

1. GENERAL DESCRIPTION

The EM34034 is a single-chip LSI TAX calculator with 12-digits 1-memory or 10-digits 1-memory. EM34034 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 EM34034 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.

2. 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 calculation.
- Automatic percentage operation with add-on discount.
- Automatic delta percentage, mark-up and mark-down operations.
- 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.
- Punction on display, commas for thousands.
- Memory contents indicator, turned on with nonzero in the memory.
- Registration overflow, indicating too many digits are entered (the most significant digit are protected).

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- 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 (1.1 to 1.8V)
- Very low power consumption.
- Floating minus.
- Key roll over function (2 keys).
- TAX function.

3. PIN DESCRIPTIONS

| Symbol | I/O | Function |
|--------|-----|--|
| COM1 | O | Common 1 to LCD |
| COM2 | O | Common 2 to LCD |
| COM3 | O | Common 3 to LCD |
| A1 | O | O/P Signal to LCD and O/P strobe to lock key |
| B1 | O | O/P Signal to LCD and O/P strobe to lock key |
| C1 | O | O/P Signal to LCD and O/P strobe to lock key |
| A2 | O | O/P Signal to LCD and O/P strobe to lock key |
| B2 | O | O/P Signal to LCD and O/P strobe to lock key |
| C2 | O | O/P Signal to LCD and O/P strobe to lock key |
| A3 | O | O/P Signal to LCD and O/P strobe to lock key |
| B3 | O | O/P Signal to LCD and O/P strobe to lock key |
| C3 | O | O/P Signal to LCD and O/P strobe to lock key |
| A4 | O | O/P Signal to LCD and O/P strobe to lock key |
| B4 | O | O/P Signal to LCD |
| C4 | O | O/P Signal to LCD |
| A5 | O | O/P Signal to LCD |
| B5 | O | O/P Signal to LCD |
| C5 | O | O/P Signal to LCD |

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| Symbol | I/O | Function |
|--------|-----|--------------------------------------|
| A6 | O | O/P Signal to LCD |
| B6 | O | O/P Signal to LCD |
| C6 | O | O/P Signal to LCD |
| A7 | O | O/P Signal to LCD |
| B7 | O | O/P Signal to LCD |
| C7 | O | O/P Signal to LCD |
| A8 | O | O/P Signal to LCD |
| B8 | O | O/P Signal to LCD |
| C8 | O | O/P Signal to LCD |
| A9 | O | O/P Signal to LCD |
| B9 | O | O/P Signal to LCD |
| C9 | O | O/P Signal to LCD |
| A10 | O | O/P Signal to LCD |
| B10 | O | O/P Signal to LCD |
| C10 | O | O/P Signal to LCD |
| A11 | O | O/P Signal to LCD |
| B11 | O | O/P Signal to LCD |
| C11 | O | O/P Signal to LCD |
| A12 | O | O/P Signal to LCD |
| B12 | O | O/P Signal to LCD |
| C12 | O | O/P Signal to LCD |
| S1 | O | O/P Signal to LCD |
| S2 | O | O/P Signal to LCD |
| GND | | Ground |
| VA | | Connected as voltage doubler |
| VB | | Connected as voltage doubler |
| VEE | | Connected to capacitor |
| VDD | | Power supply |
| TS1 | | Test pin |
| RESET | I | System reset |
| K1 | O | O/P strobe signal to key |
| K2 | O | O/P strobe signal to key |
| K3 | I/O | O/P strobe signal and key I/P signal |
| K4 | I/O | O/P strobe signal and key I/P signal |
| K5 | I/O | O/P strobe signal and key I/P signal |
| K6 | I/O | O/P strobe signal and key I/P signal |
| K7 | I/O | O/P strobe signal and key I/P signal |
| K8 | I/O | O/P strobe signal and key I/P signal |
| K9 | I | Key I/P signal |
| K10 | I | Key I/P signal |
| K11 | I | Key I/P signal |
| K12 | I | Key I/P signal |
| K13 | I | Key I/P signal |
| K14 | I | Key I/P signal |

4. FUNCTION DESCRIPTIONS

A) OPERATION CHARACTERISTICS

CONSTANT OPERATION

The EM34034 has implied constant mode on +, -, X, \div & % operations. The constant is performed automatically by the "=" key, "%" key, or "C" 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 12-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.

