

9325812 UNITED MICROELECTRONICS

92D 00707

D T-49-13-02



UM3032A

8-Digit Single-Chip CMOS Calculator

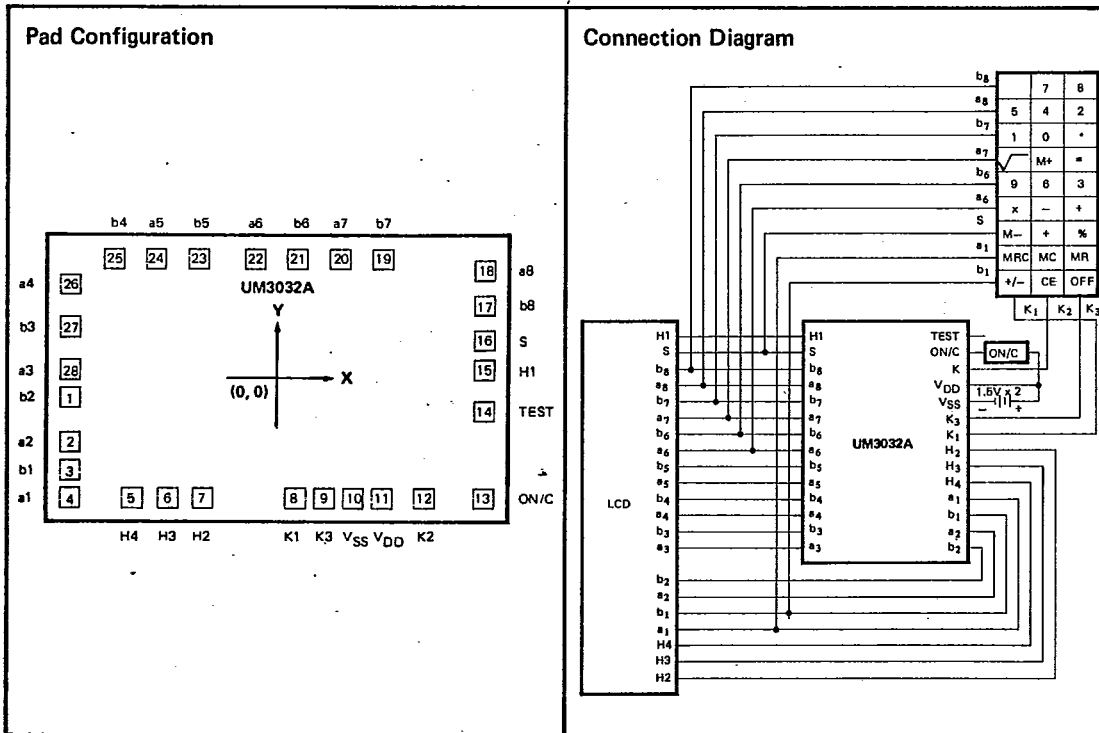
Features

- 8-Digit number capacity with floating decimal point
- Memory (M), negative (-) and error (E) symbols
- Memory calculations
- Six mathematical functions (+, -, x, ÷, %, $\sqrt{\quad}$)
- Leading zero and trailing zero suppression
- Multiplexed output for direct driving of LCD
- On-Chip clock generator that requires no external circuits
- On-Chip keyboard encoding and debouncing circuit
- Power-On/clear and power-off keys
- Automatic power-off, typically 6 minutes after the last key entry

General Description

The UM3032A is an 8-digit, one-memory IC. It provides an on-chip clock generator, input pins for keyboard matrix, and all necessary pins for direct driving of a liquid

crystal display. The UM3032A is intended for battery-operated, hand-held calculators.



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Absolute Maximum Ratings*

All Voltages Pertain to V_{SS}

Supply Voltage V_{DD}	0 to 3.3V
Input Voltage	-0.3 to $V_{DD} + 0.3V$
Operating Temperature	0 to 50°C
Storage Temperature	-20 to 70°C
Load Capacitance	μP to 100PF

