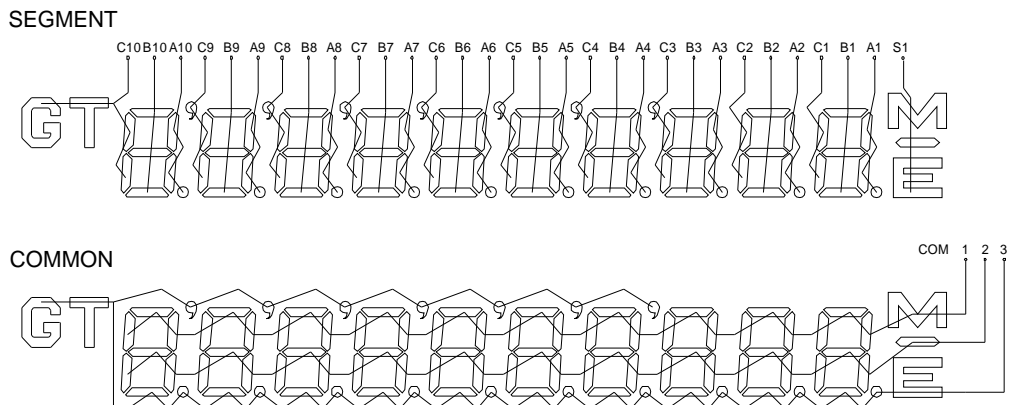
D). LCD Display

   a).Inter Connection of LCD
