

EMPCD081A

**8-Digit Calculator With
Tax / Euro Function
(Battery / Solar / Dual
Power Type)**

Product Specification

DOC. VERSION 0.3

ELAN MICROELECTRONICS CORP.


September 2004



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Contents

| | | |
|----------|---|-----------|
| 1 | General Description | 1 |
| 2 | Features | 1 |
| 3 | Pin Descriptions | 2 |
| 4 | Function Descriptions | 2 |
| | A) Operation Characteristics | 2 |
| | B) Keyboard Description | 4 |
| | C) Error Conditions | 7 |
| | D) Lcd Display | 8 |
| | E) Waveforms For Display | 9 |
| 5 | Absolute Maximum Ratings | 10 |
| 6 | Electrical Characteristics | 10 |
| 7 | Application Circuit | 12 |
| 8 | Pad Diagram | 13 |



Specification Revision History

| Doc. Version | Revision Description | Date |
|--------------|---|----------------------------|
| 0.1 | Initial version | 2004/05/04 |
| 0.2 | a. Modify PIN DESCRIPTIONS in page4. b. Delete K11 and K12 in page6. c. Modify LCD display S1A9 and S2B9 in page11. | 2004/05/10 |
| 0.3 | a. Modify DC spec. of IDDOP as page14. | 2004/09/15 |



1 General Description

The EMPCD081A is a single-chip LS1 CMOS calculator for 8-digit 1 memory. Besides, the EMPCD081A is an arithmetic four standard types of general function (+, -, ×, ÷), TAX / EURO function, percentage calculation functions, leading zero and trailing zero suppression, chain calculations, MU calculation, Auto Power OFF available. Dual power supply operation, wide operating voltage, and lower power consumption make it suitable for 1.5 solar battery operated calculator.

2 Features

- Display : 8-digit of data, 1-digits of sign, error, memory load symbol.
- TAX / EURO function available.
- Algebraic mode.
- Standard 4 function (addition, subtraction, multiplication, division).
- Memory calculation.
- Automatic percentage operation with add-on discount.
- Constant calculation.
- Chain calculation.
- Change sign.
- Trailing zero suppression.
- Punction on display, commas for thousands.
- Memory contents indicator, turned on with nonzero in the memory.
- Result overflow, indicating during calculation (most function key are locked as it happened).
- Memory overflow indicating.
- Complementary output buffer for direct driving of liquid crystal display.
- Oscillator/clock generator internal to chip.
- Keyboard encoding internal to chip.
- Automatic power on clear.
- Wide supply voltage range (1.2 to 1.8V)
- Very low power consumption.
- Floating minus.
- Two key roll over available.



3 Pin Descriptions

| Symbol | I/O | Function |
|----------|-----|--|
| COM1~3 | O | LCD Common signal output. |
| A1 ~ A3 | O | LCD Segment signal output and strobe output for switch status. |
| A4 ~ A13 | O | LCD Segment signal output. |
| B1 ~ B3 | O | LCD Segment signal output and strobe output for switch status. |
| B4 ~ B13 | O | LCD Segment signal output. |
| C1 ~ C2 | O | LCD Segment signal output and strobe output for switch status. |
| C3 ~ C13 | O | LCD Segment signal output. |
| VDD,VSS | --- | Positive and negative power supply pin. |
| VA,VB | --- | Voltage doubler for LCD, connects a capacitor (0.1uF) between both pins. |
| VEE | --- | LCD voltage from voltage doubler, connects a capacitor (0.1uF) to pin VDD. |
| TS1 | I | Test pin input, be opened. |
| RESET | I | System reset / AC key input. (built-in schmitt trigger for debouncing) |
| K0 ~ K2 | O | Keyboard polling signal output pins. |
| K3 ~ K7 | I/O | Keyboard polling signal output and strobe input pins. |
| K8 ~ K10 | I | Keyboard strobe input pins. |
| K11~K14 | I | Switch status strobe input pins. |

4 Function Descriptions

A) Operation Characteristics

CONSTANT OPERATION

The EM34011 has implied constant mode on +, -, X, ÷ and % 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.

NUMBER ENTRY

Numericals can be entered up to 8-digit.

MEMORY PROTECTION

In any error detection, the memory contents present before the error detection are protected.