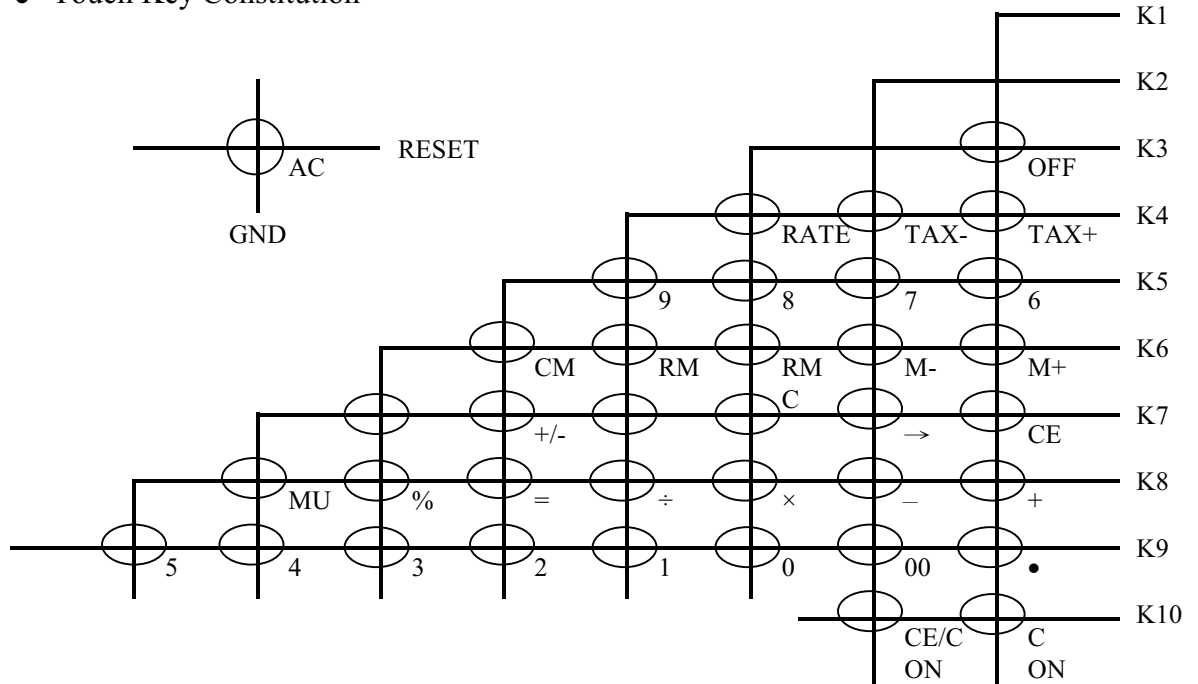
AUTO POWER OFF

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

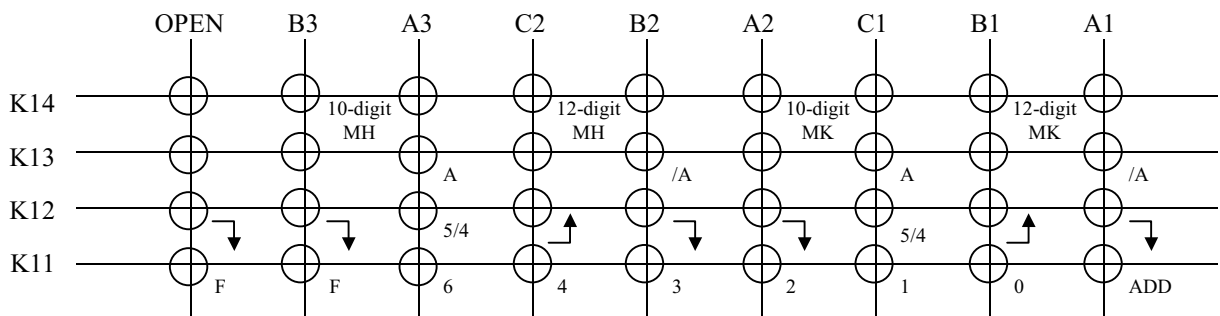
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KEY DEFINITION

- Touch Key Constitution



- Lock Key Constitution



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

K13 : Select with Auto Power OFF mode.

K12 : Rounding switches.

K11 : Select with Fixed point or floating point mode.

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B) KEYBOARD DESCRIPTION

EQUAL KEY (=)

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

MULTIPLICATION KEY (X)

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

DIVISION KEY (÷)

- 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.

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CLEAR KEY AND POWER ON KEY (C & ON)

- 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/ON)

- 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".

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.