***Comments**

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

($V_{DD} = 3V, T_A = 25^\circ C$, unless otherwise specified.)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition	Notes (below)
Supply Voltage	V_{DD}	2.7	3.0	3.3	V	-	1
Input Voltage (High)	V_{IH}	2.3	-	3.0	V	-	1
Input Voltage (Low)	V_{IL}	0	-	0.7	V	-	1
Output Voltage (0)	V_0	0	0	0.2	V	-	2
Output Voltage (1)	V_1	0.8	1	1.2	V	-	2
Output Voltage (2)	V_2	1.8	2.0	2.2	V	-	2
Output Voltage (3)	V_3	2.8	3.0	3.0	V	-	2
Output Voltage (High)	V_{OH}	2.8	3.0	-	V	-	3
Output Voltage (Low)	V_{OL}	-	0	0.2	V	-	3
Output Current (High)	I_{OH}	20	40	-	μA	$V_{OH} = 2.8V$	3
Output Current (Low)	$-I_{OL}$	10	20	-	μA	$V_{OL} = 0.2V$	3
Input Current (High)	I_{IH}	-	3	15	μA	$V_{IH} = 3V$	1
Input Current (Low)	$-I_{IL}$	-	2	5	μA	$V_{IL} = 0V$	1
Frame Frequency	F_{FR}	55	72	-	Hz	-	4
Supply Current (On)	$I_{DD} (on)$	-	-	70	μA	All clear	5
Supply Current (Off)	$I_{DD} (off)$	-	0.3	1	μA	Power off	6

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Pad Description

Pad No.	Label		Description
	Input	Output	
1		b2	b2 output signal to LCD
2		a2	a2 output signal to LCD
3		b1	b1 output signal to LCD and strobe to key
4		a1	a1 output signal to LCD and strobe to key
5		H4	H4 output signal to LCD
6		H3	H3 output signal to LCD
7		H2	H2 output signal to LCD
8	K1		Key input signal 1
9	K3		Key input signal 3
10	V _{SS}		Ground
11	V _{DD}		Power supply terminal
12	K2		Key input signal 2
13	ON/C		Auto-power-on and clear input
14			Test
15		H1	H1 output signal to LCD
16		S	S output signal to LCD and strobe to key
17		b8	b8 output signal to LCD and strobe to key
18		a8	a8 output signal to LCD and strobe to key
19		b7	b7 output signal to LCD and strobe to key
20		a7	a7 output signal to LCD and strobe to key
21		b6	b6 output signal to LCD and strobe to key
22		a6	a6 output signal to LCD and strobe to key
23		b5	b5 output signal to LCD and strobe to key
24		a5	a5 output signal to LCD and strobe to key
25		b4	b4 output signal to LCD and strobe to key
26		a4	a4 output signal to LCD
27		b3	b3 output signal to LCD
28		a3	a3 output signal to LCD

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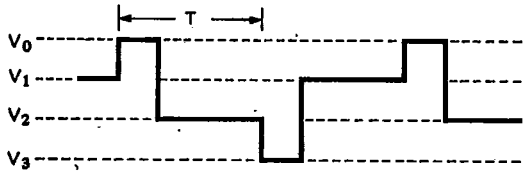
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UM3032A

Notes: 1. Applies to key input signals $K_1, K_2,$ & K_3 .

2. Applies to LCD back plate signals H_i ($i = 1-4$) and a_j, b_j ($j = 1-8$), and S , when used as LCD segment signals. The following diagram shows an example of output waveform in which spikes are excluded.

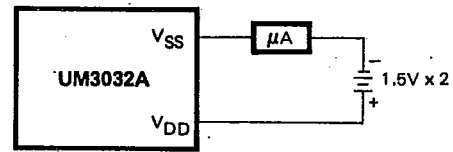


$F_{FR} = 1/T$

3. Applies to a_k, b_k ($k = 5-8$), b_4 , when used as keyboard scanning strobes.

4. Measures the waveform of the back plate signals during the key non-depressing state. $F_{FR} = 1/T$, as shown in note 2.

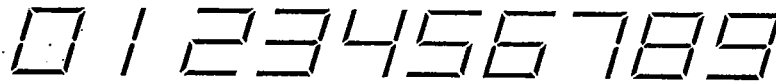
5. For measurement, apply the following circuit, with "0" displayed and no key depressed.



6. For measurement, apply the circuit shown above, after the operation of auto-power-off or depression of "OFF" key.

Display Format

NUMBERS:



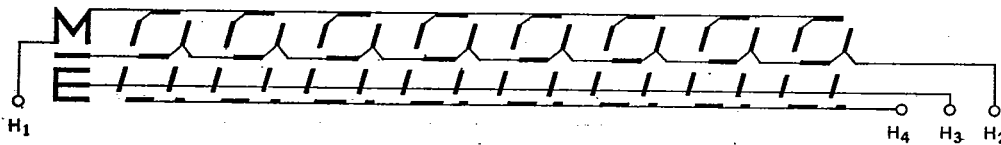
SYMBOLS:

M: Displayed when memory content is not zero.
 -: Displayed when data is negative.

