

9325812 UNITED MICROELECTRONICS

92D 00730

D T-4913-02



UM3135

ADVANCED PRODUCT DESCRIPTION

8-Digit Single-Chip CMOS Calculator

Features

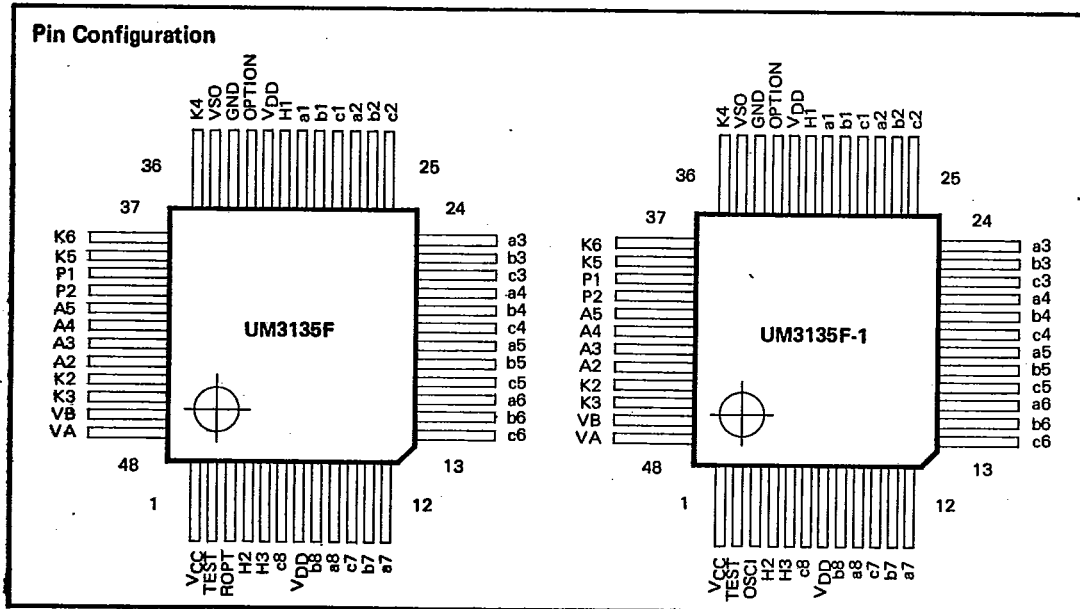
- Number of digits
 - 8 digits (rough estimate calculation possible).
- Calculations
 - Standard four functions (+, -, x, ÷).
 - Chain multiplication and division.
 - Auto-constant calculation (constant multiplicand, divisor, addend or subtrahend).
 - Square and reciprocal calculations.
 - Mark-up and mark-down calculations.
 - Extraction of square root.
 - Percentage calculations.
 - Power calculations.
 - Rough estimate calculations.
 - Memory calculations.
- Decimal point system
 - Complete floating decimal point system.
- Display format
 - 8 digits + sign (-, E, and M) leading zero suppression, zero shift.
- Negative number indication
 - Number + minus (-) sign.
- On-chip supply voltage limiter by bonding option.
- Built-in RC Oscillator.
- Auto-power-off or no auto-power-off by bonding option.
- Quad in line flat package (48 pin) or chip is available.

General Description

The UM3135 is a single-chip CMOS calculator LSI with 8-digit, four-function arithmetic operations, single memory, extraction-of-square-root and percentage calculation functions, leading zero and trailing zero suppression, chain calculations, and internal debouncing

and encoding of keyboard inputs. It is designed for LCD operation with a 1.5V power supply. Low power dissipation, low system cost, and single power supply make the UM3135 ideal for battery or solar cell operated, hand-held calculators.

Pin Configuration



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**UM3135****Absolute Maximum Ratings***Terminal voltage, V_{DD} : $-0.3 \sim +2.3V^*$ Terminal voltage, V_{IN} : $-0.3 \sim V_{DD} + 0.3V$ Operating temperature: T_{opr} $0 \sim +50^\circ C$ Storage temperature: T_{stg} $-20 \sim +70^\circ C$

*Maximum voltage on any pin with respect to GND.