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 11 decimal places will be ignored.

SHIFT KEY (→)

Delete the rightest digit and others will shift to right.

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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.

TAX RATE SET KEY (RATE)

- The depressing will save the entry number as rate.

TAX RECALL KEY (TAX RECALL)

- The depressing will recall the rate.

C) ERROR CONDITIONS

ERROR DETECTION

System errors occur when :

- The integral part of any calculation result exceeds 12 digits.
- 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.
- The integral part of a mark-up and mark-down calculation result exceeds 12-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 12-digit of a calculation result is indicated together with "E". The location of the decimal point corresponds to the result of calculation times $1e-12$, and no zero shift is performed.

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ERROR RELEASE

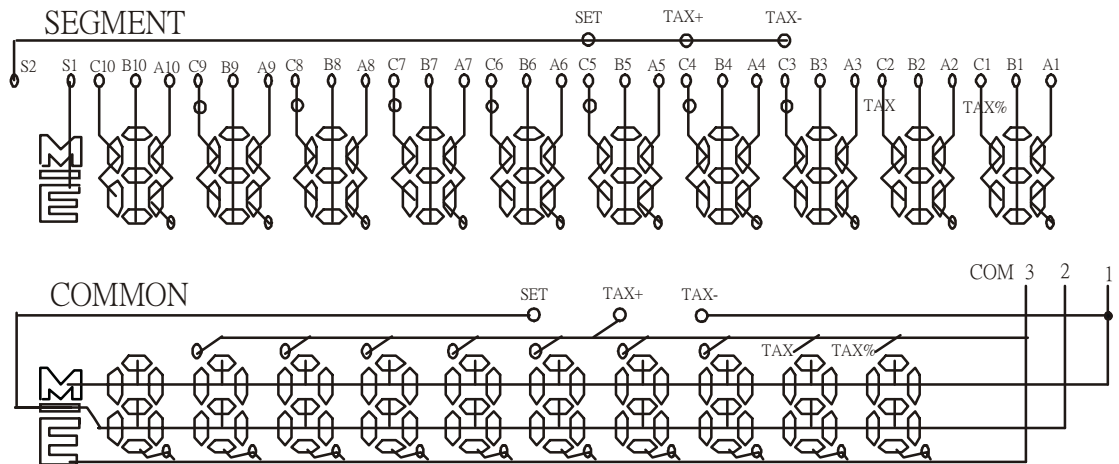
System error :

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.

