RCL Semiconductors Ltd.

1.5V Touch Tone Calculator LSI   C9289

GENERAL DESCRIPTION

C9289 is a CMOS LSI calculator chip with 8 digits arithmetic operations, single memory, extraction-of-square-root percentage calculation, auto power off and punctuation and touch tone function, design for FEM LCD operation with 1.5V single battery power supply.

APPLICATION

This specification contains complete information of functional operations, electrical characteristics, packaging, and crating requirements of C9289.

FUNCTIONS

- Four standard functions (+, -, x, ÷).
- Auto-constant calculations (constant : multiplicand, divisor, addend and subtrahend).
- Square and reciprocal calculations.
- Mark-up and mark-down calculations.
- Extraction of square root.
- Percentage calculations.
- Chain multiplication and division.
- Power calculations.
- Rough estimate calculations.
- Touch tone function.
- Punctuation comma and touch tone mark display.
- Clear key: ON/C, ON/CE,CE.

FEATURES

- Single 1.5V battery supply
- Accumulating memory : M+, M-, RM, CM, RM/CM.
- Rollover capability.
- Floating decimal.
- Overflow indication: E
- Automatic power off function.
- LCD direct drive.
- 48 QFP and bare chip available

FUNCTIONAL DESCRIPTION

a. Floating point system

i) 8 digits floating decimal point system, with leading zero suppression, Zero shift.

ii) Symbols   : '-' negative number indicator.

: 'E' Error status indicator.

: 'M' Non-zero memory indicator.

: '♪' punctuation comma

: '♪' touch tone indicator

b. Error Detections

i) System errors occur when :

- The integral part of any memory calculation result exceeds 8 digits.
- The integral part of any addend or subtrahend to memory exceed 8 digits.
- The division by zero.
- The extraction of square root of a negative number.

ii) Rough estimate calculation error

- The integral part of the result of any standard functions, percentage, square, reciprocal or power calculations result exceed 8 digits.

c. Error Indication

i) System error

'0' is indicated in the 1-digit position and 'E' in the sign indicator position.

ii)Rough estimate calculation error

The high-order 8 digits of a calculation result is indicated together with 'E'. The decimal point is indicated in the position corresponding to a calculation result times 10^{-8}, and no zero shift is performed.

d. Error Release

i) System error can be released by the ON/C or ON/CE key.

ii)Rough estimate calculation error can be released by the ON/C, ON/CE, CE key.

A calculation result is not cleared by ON/CE, CE key but is retained.

e. Number Entry

Numerical can be entered up to 8 digits, entries that equal to 9 digits or more will be ignored.

f. Memory Protection

The memory contents before any error detection are protected.

g. Memory Indication

If the memory contents is non-zero, 'M' is indicated in the memory indicator position.

h. Double Key Depression

The order of priority when two keys are being depressed simultaneously is as follows :
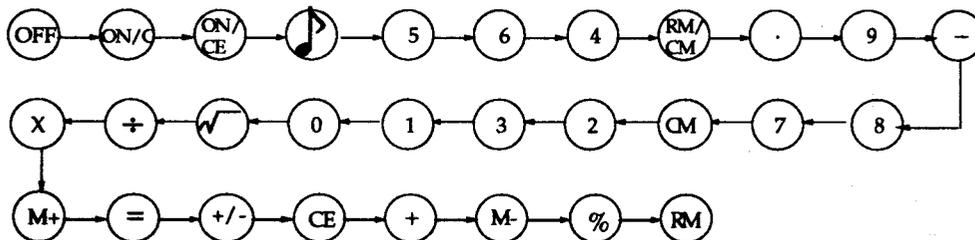
When the OFF and ON/C key are depressed simultaneously, the OFF key is given priority.

i. Key bounce protection

i) Front edge : Minimum 3 words.

ii)Trailing edge : Minimum 9 words. (1 word is 3.3ms when display frequency is Fd=100Hz.)

j. Auto Power Off

Power automatically turns off after 9 - 11 minutes pass from the last key press.

k. Clear Operation

All operations except memory content are cleared by ON/C key.