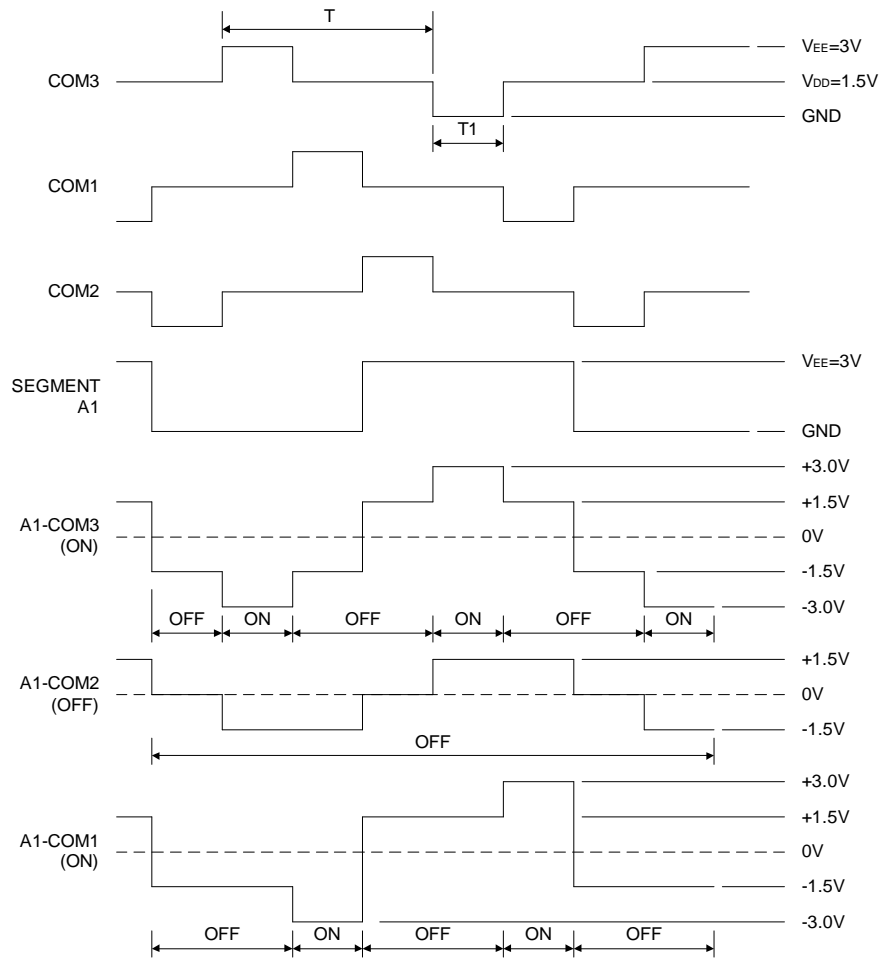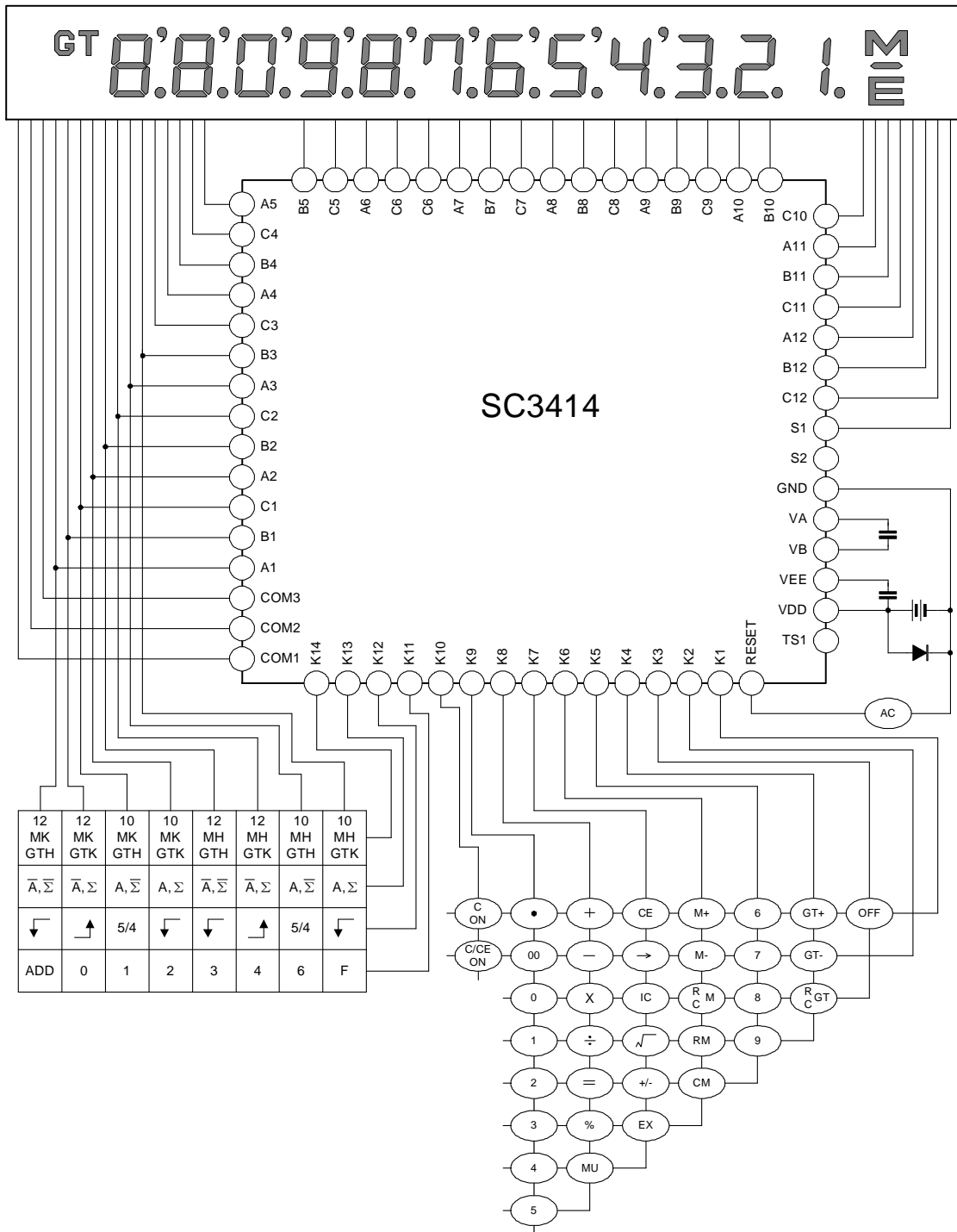
   i).Select of 10-digits