MEMORY INDICATION

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

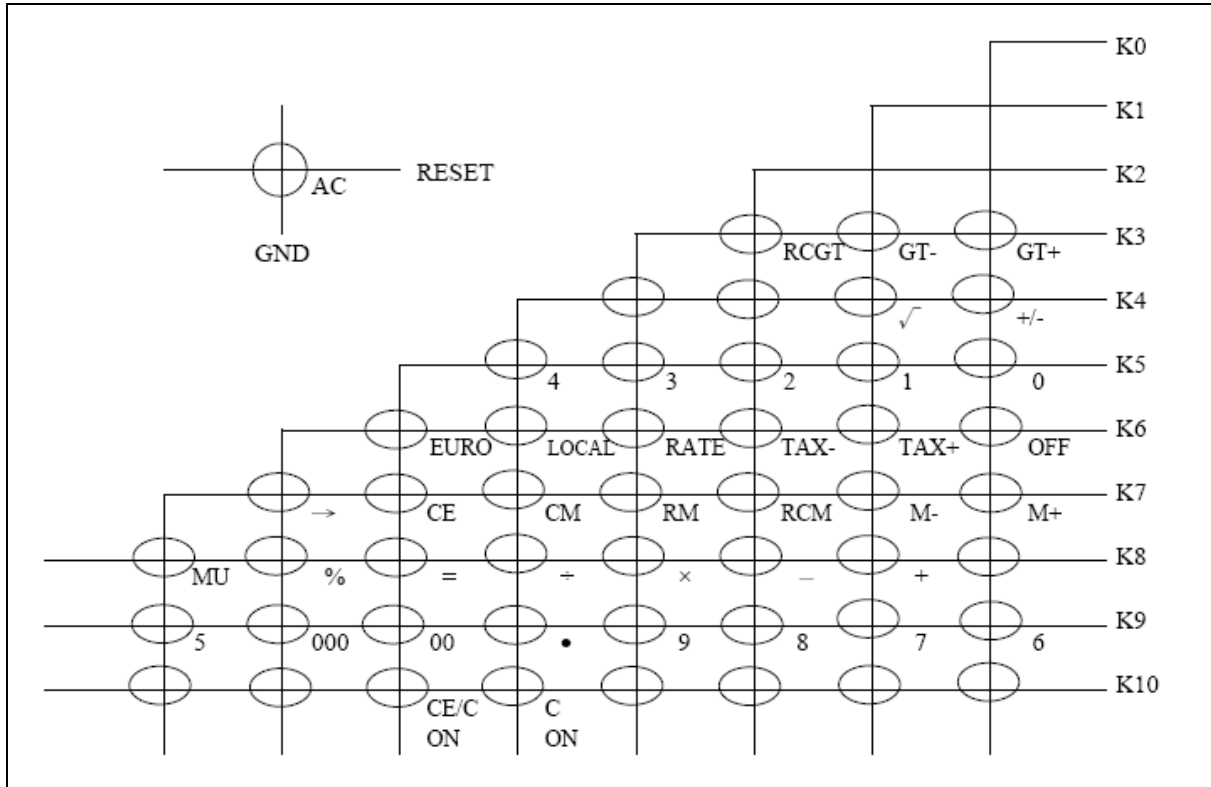
AUTO POWER OFF

If no key is depressed for a specific period of time, the power supply will automatically turn off.

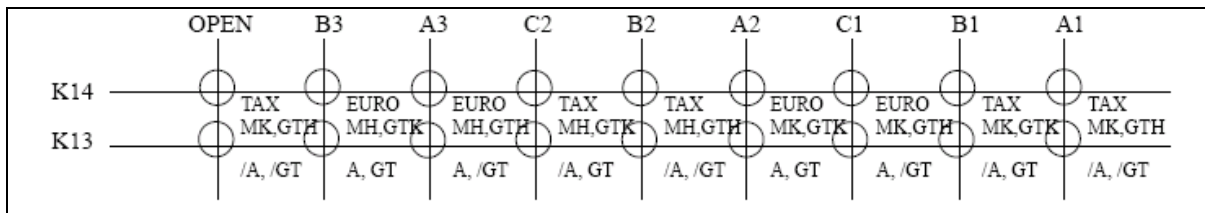


KEY DEFINITION

■ Touch Key Constitution



■ Lock Key Constitution



K14 : Select with TAX / EURO function 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 : Select with Auto Power OFF mode (A) and Grand total function (GT).