***Comments**

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Characteristics $(V_{DD} = 1.5V, T_A = 25^\circ C, \text{ unless otherwise specified.})$

Parameter	Symbol	Test Conditions	Rating			Unit
			Min.	Typ.	Max.	
Supply Voltage	V_{DD}		1.2		1.7	V
Input Voltage	$V_{IL}^{(1*)}$				0.4	V
	$V_{IH}^{(1*)}$		$V_{DD} - 0.4$			V
Input Current	$I_{IH}^{(1*)}$	$V_{IN} = V_{DD}$	0.3	1.0	3	μA
	$I_{IL}^{(1*)}$	$V_{IN} = 0V$			1	μA
Output Voltage	$V_{OH}^{(2*)}$	No load	$V_{DD} - 0.15$			V
	$V_{OL}^{(2*)}$	$I_{OUT} = 15 A$			0.15	V
	$V_{OA}^{(3*)}$		1.2	1.5		V
	$V_{OB}^{(3*)}$		-0.2	0.0	0.2	V
	$V_{OC}^{(3*)}$			-1.5	-1.2	V
Output Voltage (High)	$V_H^{(4*)}$		1.2	1.5		V
Output Voltage (Low)	$V_L^{(4*)}$			-1.5	-1.2	V
Output Current (High)	I_{OH}	$V_H = 1.2V$	20	40		μA
Output Current (Low)	$-I_{OL}$	$V_L = -1.2V$	10	20		μA
Display Frequency	$f_{dl}^{(3*)}$	$V_{DD} = 1.5V$, Display on	70	100	120	Hz
Dissipation Current	$I_{DD}^{(4*)}$	Display off			0.8	μA
	$I_{DD1}^{(5*)}$	$V_{DD} = 1.5V$, Display on		3	5	μA

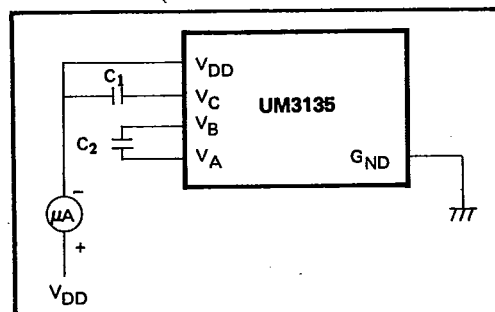
1* Applies to terminals K2 - K6.

2* Applies to terminals P1, P2 and A2 - A5.

3* Applies to terminals H_i ($i = 1 - 3$), a_i , b_i and c_i ($i = 1 - 8$).

4* Measured by the following test circuit after power supply automatically turns off.

5* Measured by the above test circuit while "0" is being displayed after auto-clear operation and while no key is being depressed.



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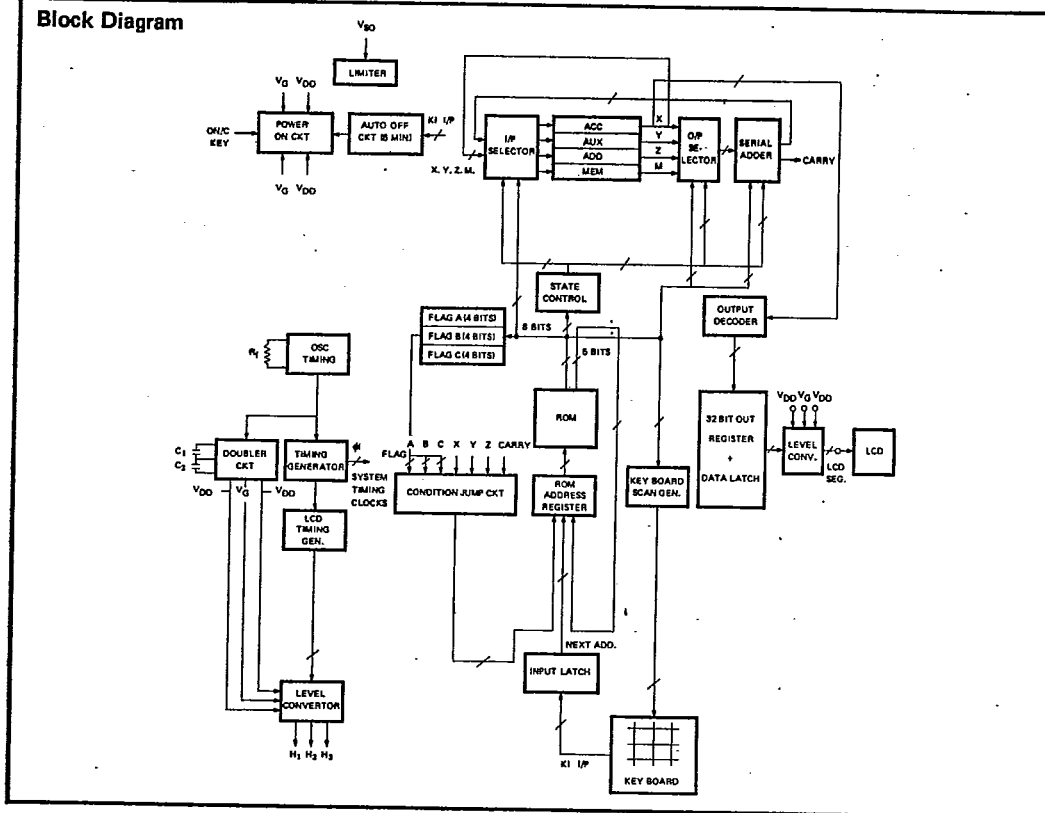
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Block Diagram