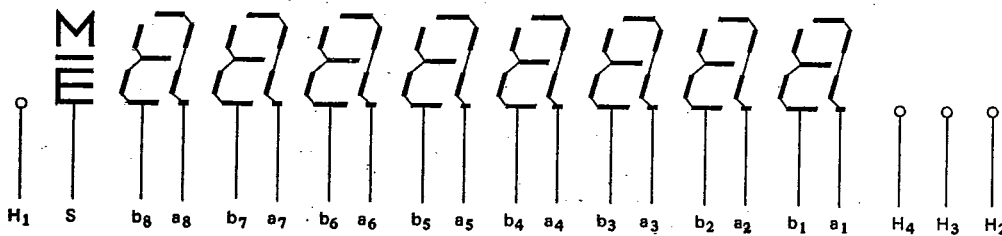
E: Displayed when error occurs.

LCD Configuration

H LINES (BACK PLATE):



SEGMENT LINES:



KEYBOARD DEBOUNCE: Key make time - 20 ms Max.
 Key break time - 30 ms Max.

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Keyboard Description

Equals Key (=)

Performs previous 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 (÷)

Enters dividend.
Performs previous operation and displays result.

Addition Key (+)

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

Subtraction Key (-)

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

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 be principal.

Change Sign Key (+/-)

Pushing the "+" or "-" 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/Clear Key (ON/C)

First push as power on will disp ay "0".
In the middle of a digit entry, a second push will clear all registers except memory.

Clear Entry Key (CE)

During digit entry, one depression will clear the entry register to zero.

Square Root Key ($\sqrt{\quad}$)

The 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. This will terminate a number entry.

Memory Minus Key "M-"

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

Memory Recall and Clear Key (R. CM)

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

Number, Decimal Key (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 enter data in the display register. The first decimal point entered is effective. An attempted entry of more than 8 digits or 7 decimal places will be ignored.

Memory Clear Key (CM)

Clears the memory.

Memory Recall Key (RM)

Transfers the contents of the memory register into the display register.

Error Conditions

System Error

- An absolute value exceeding $10^{16} - 1$.
- In the memory calculation, a result in absolute value exceeding $10^8 - 1$.
- At the discount/mark-up calculation, a result in absolute value exceeding $10^8 - 1$.
- Division by zero.
- Negative number square root calculation.

Operation Error

In the arithmetic, %, square/reciprocation calculation, a result exceeding $10^8 - 1$ below $10^{16} - 1$.

Error Indication

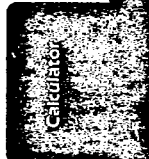
System error:

The first digit is 0 and the symbol digit display "E".

Operation error:

When the result in absolute value exceeds $10^8 - 1$, the symbol digit will display "E"

If the result in absolute value is less than 10^{-8} , zero shift is stop.



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Error Release

System error:

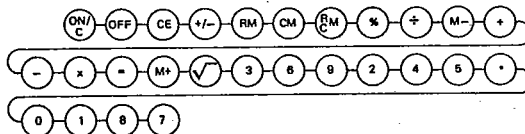
Push the ON/C key.

Operation error:

Push the ON/C key or CE key. When CE key is pushed the symbol "E" disappears and the result is still kept in register to allow the calculation to continue.

Key Priority

If more than one key is depressed simultaneously, the following figure show key priority.



Operation Characteristics

Constant Operation

The UM3032A has an implied constant mode on \div , $-$, \times , and $\%$ operations. The constant calculation is performed automatically by the = key, % key, or $\% =$ keys without a constant switch. The second operand is treated as the constant for addition, subtraction, and division, while the first operand is the constant for multiplication.

If any number except zero is in the memory, the symbol digit will display an "M"

Application Note

The UM3032A includes a display test/chip identification function that requires few external components and will cause the following to be displayed:

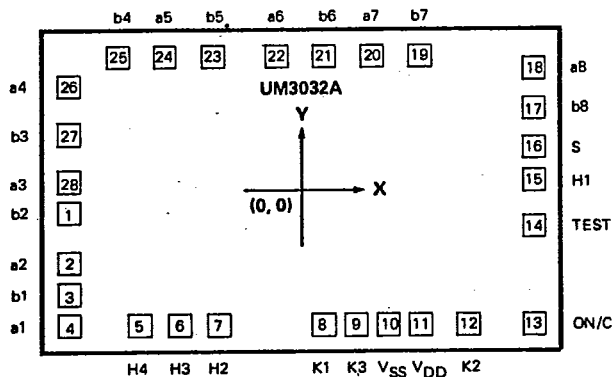


Automatic Power-Off

If no key is depressed for 6 minutes, an internal automatic power-off. circuit will turn off the power.

The operation is to press simultaneously all of the keys on the keyboard except those in the top row ($\sqrt{\quad}$, $\%$, OFF, ON/C).