B) Keyboard Description

EQUAL KEY (=)

- Performs Keyed-in operation and maintains that operation for possible use.
- Establishes power/reciprocation calculation.

MULTIPLICATION KEY (X)

- Enters multiplicand.
- Performs previous operation and displays result.

DIVISION KEY (\div)

- Enters dividend.
- Performs previous operation and displays result.

ADDITION KEY (+)

- Conditions machine for an addition.
- Performs previous operation and displays result.

SUBTRACTION KEY (-)

- Conditions machine for a subtraction.
- Performs previous operation and displays result.

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.

CHANGE SIGN KEY (+/-)

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



POWER ON/ALL CLEAR KEY (ON/AC)

- First push power-on displays "0".
- In the middle of a digit entry, a second push will clear all operating register.

CLEAR ENTRY/CLEAR KEY (CE/C)

- During the digit entry, the first depression will clear the entry register. And display the previous enter number again.
- The second push will clear all registers.

CLEAR ENTRY KEY (CE)

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

SQUARE ROOT KEY ()

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

MEMORY PLUS KEY (M+)

- Adds the current display to the contents of memory.
- It will terminate a number entry.

MEMORY MINUS KEY (M-)

- Subtracts the current display from the contents of memory
- It will terminate a number entry.

MEMORY RECALL AND CLEAR KEY (RCM)

- First push, as RM key, transfers the contents of the memory register into the display register.
- Second push, as CM key, clears the memory.

MARK-UP KEY (MU)

- Execute add-on calculation by $A (\times) B$ (MU) or discount calculation by $A (\times) B (+/-)$ (MU).
- Execute selling price (mark-up) calculation by $A [/] B$ [MU] or cost (mark-down) calculation by $A [/] B [+/-]$ [MU].
- When intermediate result of addition and subtraction is displayed, execute changing rate calculation, which is increase rate calculation by $A [+] B [-]$ [MU] or growing rate calculation by $A [+] B [+]$ [MU].

**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 8 digits or 7 decimal places will be ignored.

SHIFT KEY (→)

Delete the rightmost digit and others will shift to right.

TAX+ (TAX+)

- Execute TAX-including calculation of displayed number, TAX rate is in TAX memory.
- In the halfway of four rules of arithmetic, TAX-including calculation don't break the intermediate result, so TAX-including is used in expression.
- When immediately after [RATE] key, store displayed number in TAX memory.

TAX- (TAX-)

- Execute TAX-excluding calculation of displayed number, TAX rate is in TAX memory.
- In the halfway of four rules of arithmetic, TAX-excluding calculation don't break the intermediate result, so TAX-excluding is used in expression.

ERUO KEY (EURO)

- The depressing will perform the conversion of "key-in number/rate".
The result is automatically rounded to 2 decimal.
- After LOCAL key is depressed and make the conversion, the depressing of EURO key will recall the key-in number.

LOCAL KEY (LOCAL)

- The depressing will perform the conversion of "key-in number x rate".
The result is automatically rounded to 2 decimal.
- After EURO key is depressed and make the conversion, the depressing of LOCAL key will recall the key-in number.

TAX RATE SET KEY (RATE)

- The depressing will save the entry number as TAX / EURO rate.



C) Error Conditions

ERROR DETECTION

System errors occur when :

- The integral part of any calculation result exceeds 8 digits.
- The integral part of any memory calculation result exceeds 8-digit or when the integral part of any addend or subtrahend to memory exceeds 8-digit.
- A division by zero is attempted.

ERROR INDICATION

System error :

- "0" is indicated in the first-digit position and "E" in the sign-digit position.
- The high-order 8-digit of a calculation result is indicated together with "E". The location of the decimal point corresponds to the result of calculation times $1e-8$, and no zero shift is performed.