SEGMENT

COMMON

   ii).Select of 12-digits

SEGMENT

COMMON

E). Waveforms for Display

When f0=18kHz
T=1/93.8Hz   T1=3.56ms

Silan
Microelectronics

APPLICATION CIRCUITS

CHIP TOPOGRAPHY
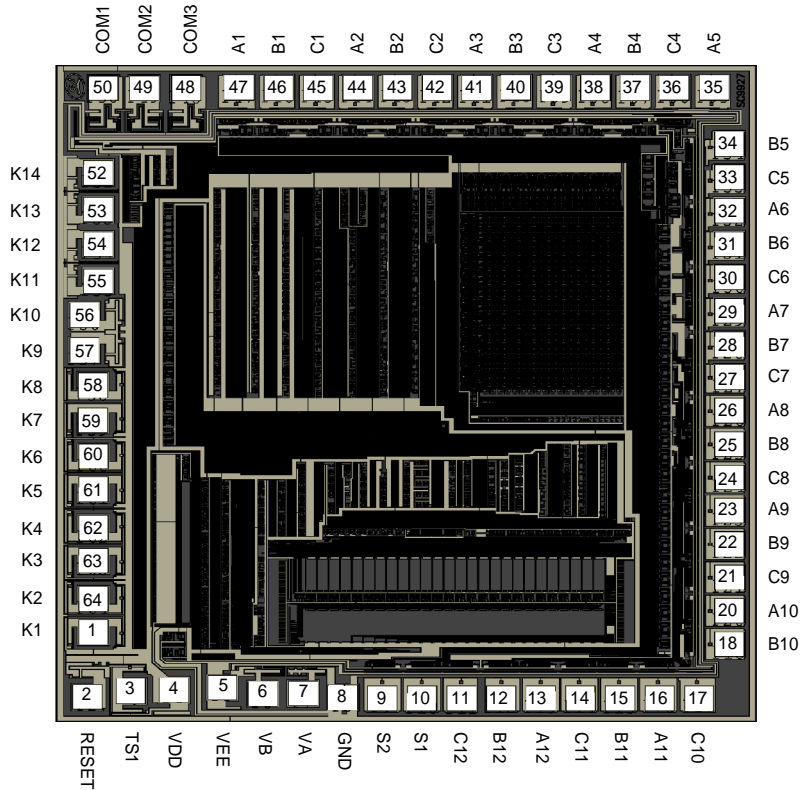
Chip Size : 2.780 x 2.510 (mm^2)

PAD COORDINATES (Unit: μm)

Pin No.	Symbol	X	Y	Pin No.	Symbol	X	Y
1	K1	-1065	-995	33	C5	1100	875
2	RESET	-1085	-1230	34	B5	1100	1010
3	TS1	-940	-1205	35	A5	1050	1240
4	VDD	-790	-1200	36	C4	920	1240
5	VEE	-625	-1200	37	B4	780	1240
6	VB	-490	-1220	38	A4	645	1240
7	VA	-350	-1215	39	C3	510	1240
8	GND	-215	-1230	40	B3	375	1240
9	S2	-80	-1235	41	A3	240	1240
10	S1	55	-1235	42	C2	105	1240
11	C12	190	-1235	43	B2	-30	1240
12	B12	325	-1235	44	A2	-165	1240
13	A12	460	-1235	45	C1	-300	1240
14	C11	595	-1235	46	B1	-435	1240
15	B11	730	-1235	47	A1	-570	1240

(To be continued)

(Continued)

Pin No.	Symbol	X	Y	Pin No.	Symbol	X	Y
16	A11	865	-1235	48	COM3	-750	1240
17	C10	1000	-1235	49	COM2	-890	1240
18	B10	1100	-1015	50	COM1	-1030	1240
20	A10	1100	-880	52	K14	-1050	895
21	C9	1100	-745	53	K13	-1050	745
22	B9	1100	-610	54	K12	-1050	605
23	A9	1100	-475	55	K11	-1050	455
24	C8	1100	-340	56	K10	-1100	320
25	B8	1100	-205	57	K9	-1100	175
26	A8	1100	-70	58	K8	-1065	35
27	C7	1100	65	59	K7	-1065	-110
28	B7	1100	200	60	K6	-1065	-255
29	A7	1100	335	61	K5	-1065	-390
30	C6	1100	470	62	K4	-1065	-545
31	B6	1100	605	63	K3	-1065	-675
32	A6	1100	740	64	K2	-1065	-830

Note: The original point of the coordinate is the die center.

CAUTION
ELECTROSTATIC
SENSITIVE DEVICE
DO NOT OPEN OR HANDLE
EXPECT AT A STATIC-FREE
WORKSTATION

HANDLING MOS DEVICES:

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

• Persons at a work bench should be earthed via a wrist strap.
• Equipment cases should be earthed.
• All tools used during assembly, including soldering tools and solder baths, must be earthed.
• MOS devices should be packed for dispatch in antistatic/conductive containers.

Attachment

Revision History

Data	REV	Description	Page
2000.12.31	1.0	Original	
2003.02.25	1.1	Modify "APPLICATION CIRCUITS".	11