l. Touch Tone(♪) Key

i) When power is on, the touch tone function is enable and the beep sound is generated output during

125 ms and ♪ sign is displayed on LCD.

ii) Selection of touch tone function is toggled by touch tone key.

iii) Output waveform
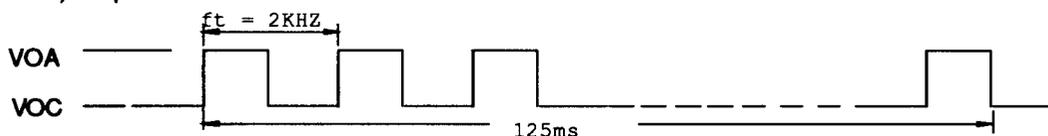
ABSOLUTE MAXIMUM RATINGS

Parameters	Symbol	Value	Unit	Note
Terminal voltage	V_{DD}	- 0.3 ~ + 2.1	V	1
	V_{IN}	- 0.3 ~ V_{DD} + 0.3	V	1
Operating temperature range	T_{OPR}	0 ~ + 50	°C	—
Storage temperature range	T_{STG}	- 55 ~ + 125	°C	—

Note 1   : Maximum voltage on any pin is referenced to GND.

ELECTRICAL CHARACTERISTICS
(Ta = 25°C, V_{DD} = 1.5V unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition	Note
Input Voltage 1	V_{IH1}	V_{DD}-0.4	—	—	V	—	2
	V_{IL1}	—	—	0.4		—	
Input Current 1	I_{IH1}	—	—	1	uA	Vin = V_{DD}	3
	I_{IL1}	—	2.5	3		Vin = 0V	
Output Voltage 1	V_{OH1}	V_{DD}-0.15	—	—	V	No load	4
	V_{OL1}	—	—	0.15		I_{OUT} = 15μA	
Output Voltage 2	V_{OA}	2.80	2.95	—		No load	5
	V_{OB}	1.30	1.50	1.70	V	No load	
	V_{OC}	—	0	0.20		No load	
Display Frequency	Fd	50	75	—	Hz	V_{DD} = 1.3V while display is ON.	5
Dissipation Current	I_{OFF}	—	—	0.1	μA	Display is OFF	6
	I_{DIS}	—	6	10		V_{DD} = 1.3V while display is ON.	7
Touch Tone Output Drive Current	I_{OL}	1.3	2.0	—	MA	VDD = 1.5V V_{OL} = 0.5V T1 = 1.5V	8
	I_{OH}	1.3	2.0	—		VDD = 1.5V V_{OH} = 1.0V T1 = 0V	

Note 2   : Applies to Pins K2 ~ K6, TI.
Note 3   : Applies to Pins K2 ~ K6 and TI.
Note 4   : Applies to P1, P2, A2 ~ A5.
Note 5   : Applies to Pins H1 ~ H3, a1 ~ a9, b1 ~ b8, c1 ~ c8.
Note 6   : Measured by the next test circuit after power supply automatically turns off.
Note 7   : Measured by the next test circuit while "0" is being displayed after auto-clear operation and while key is not being depressed.
Note 8   : Applies to PO
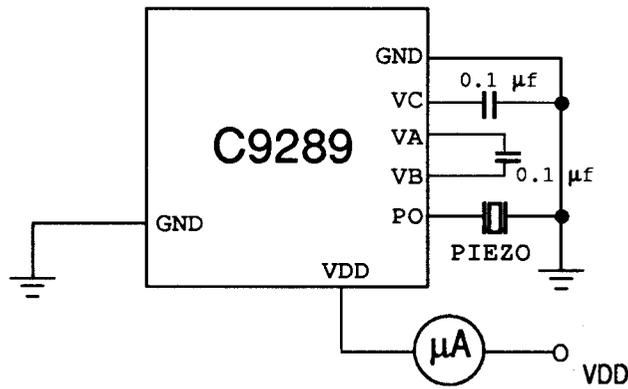
LCD BACKPLANE OUTPUT WAVEFORM 1; HI