ERROR RELEASE

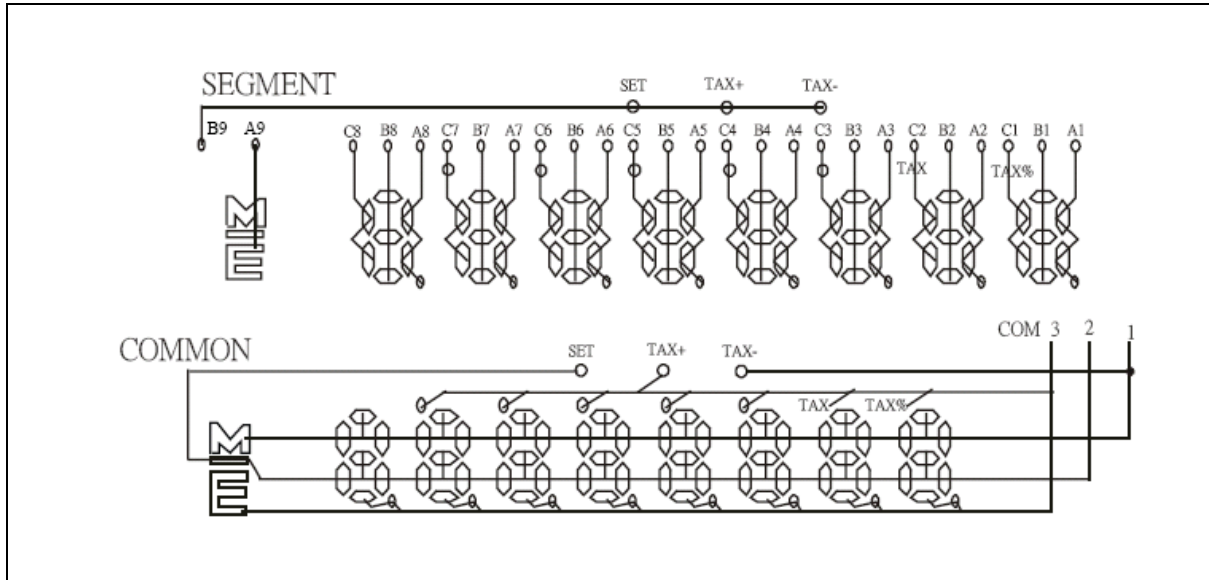
System error :

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.

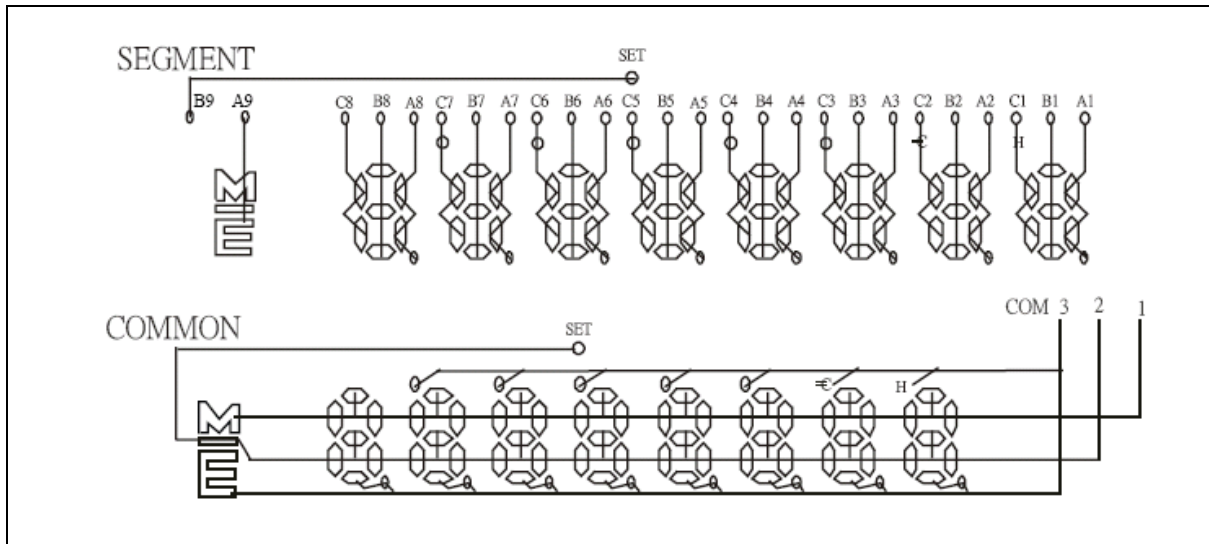


D) Lcd Display

INTER CONNECTION OF LCD (TAX FUNCTION)