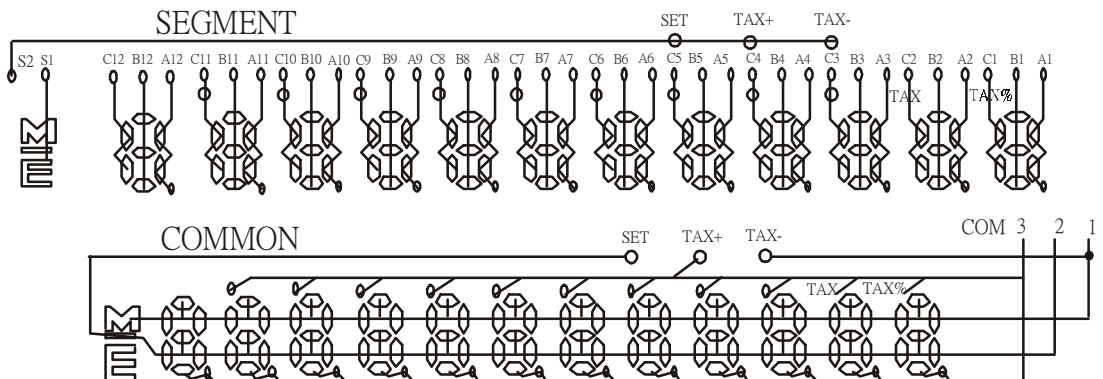
D) LCD DISPLAY

INTER CONNECTION OF LCD

- Select of 10-digits

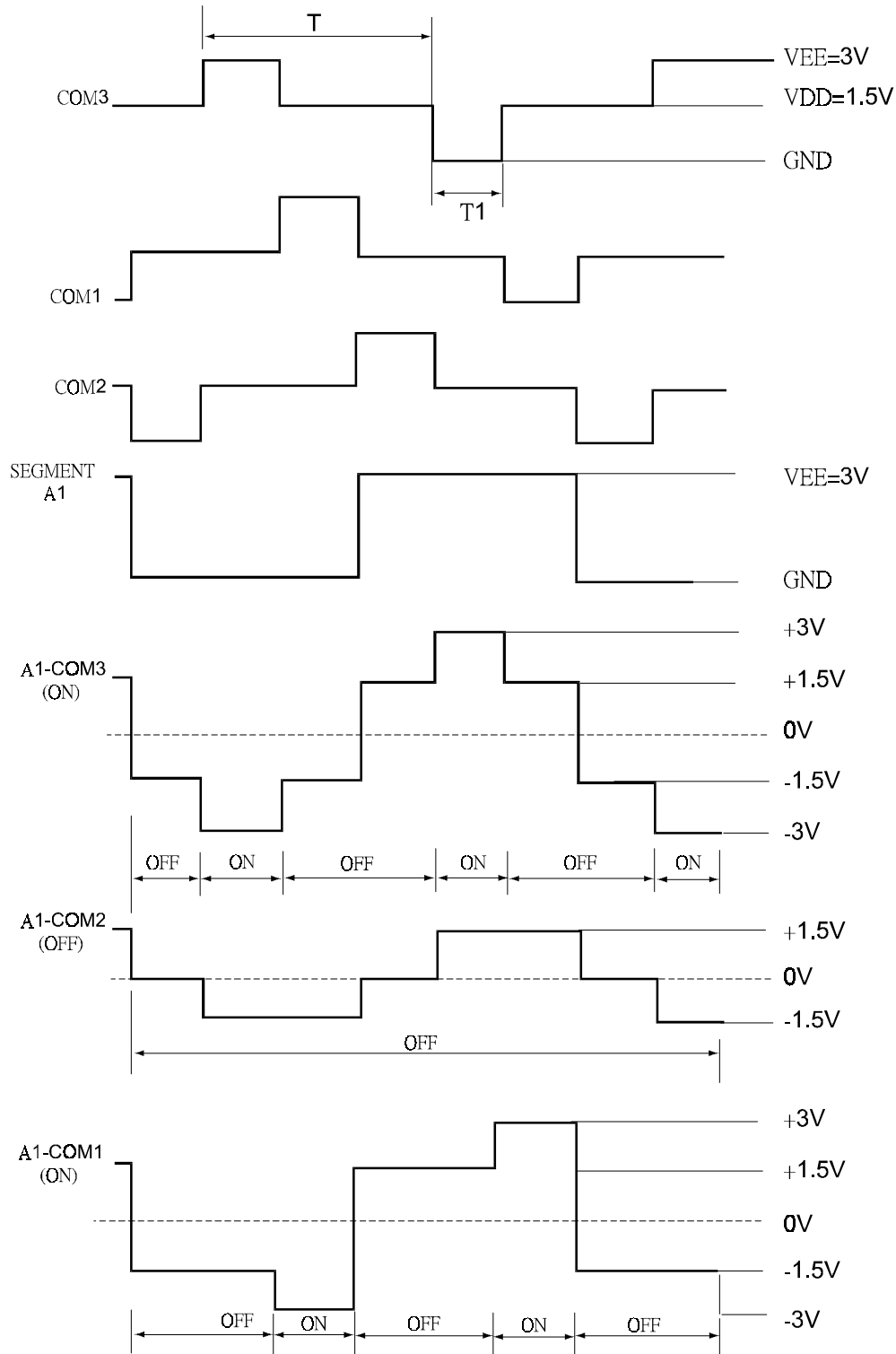


- Select of 12-digits



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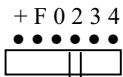
E) WAVEFORMS FOR DISPLAY



When $f_0 = 18\text{KHz}$, $T = 1/93.8\text{ Hz}$, $T_1 = 3.56\text{ms}$

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If the following switches are not shown in an explanation, set as shown :