Bonding Diagram



unit: μm

Pad No.	Designation	X	Y	Pad No.	Designation	X	Y
1	b2	-985.01	117.09	15	H1	963.93	-363.98
2	a2	-981.96	-140.97	16	S	970.02	-171.95
3	b1	-985.01	-325.12	17	b8	970.02	115.06
4	a1	-985.01	-700.02	18	a8	963.93	462.02
6	H4	-788.92	-852.93	19	b7	895.09	855.98
6	H3	-608.07	-848.10	20	a7	686.05	855.98
7	H2	-420.87	-848.10	21	b6	496.06	853.94
8	K1	17.01	-848.10	22	a6	136.90	855.98
9	K3	207.01	-848.10	23	b5	-360.93	853.94
10	VSS	390.90	-848.10	24	a5	-595.88	853.94
11	VDD	583.94	-848.10	25	b4	-788.92	855.98
12	K2	776.98	-848.10	26	a4	-985.01	738.88
13	ON/C	963.93	-848.10	27	b3	-985.01	551.94
14	Test	970.02	-553.97	28	a3	-985.01	296.92

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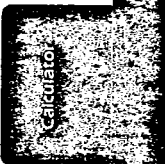
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Arithmetic Operations

	Key Operation	Display
Entry	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 1 2 3 4 5 6 7 8
Four Fundamental Arithmetic Calculation	$a + b =$ $a - b =$ $a \times b =$ $a \div b =$	$a + b$ $a - b$ $a \cdot b$ $a \div b$
Square Root Calculation	$a \sqrt{\quad}$ $a \pm \sqrt{\quad}$ ON/C $a \times b \sqrt{\quad}$ $=$	\sqrt{a} E \sqrt{b} $a \cdot \sqrt{b}$
Percent Calculation	$a \times b \%$ $+ =$ $a \times b \%$ $- =$ $a \div b \%$ $+ =$ $a - b \%$	$a \cdot b/100$ $a + (a \cdot b/100)$ $a \cdot b/100$ $a - (a \cdot b/100)$ $100 \cdot a/b$ $a + (a \cdot b/100)$ $a - (a \cdot b/100)$
Constant Calculations	$k \times b =$ $c =$ $a \div k =$ $c =$ $k \times b \%$ $c \%$ $a \div k \%$ $c \%$ $a + k =$ $b =$ $a - k =$ $b =$	$k \cdot b$ $k \cdot c$ a/k c/k $k \cdot b/100$ $k \cdot c/100$ $100 \cdot a/k$ $100 \cdot c/k$ $a + k$ $b + k$ $a - k$ $b - k$



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	Key Operation	Display	Memory
Repeated Calculation	a $\boxed{+}$ b $\boxed{=}$ $\boxed{=}$	a + 2b	
	a $\boxed{-}$ b $\boxed{=}$ $\boxed{=}$	a - 2b	
	a $\boxed{\div}$ b $\boxed{=}$ $\boxed{=}$	(a/b)/b	
	a $\boxed{\times}$ b $\boxed{=}$ $\boxed{=}$	(a * b) * a	
Mixed Calculations (at $[(a+b) \cdot c/d] \cdot e > 10^8$)	a $\boxed{+}$ b $\boxed{\times}$ c $\boxed{\div}$ d $\boxed{=}$	(a + b) * c/d	
	$\boxed{\times}$ e $\boxed{=}$	((a+b) * c/d) * e / 10 ⁸ E	
	\boxed{CE}	((a+b) * c/d) * e / 10 ⁸	
Power Calculation	a $\boxed{\times}$ $\boxed{=}$	a ²	
	$\boxed{\times}$ $\boxed{=}$	a ⁴	
	a $\boxed{\times}$ $\boxed{=}$ $\boxed{=}$	a ³	
	a $\boxed{\div}$ $\boxed{=}$	1/a	
	a $\boxed{\div}$ $\boxed{=}$ $\boxed{=}$	1/a ²	
Memory Calculations (at $ a+b+c \cdot d+e > 10^8$)	a $\boxed{M+}$	a ^M	a
	a $\boxed{M-}$	b ^M	a - b
	\boxed{RM}	a - b ^M	a - b
	\boxed{CM}	a - b	0
	a $\boxed{+}$ b $\boxed{M+}$	a + b ^M	a + b
	c $\boxed{\times}$ d $\boxed{M+}$	c * d ^M	a + b + c * d
	\boxed{RM}	a + b + c * d ^M	a + b + c * d
	e $\boxed{M+}$	0 ^M _E	a + b + c * d
	$\boxed{ON/C}$	0 ^M	a + b + c * d
	\boxed{RM}	a + b + c * d ^M	a + b + c * d

Ordering Information

Type	Package	Mask Type
UM3032A	PLASTIC	MIRROR
UM3032AH	CHIP	MIRROR
UM3032AB	C.O.B.	MIRROR