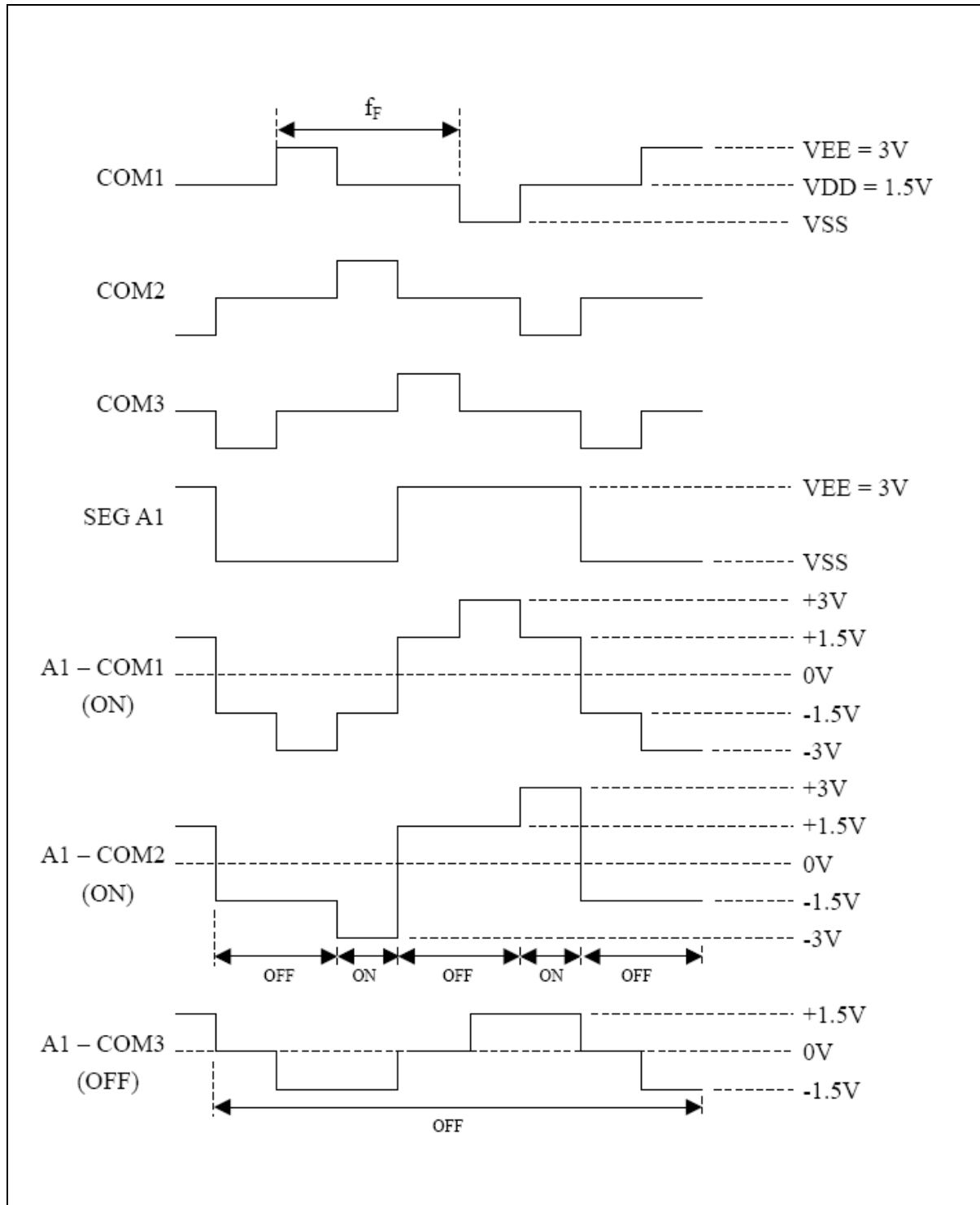


INTER CONNECTION OF LCD (EURO FUNCTION)





E) Waveforms For Display





5 Absolute Maximum Ratings

| Items | Sym. | Min. | Max. | Unit |
|-----------------------|---------|------|---------|------|
| Supply Voltage | VDD-VSS | -0.3 | 2.0 | V |
| Input Voltage | VIN | -0.3 | VDD+0.3 | V |
| Operating Temperature | TOP | 0 | 50 | °C |
| Storage Temperature | TSTG | -55 | +125 | °C |