$Fd = 1/T$
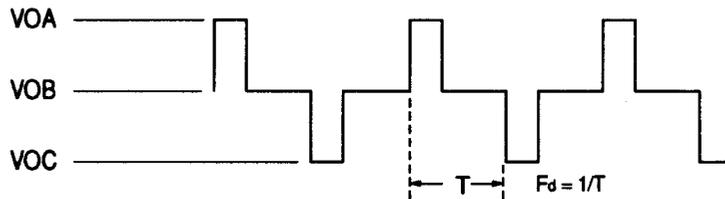
LCD BACKPLANE OUTPUT WAVEFORM 2; al, bl, cl
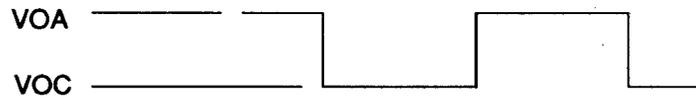
DISPLAY FONTS

a. Numerical Font

b. Sign Font

M	—	E	,	♪
Memory indicator	Negative	Error indicator	punctuation	touch tone indicator

LCD CONNECTOR

H2 H3 A9 C8 B8 A8 C7 B7 A7 C6 B6 A6 C5 B5 A5 C4 B4 A4 C3 B3 A3 C2 B2 A2 C1 B1 A1 H1
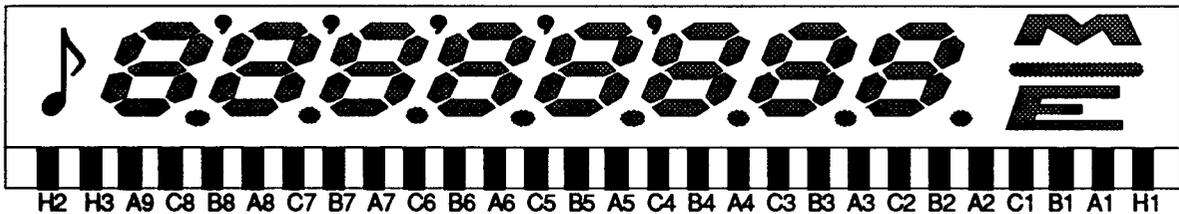
LCD Panel

Backplanes Connection

A9   C8 B8 A8 C7 B7 A7 C6 B6 A6 C5 B5 A5 C4 B4 A4 C3 B3 A3 C2 B2 A2 C1 B1 A1
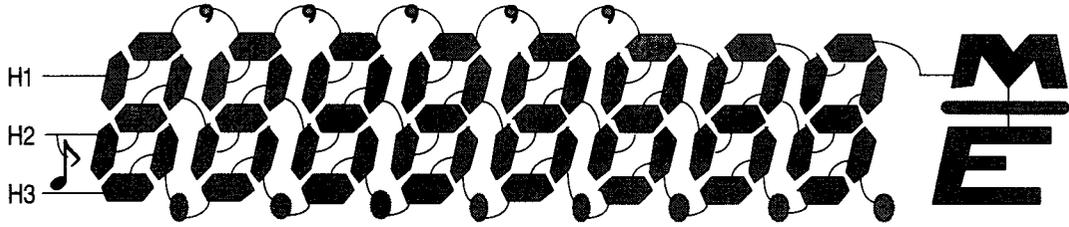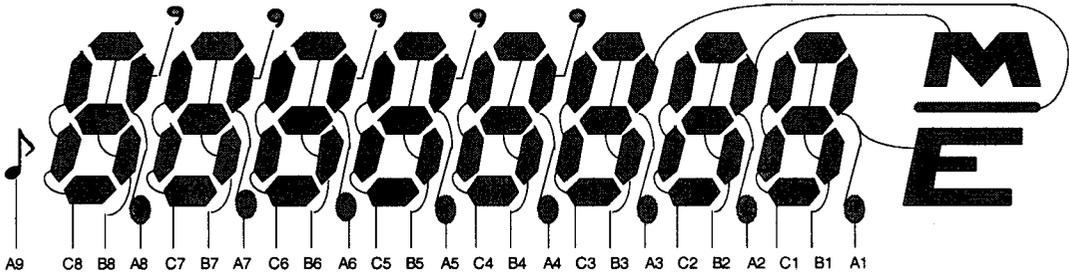
Segment Connection