| | CALCULATION | OPERATION | DISPLAY |
|----------------|--|-------------------|---|
| + | 3-5=-2 | 3 5 | 3. - 2.00 |
| | (-2)×3=-6 | 2 3 | 2. - 2. - 6.00 |
| - | (-365) ÷ 7 = -52.14 | 365 7 | 365. - 365. - 52.14 |
| × | 300×2,145=643,500 | 300 2145 | 300. 643'500.00 |
| | 300×4,950.6=1,485,180 | 4950 .6 | 1'485'180.00 |
| ÷ | 31,750÷500=63.50 | 31750 500 | 31'750. 63.50 |
| | 54,236÷500=108.47 | 54236 | 108.47 |
| X ⁿ | 3 ³ =27 | 3 | 3. 9.00 27.00 |
| 1/X | 1/4=0.25 | 4 | 4. 0.25 |
| CE | 123×456=56,088 | 123 756 CE 456 | 123. 456. 56'088.00 |
| % [±] | 2,350× ¹⁷ / ₁₀₀ =399.50 | 2350 17 | 2'350. 399.50 |
| | ⁴⁵⁶ / ₇₈₉ ×100=57.79 | 456 789 | 456. 57.79 |
| % [±] | 2,000+(2,000× ¹² / ₁₀₀) =2,240 | 2000 12 | 2'000. 240.00 240.00 2'240.00 |
| | 2,000-(2,000× ¹² / ₁₀₀) =1,760 | 2000 12 | 2'000. 240.00 240.00 1' 760.00 |



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| | CALCULATION | OPERATION | DISPLAY |
|----------------------|-------------------------|-------------------------|-------------|
| M⁺ | 243×12=2,916 | (CM) 243 × | 243. |
| | <u>576×25=14,400</u> | 12 M⁺ | M 2'916.00 |
| M- | 17,316 | 576 × | M 576. |
| | -) <u>456×32=14,592</u> | 25 M⁺ | M 14'400.00 |
| RM | 2,724 | RM | M 17'316. |
| | | 456 × | M 456. |
| CM | | 32 M- | M 14'592.00 |
| | | CM | 14'592.00 |
| | SET RATE | 5 RATE | 5. RATE |
| | | TAX+ | 5. TAX% |
| RATE | RECALL RATE | RATE TAX- | 5. TAX% |
| | TAX+ | 800 | 800. |
| | = net price × 1.05 | TAX+ | 840.00 TAX+ |
| TAX+ | = 800 × 1.05 | TAX+ | 40.00 TAX |
| | = 840 | | |
| | TAX- | 840 | 840. |
| TAX- | = price(including TAX) | TAX- | 800.00 TAX- |
| | ÷ 1.05 | TAX- | 40.00 TAX |
| | = 840 ÷ 1.05 | | |
| | = 800 | | |
| MU | 45÷(1-10/100)=50 | 45 ÷ | 45. |
| | | 10 MU | 50.00 |
| | | MU | 5.00 |

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5. ABSOLUTE MAXIMUM RATINGS

| Item | Sym. | Min. | Max. | Unit |
|-----------------------|-----------------|------|-----------|------|
| Supply Voltage | VDD – VSS | -0.3 | 2.0 | V |
| Input Voltage | V _{in} | -0.3 | VDD + 0.3 | V |
| Operating Temperature | Top | 0 | + 40 | °C |
| Storage Temperature | Tstg | -55 | + 125 | °C |

6. ELECTRICAL CHARACTERISTICS

(VDD=1.5V±0.2V, GND=0V, TA=25 °C, VEE=3.0±0.4V)