6 Electrical Characteristics

(VDD=1.5V+0.3V, VSS=0V, TA=25 °C, VEE=3.0+0.4V)

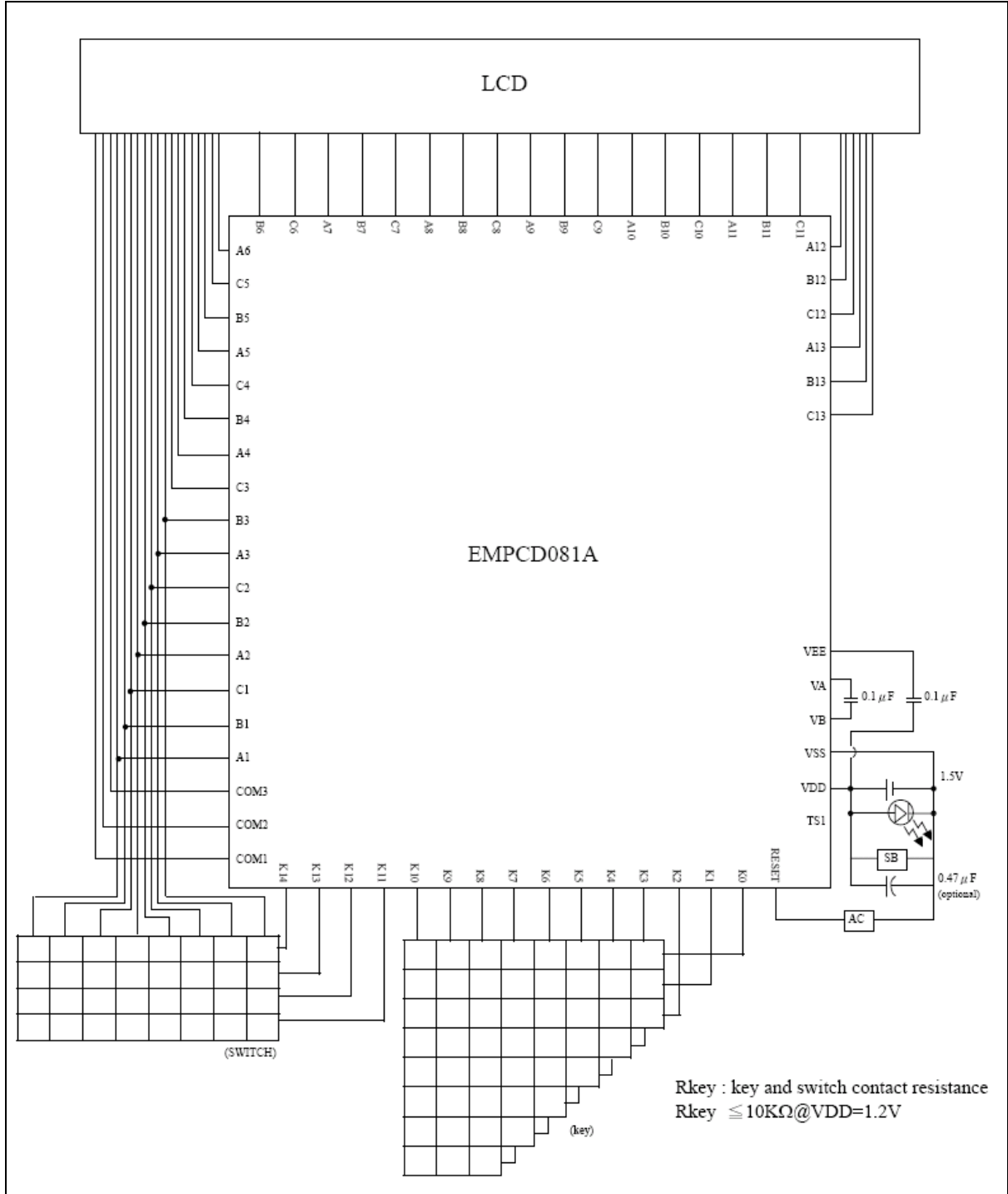
| Parameter | Pin Name | Sym. | Min. | Typ. | Max. | Unit | Condition |
|-----------------------|-------------------|--------|---------|------|---------|------|---------------|
| Operating Voltage | - | VDD | 1.2 | 1.5 | 1.8 | V | |
| "1" Input Voltage | K3~K10 | VIH(1) | VDD-0.4 | - | VDD | V | |
| "1" Input Voltage | K11~K14 | VIH(2) | VEE-0.4 | - | VEE | V | |
| "0" Input Voltage | K3~K14 | VIL(1) | 0 | - | 0.4 | V | |
| "1" Input Voltage | RESET | VIH(3) | 0.6 VDD | - | VDD | V | VDD=1.5V |
| "0" Input Voltage | RESET | VIL(2) | 0 | - | 0.4 VDD | V | VDD=1.5V |
| "1" Output Voltage | SEGMENT COM1~3 | VOH(1) | VEE-0.2 | - | VEE | V | |
| "0" Output Voltage | SEGMENT COM1~3 | VOL(1) | 0 | - | 0.2 | V | |
| "M" Output Voltage | COM1~3 | VOM | VDD-0.2 | - | VDD+0.2 | V | |
| "1" Output Voltage | K0~K7 | VOH(2) | VDD-0.2 | - | VDD | V | |
| "0" Output Voltage | K0~K7 | VOL(2) | 0 | - | 0.2 | V | |
| "1" Output Resistance | SEGMENT COM1~3 | ROH | - | - | 70 | KΩ | VOUT=VEE-0.5V |
| "0" Output Resistance | SEGMENT COM1~3 | ROL | - | - | 70 | KΩ | VOUT=0.5V |