MARK-UP AND MARK-DOWN CALCULATION

Mark-up and mark-down calculation are performed as follows.

| ENTRY		DISPLAY	
A	A	A	A
+ OR -	X	A	A
B	B	B	B
%	%	A+AM/100 OR A-AM/100	*AM/100
	+ OR -		AM/100
	=		A+AM/100 OR A-AM/100

* AM : AMOUNT

PIN DESCRIPTION

Pin No.	Signal	I/O	Description	Pin No.	Signal	I/O	Description
1	PO	O	Piezo Output	25	C7	O	Display output.
2	VDD	-	Power supply	26	A8	O	Display output.
3	H1	O	Display output	27	B8	O	Display output.
4	A1	O	Display output.	28	C8	O	Display output.
5	B1	O	Display output.	29	A9	O	Display output.
6	C1	O	Display output.	30	H2	O	Display output.
7	GND	-	Ground.	31	H3	O	Display output.
8	A2	O	Display output.	32	GND	-	Ground.
9	B2	O	Display output.	33	VC	O	Capacitor Terminal
10	C2	O	Display output.	34	VA	O	Capacitor Terminal
11	A3	O	Display output.	35	VB	O	Capacitor Terminal
12	B3	O	Display output.	36	CGIN	I	Resistor Terminal for OSC
13	C3	O	Display output.	37	k3	I	Key input
14	A4	O	Display output.	38	K2	I	Key input.
15	B4	O	Display output.	39	A2X	O	Strobe output
16	C4	O	Display output.	40	A3X	O	Strobe output.
17	A5	O	Display output.	41	A4X	O	Strobe output.
18	B5	O	Display output.	42	A5X	O	Strobe output.
19	C5	O	Display output.	43	P2	O	Strobe output.
20	A6	O	Display output.	44	P1	O	Strobe output.
21	B6	O	Display output.	45	K5	I	Key input.
22	C6	O	Display output.	46	K6	I	Key input.
23	A7	O	Display output.	47	K4	I	Key input.
24	B7	O	Display output.	48	T1	I	Test input