Pin Functional Description

Pin No.	Designation	Function
1	Vc	Connected As Voltage Doubler
2	TEST	Test Pin Connected As RC Oscillator
3-A	Ropt	For RC Oscillator Use
3-B	OSCI	Connected As RC Oscillator
4	H2	H2 O/P Signal to LCD (Segment)
5	H3	H3 O/P Signal to LCD (Segment)
6	C8	C8 O/P Signal to LCD (Segment)
7	VDD	Power Supply Terminal
8	b8	b8 O/P Signal to LCD (Segment)
9	a8	a8 O/P Signal to LCD (Segment)
10	c7	c7 O/P Signal to LCD (Segment)
11	b7	b7 O/P Signal to LCD (Segment)
12	a7	a7 O/P Signal to LCD (Segment)
13	c6	c6 O/P Signal to LCD (Segment)
14	b6	b6 O/P Signal to LCD (Segment)
15	a6	a6 O/P Signal to LCD (Segment)
16	c5	c5 O/P Signal to LCD (Segment)
17	b5	b5 O/P Signal to LCD (Segment)
18	a5	a5 O/P Signal to LCD (Segment)
19	c4	c4 O/P Signal to LCD (Segment)
20	b4	b4 O/P Signal to LCD (Segment)
21	a4	a4 O/P Signal to LCD (Segment)
22	c3	c3 O/P Signal to LCD (Segment)
23	b3	b3 O/P Signal to LCD (Segment)
24	a3	a3 O/P Signal to LCD (Segment)

Pin No.	Designation	Function
25	c2	c2 O/P Signal to LCD (Segment)
26	b2	b2 O/P Signal to LCD (Segment)
27	a2	a2 O/P Signal to LCD (Segment)
28	c1	c1 O/P Signal to LCD (Segment)
29	b1	b1 O/P Signal to LCD (Segment)
30	a1	a1 O/P Signal to LCD (Segment)
31	H1	H1 O/P Signal to LCD (Segment)
32	V _{DD}	Power Supply Terminal
33	OPTION	Auto-Power-Off Option
34	GND	Ground
35	V _{SO}	Solar Cell Voltage
36	K4	Key I/P Signal
37	K6	Key I/P Signal
38	K5	Key I/P Signal
39	P1	P1 O/P Strobe Signal To Key
40	P2	P2 O/P Strobe Signal To Key
41	A5	A5 O/P Strobe Signal To Key
42	A4	A4 O/P Strobe Signal To Key
43	A3	A3 O/P Strobe Signal To Key
44	A2	A2 O/P Strobe Signal To Key
45	K2	Key I/P Signal
46	K3	Key I/P Signal
47	V _B	Connected As Voltage Doubler
48	V _A	Connected As Voltage Doubler