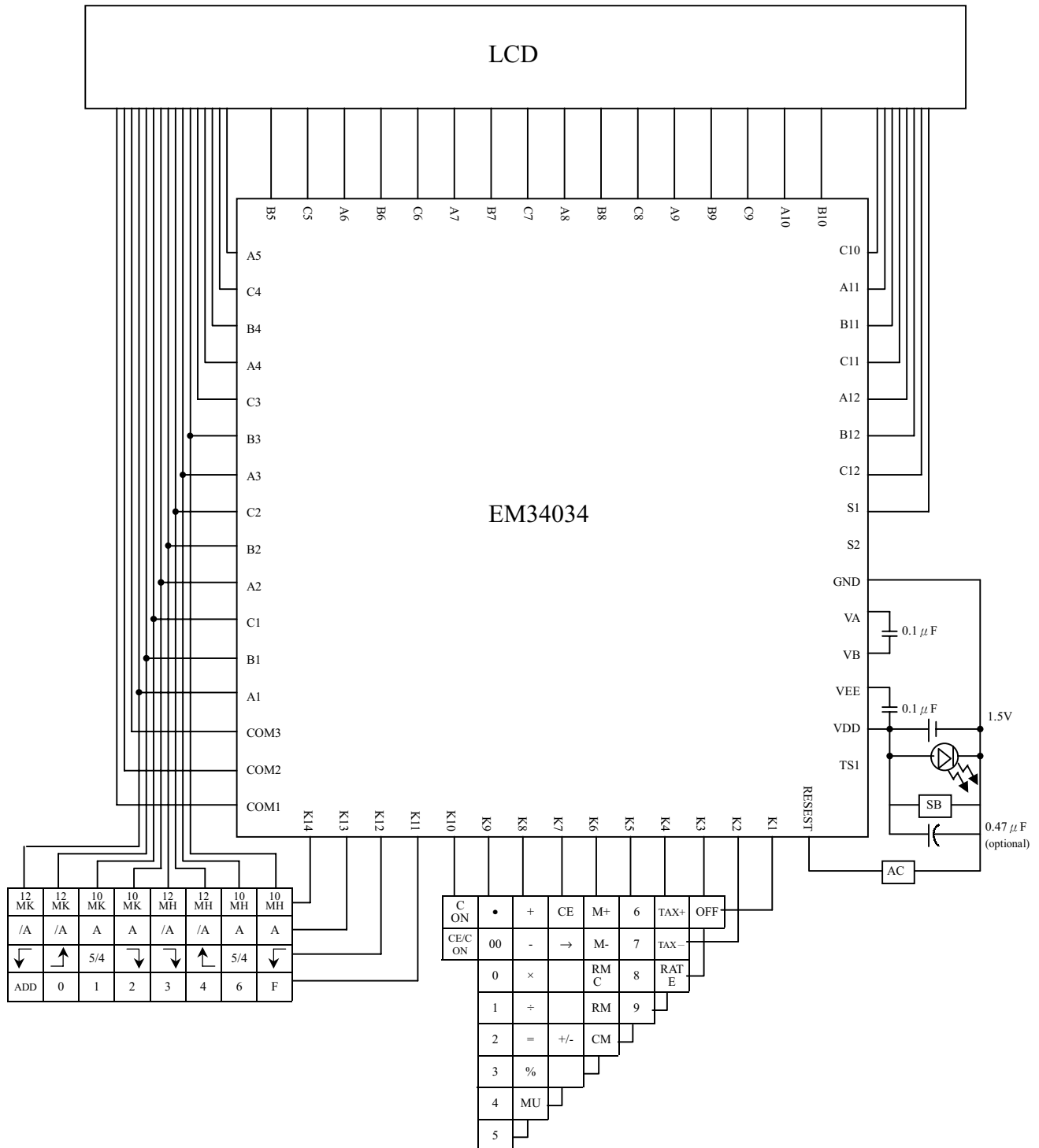
| Parameter | Name | Sym. | Min. | Typ. | Max. | Unit | Condition |
|-----------------------|-------------------|---------------------|----------------------|------|----------------------|------|--|
| Operating Voltage | - | V _{DD} | 1.1 | 1.5 | 1.8 | V | |
| “1” Input Voltage | K3~K10 RESET | V _{IH} (1) | V _{DD} -0.4 | - | V _{DD} | V | |
| “1” Input Voltage | K11~K14 | V _{IH} (2) | V _{EE} -0.4 | - | V _{EE} | V | |
| “0” Input Voltage | K3~K14 RESET | V _{IL} | 0 | - | 0.4 | V | |
| “1” Output Voltage | SEGMENT COM1~3 | V _{OH} (1) | V _{EE} -0.2 | - | V _{EE} | V | |
| “0” Output Voltage | SEGMENT COM1~3 | V _{OL} (1) | 0 | - | 0.2 | V | |
| “M” Output Voltage | COM1~3 | V _{OM} | V _{DD} -0.2 | - | V _{DD} +0.2 | V | |
| “1” Output Voltage | K1~K10 | V _{OH} (2) | V _{DD} -0.2 | - | V _{DD} | V | |
| “0” Output Voltage | K1~K14 | V _{OL} (2) | 0 | - | 0.2 | V | |
| “1” Output Resistance | SEGMENT COM1~3 | R _{OH} | - | - | 70 | KΩ | V _{OUT} = V _{EE} -0.5V |
| “0” Output Resistance | SEGMENT COM1~3 | R _{OL} | - | - | 70 | KΩ | V _{OUT} = 0.5V |