PAD DIAGRAM

Top row: K4 K6 K5 P1 P2 A5 A4 A3 A2 K2 K3 CGIN

Left column: T1 PO VDD H1 A1 B1 C1 A2 B2 C2 A3

Right column: VB VA VC GND H3 H2 A9 C8 B8 A8

C9289

Die Size = 88 mil x 79 mil
Pad Size = 86 um x 86 um

Bottom row: B3 C3 A4 B4 C4 A5 B5 C5 A6 B6 C6 A7 B7 C7
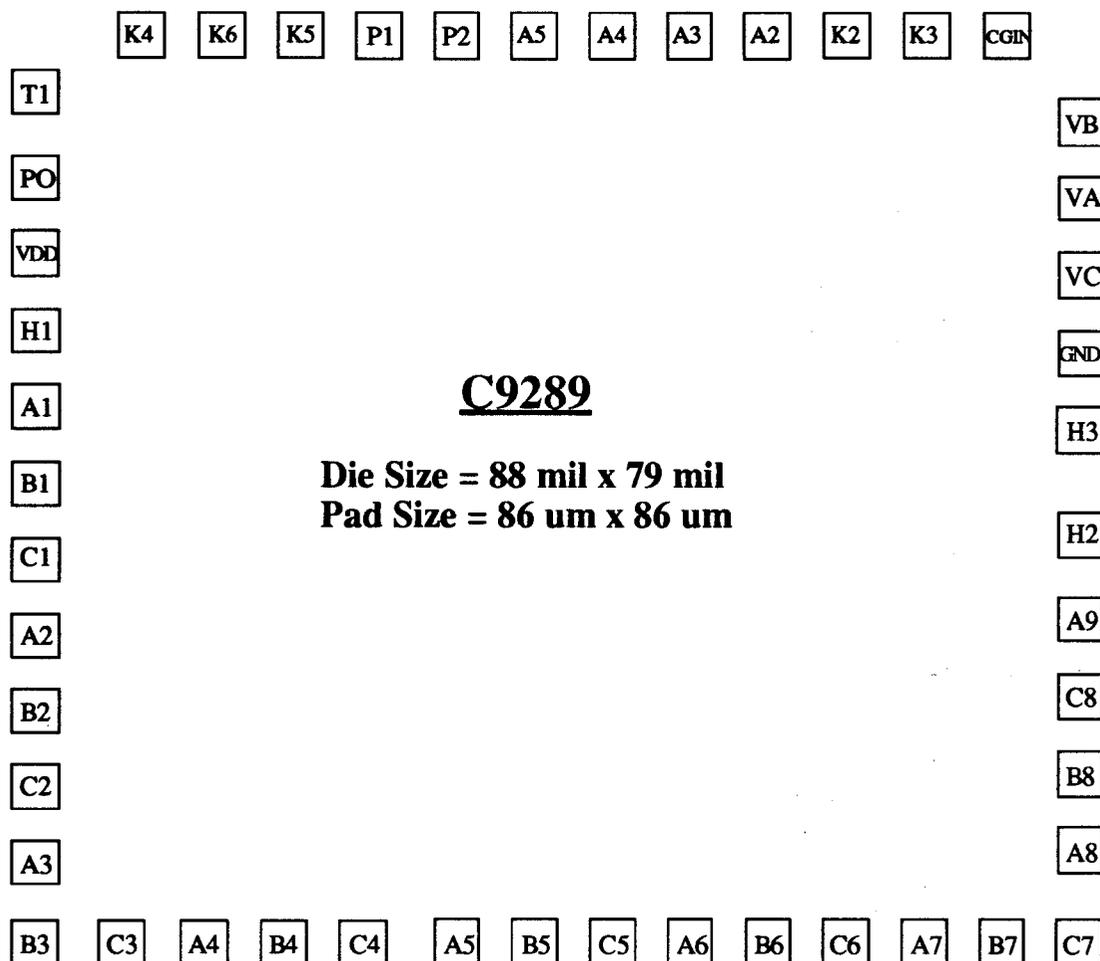
The Co-ordinate For Low Left Corner of Each Pad

C3(-860.2, -912.9)	A8 (935.8, -735.7)	CGIN(795.2, 827.9)	T1 (-1022.8, 717.9)
A4(-706.6, -912.9)	B8 (935.8, -587.7)	K3 (645.4, 827.9)	PO (-1022.8, 554.8)
B4(-558.2, -912.9)	C8 (935.8, -439.7)	K2 (497.1, 827.9)	VDD(-1021.8, 408.8)
C4(-410.2, -912.9)	A9 (935.8, -291.7)	A2 (348.8, 826.9)	H1 (-1021.8, 262.8)
A5(-232.2, -912.9)	H2 (935.8, -127.3)	A3 (202.8, 826.9)	A1 (-1021.8, 116.8)
B5(- 86.2, -912.9)	H3 (935.8, 71.5)	A4 (56.8, 826.9)	B1 (-1021.8, - 29.2)
C5(59.8, -912.9)	GND(935.8, 217.5)	A5 (- 89.2, 826.9)	C1 (-1021.8, -175.2)
A6(205.8, -912.9)	VC (935.8, 370.2)	P2 (-235.2, 826.9)	A2 (-1021.8, -321.2)
B6(351.8, -912.9)	VA (935.8, 516.2)	P1 (-381.2, 826.9)	B2 (-1021.8, -467.2)
C6(497.8, -912.9)	VB (935.8, 662.2)	K5 (-527.2, 827.9)	C2 (-1021.8, -613.2)
A7(643.8, -912.9)		K6 (-675.5, 827.9)	A3 (-1021.8, -759.2)
B7(789.8, -912.9)		K4 (-823.8, 827.9)	B3 (-1021.8, -912.9)
C7(935.8, -912.9)			