| Parameter | Name | Sym. | Min. | Typ. | Max. | Unit | Condition |
|-----------------------------|----------------|----------|------|------|-------|------|--------------------|
| Key Pull Down Resistance | K0~K10 | RKEYL(1) | 100 | 180 | 650 | KΩ | VOUT=VDD= 1.2~1.8V |
| Key Pull Up Resistance | K0~K7 | RKEYH(1) | - | - | 10 | KΩ | VOUT=0.5V |
| | RESET | RKEYH(2) | 50 | - | 370 | KΩ | |
| Switch Pull Down Resistance | K11~K14 | RSW(1) | 240 | 400 | 800 | KΩ | VOUT=VEE |
| Oscillating Frequency | (Wait) TS1 | FWAIT | 10.8 | 18 | 25.2 | KHz | VDD=1.2 ~ 1.8V |
| | (Operate) TS1 | FOP | 120 | 200 | 280 | KHz | |
| Frame Frequency | SEGMENT COM1~3 | fF | 56.3 | 93.8 | 131.3 | Hz | Wait clock |
| | | | 62.5 | 104 | 145.6 | Hz | Fast clock |
| Supply Current | 1 (WAIT) | IDDWAIT | - | 3.0 | 4.5 | μ | VDD=1.5V, no load |
| | 2 (OPERATE) | IDDOP | - | 13 | 20 | μ | VDD=1.5V, no load |
| | 3 (OFF) | IDDOFF | - | - | 1.0 | μ | VDD=1.5V, no load |