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| Parameter | Name | Sym. | Min. | Typ. | Max. | Unit | Condition |
|--------------------------|-------------------|-----------------------|------|------|-------|------|------------------------------------|
| Key Pull Down Resistance | K1~K10 | R _{KEYL} (1) | 240 | - | 650 | KΩ | V _{OUT} = V _{DD} |
| Key Pull Up Resistance | K1~10 | R _{KEYH} (1) | - | - | 10 | KΩ | V _{OUT} = 0.5V |
| | RESET | R _{KEYH} (2) | 50 | - | 370 | KΩ | V _{OUT} = 0.5V |
| Oscillating (WAIT) | | f _{0WAIT} | 10.8 | 18.0 | 25.2 | KHz | V _{DD} = 1.5V |
| Frequency (OPERATE) | | f _{0OP} | 57.6 | 96.0 | 134.4 | KHz | V _{DD} = 1.5V |
| Frame Frequency | SEGMENT COM1~3 | f _F | 56.3 | 93.8 | 131 | Hz | V _{DD} = 1.5V |
| Supply Current | 1 (WAIT) | I _{DDWAIT} | - | 2.2 | 3.4 | μA | V _{DD} = 1.5V |
| | 2 (OPERATE) | I _{DDOP} | - | 7.0 | 11.0 | μA | V _{DD} = 1.5V |
| | 3 (OFF) | I _{DDOFF} | - | - | 1.0 | μA | V _{DD} = 1.5V |
| Power off Timer Times | | T | 429 | 600 | 1001 | SEC | V _{DD} = 1.5V |