APPLICATION DIAGRAM
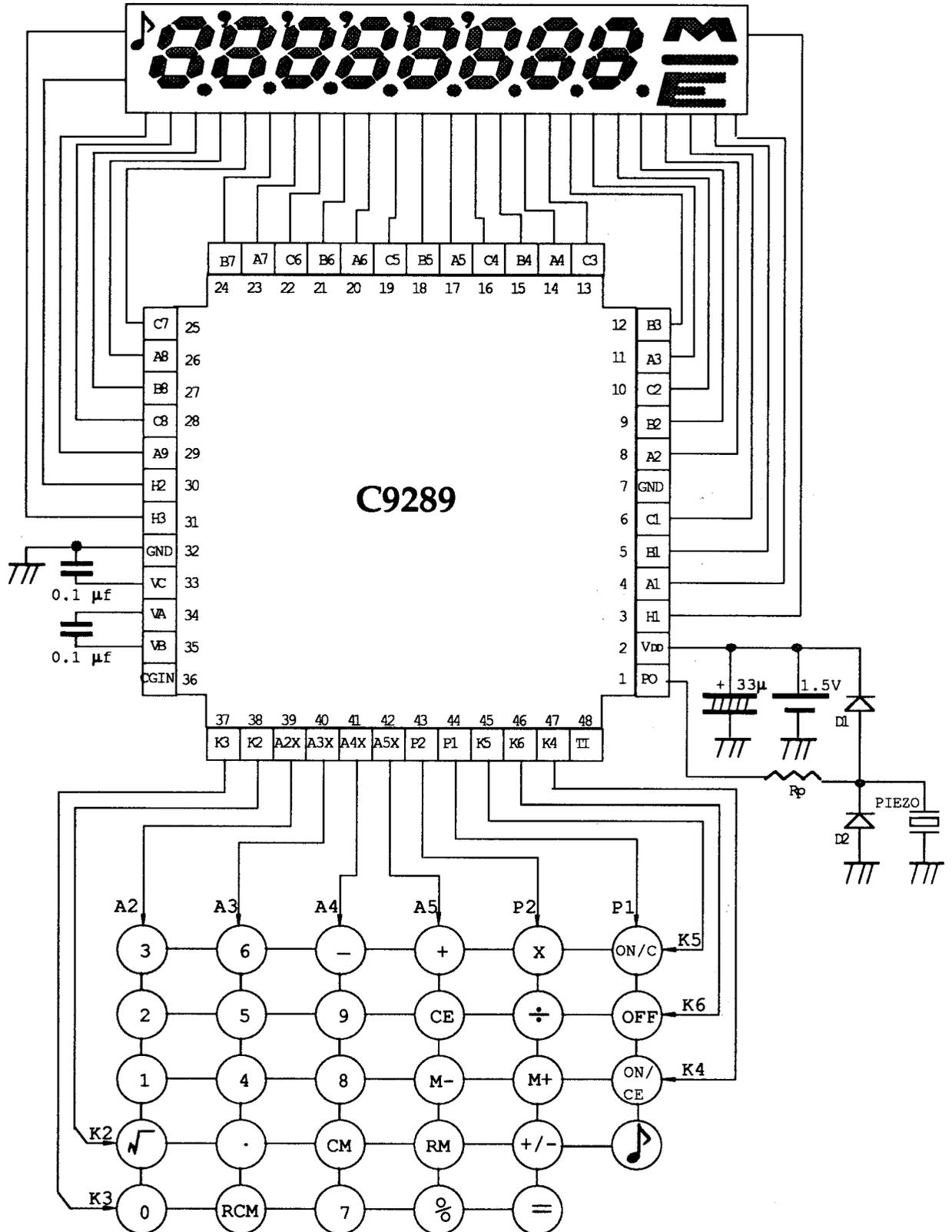
Note: 1. Chip substrate must be floating or connected to GND
       2. D1, D2 are protection diodes; Rp is protection resistor 0.5-1.5(KO)