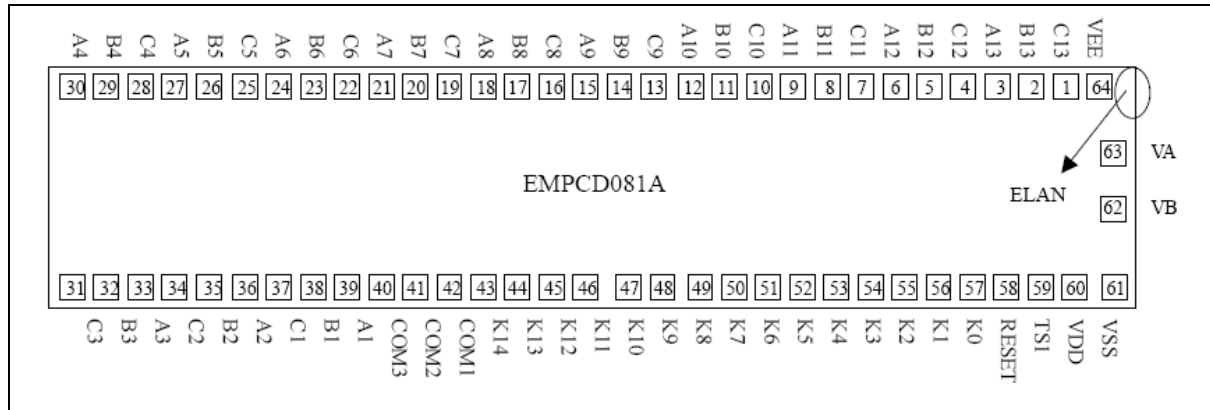


7 Application Circuit





8 Pad Diagram



| Pad No. | Symbol | X | Y |
|---------|--------|---------|-------|
| 1 | C13 | 1510.0 | 350.0 |
| 2 | B13 | 1400.0 | 350.0 |
| 3 | A13 | 1290.0 | 350.0 |
| 4 | C12 | 1180.0 | 350.0 |
| 5 | B12 | 1070.0 | 350.0 |
| 6 | A12 | 960.0 | 350.0 |
| 7 | C11 | 850.0 | 350.0 |
| 8 | B11 | 740.0 | 350.0 |
| 9 | A11 | 630.0 | 350.0 |
| 10 | C10 | 520.0 | 350.0 |
| 11 | B10 | 410.0 | 350.0 |
| 12 | A10 | 300.0 | 350.0 |
| 13 | C9 | 190.0 | 350.0 |
| 14 | B9 | 80.0 | 350.0 |
| 15 | A9 | -30.0 | 350.0 |
| 16 | C8 | -140.0 | 350.0 |
| 17 | B8 | -250.0 | 350.0 |
| 18 | A8 | -360.0 | 350.0 |
| 19 | C7 | -470.0 | 350.0 |
| 20 | B7 | -580.0 | 350.0 |
| 21 | A7 | -690.0 | 350.0 |
| 22 | C6 | -800.0 | 350.0 |
| 23 | B6 | -910.0 | 350.0 |
| 24 | A6 | -1020.0 | 350.0 |
| 25 | C5 | -1130.0 | 350.0 |

EMPCD081A**8-Digit Calculator With Tax / Euro Function (Battery / Solar / Dual Power Type)**

| Pad No. | Symbol | X | Y |
|---------|--------|---------|--------|
| 26 | B5 | -1240.0 | 350.0 |
| 27 | A5 | -1350.0 | 350.0 |
| 28 | C4 | -1460.0 | 350.0 |
| 29 | B4 | -1570.0 | 350.0 |
| 30 | A4 | -1680.0 | 350.0 |
| 31 | C3 | -1680.0 | -350.0 |
| 32 | B3 | -1570.0 | -350.0 |
| 33 | A3 | -1460.0 | -350.0 |
| 34 | C2 | -1350.0 | -350.0 |
| 35 | B2 | -1240.0 | -350.0 |
| 36 | A2 | -1130.0 | -350.0 |
| 37 | C1 | -1020.0 | -350.0 |
| 38 | B1 | -910.0 | -350.0 |
| 39 | A1 | -800.0 | -350.0 |
| 40 | COM3 | -690.0 | -350.0 |
| 41 | COM2 | -580.0 | -350.0 |
| 42 | COM1 | -470.0 | -350.0 |
| 43 | K14 | -360.0 | -350.0 |
| 44 | K13 | -250.0 | -350.0 |
| 45 | K12 | -140.0 | -350.0 |
| 46 | K11 | -30.0 | -350.0 |
| 47 | K10 | 98.0 | -350.0 |
| 48 | K9 | 208.0 | -350.0 |
| 49 | K8 | 318.0 | -350.0 |
| 50 | K7 | 428.0 | -350.0 |
| 51 | K6 | 538.0 | -350.0 |
| 52 | K5 | 648.0 | -350.0 |
| 53 | K4 | 758.0 | -350.0 |
| 54 | K3 | 868.0 | -350.0 |
| 55 | K2 | 978.0 | -350.0 |
| 56 | K1 | 1088.0 | -350.0 |
| 57 | K0 | 1198.0 | -350.0 |
| 58 | RESET | 1308.0 | -350.0 |
| 59 | TS1 | 1418.0 | -350.0 |
| 60 | VDD | 1540.1 | -350.0 |
| 61 | VSS | 1666.7 | -350.0 |
| 62 | VB | 1675.0 | -59.3 |
| 63 | VA | 1675.0 | 130.7 |
| 64 | VEE | 1634.0 | 350.0 |

Chip size:3620 x 1010 um

NOTE*For PCB layout, IC substrate must be connected to VSS.*



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