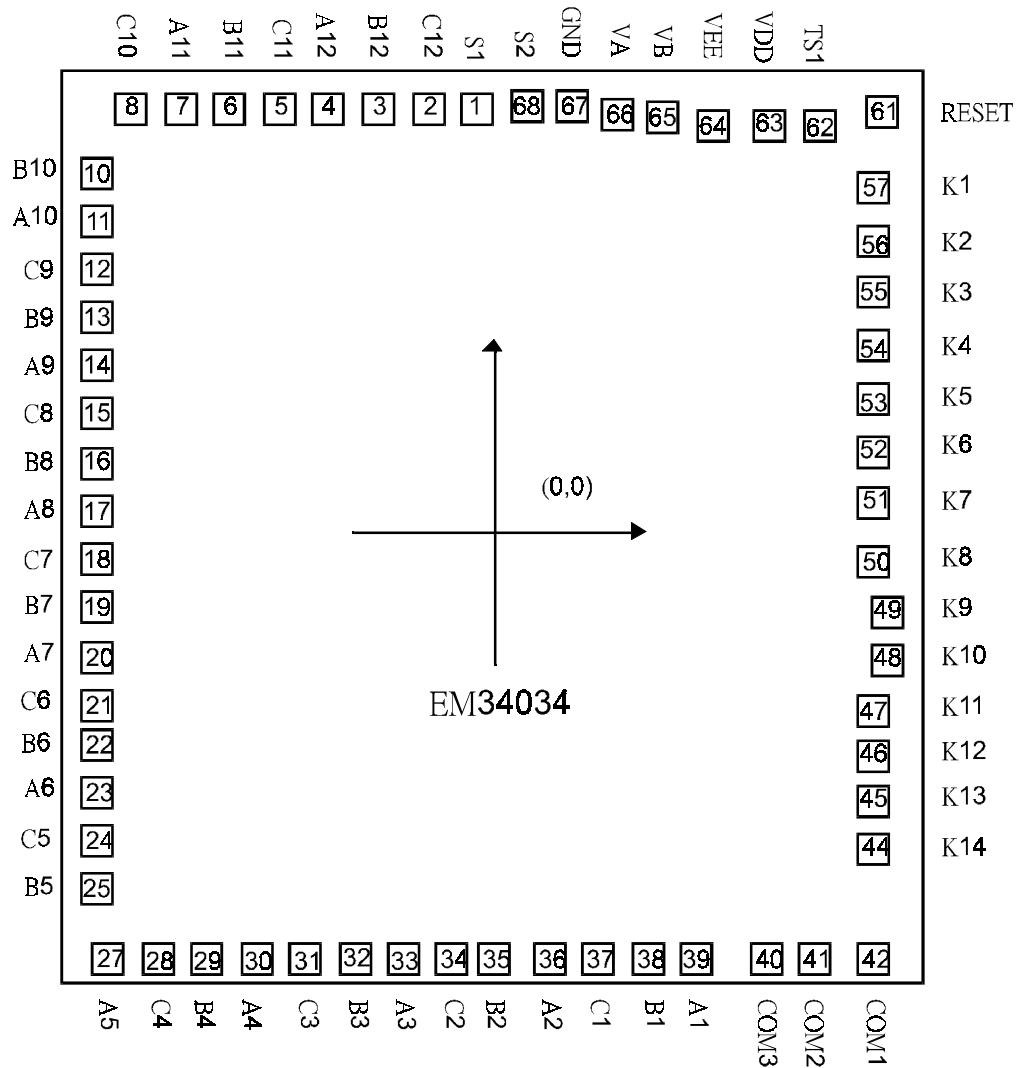
Preliminary

7. APPLICATION BLOCK DIAGRAM



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8. PAD DIAGRAM



| Pad No. | Symbol | X | Y |
|---------|--------|--------|--------|
| 1 | S1 | -53.3 | 1207.0 |
| 2 | C12 | -188.3 | 1207.0 |
| 3 | B12 | -323.3 | 1207.0 |
| 4 | A12 | -458.3 | 1207.0 |
| 5 | C11 | -593.3 | 1207.0 |
| 6 | B11 | -728.2 | 1207.0 |
| 7 | A11 | -863.3 | 1207.0 |



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| Pad No. | Symbol | X | Y |
|---------|--------|---------|---------|
| 8 | C10 | -998.3 | 1207.0 |
| 9 | NC | | |
| 10 | B10 | -1096.4 | 991.4 |
| 11 | A10 | -1096.4 | 856.4 |
| 12 | C9 | -1096.4 | 721.4 |
| 13 | B9 | -1096.4 | 586.4 |
| 14 | A9 | -1096.4 | 451.4 |
| 15 | C8 | -1096.4 | 316.4 |
| 16 | B8 | -1096.4 | 181.4 |
| 17 | A8 | -1096.4 | 46.4 |
| 18 | C7 | -1096.4 | -88.6 |
| 19 | B7 | -1096.4 | -223.6 |
| 20 | A7 | -1096.4 | -358.6 |
| 21 | C6 | -1096.4 | -493.6 |
| 22 | B6 | -1096.4 | -628.6 |
| 23 | A6 | -1096.4 | -763.6 |
| 24 | C5 | -1096.4 | -898.6 |
| 25 | B5 | -1096.4 | -1033.6 |
| 26 | NC | | |
| 27 | A5 | -1049.4 | -1249.4 |
| 28 | C4 | -914.4 | -1249.4 |
| 29 | B4 | -779.4 | -1249.4 |
| 30 | A4 | -644.4 | -1249.4 |
| 31 | C3 | -509.4 | -1249.4 |
| 32 | B3 | -374.4 | -1249.4 |
| 33 | A3 | -239.4 | -1249.4 |
| 34 | C2 | -104.4 | -1249.4 |
| 35 | B2 | 30.6 | -1249.4 |
| 36 | A2 | 165.6 | -1249.4 |
| 37 | C1 | 300.6 | -1249.4 |
| 38 | B1 | 435.6 | -1249.4 |
| 39 | A1 | 570.6 | -1249.4 |
| 40 | COM3 | 751.3 | -1249.4 |
| 41 | COM2 | 892.3 | -1249.4 |
| 42 | COM1 | 1032.7 | -1249.4 |
| 43 | NC | | |
| 44 | K14 | 1039.8 | -915.5 |
| 45 | K13 | 1039.8 | -769.0 |
| 46 | K12 | 1039.8 | -625.8 |
| 47 | K11 | 1039.8 | -479.3 |



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| Pad No. | Symbol | X | Y |
|---------|--------|--------|--------|
| 48 | K10 | 1087.2 | -339.1 |
| 49 | K9 | 1087.2 | -198.6 |
| 50 | K8 | 1057.6 | -56.3 |
| 51 | K7 | 1057.6 | 86.8 |
| 52 | K6 | 1057.6 | 232.6 |
| 53 | K5 | 1057.6 | 375.7 |
| 54 | K4 | 1057.6 | 521.5 |
| 55 | K3 | 1057.6 | 664.6 |
| 56 | K2 | 1057.6 | 810.4 |
| 57 | K1 | 1057.6 | 953.5 |
| 58 | NC | | |
| 59 | NC | | |
| 60 | NC | | |
| 61 | RESET | 1085.2 | 1201.8 |
| 62 | TS1 | 939.3 | 1172.2 |
| 63 | VDD | 792.6 | 1170.8 |
| 64 | VEE | 624.9 | 1164.2 |
| 65 | VB | 489.9 | 1188.5 |
| 66 | VA | 351.7 | 1188.5 |
| 67 | GND | 216.7 | 1207.0 |
| 68 | S2 | 81.7 | 1207.0 |

Chip Size : 2500 x 2800 um

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