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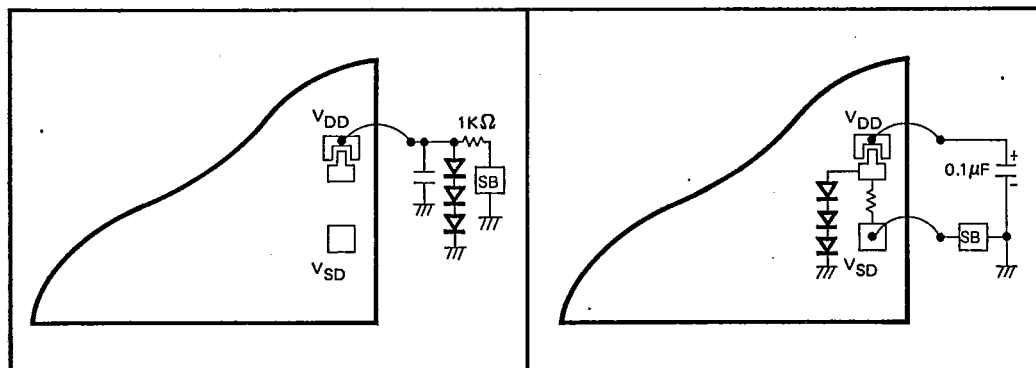
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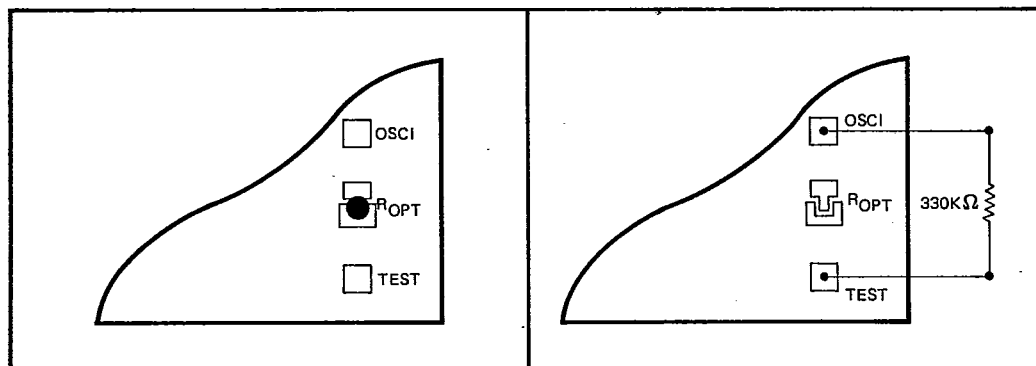
Voltage Limiter Bonding Option Method



a) Configuration Using External Voltage Limiter

b) Configuration Using Internal Voltage Limiter

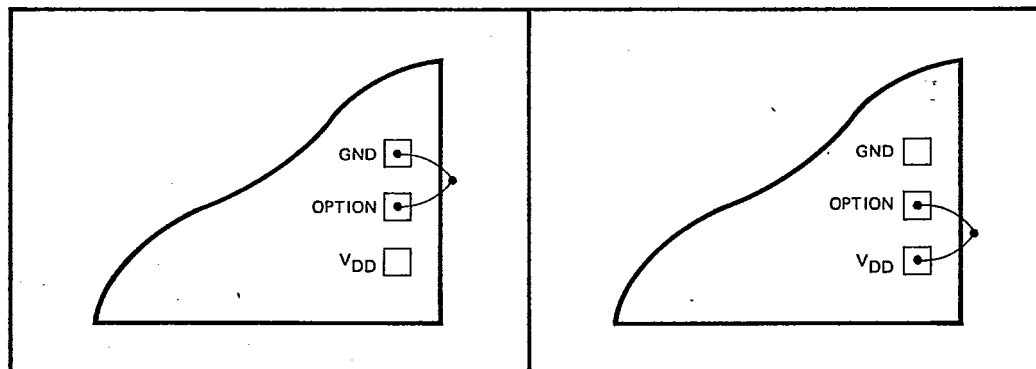
RC Oscillator Bonding Option Method



a) Configuration Using Internal RC Oscillator

b) Configuration Using External RC Oscillator

Auto-power-off Bonding Option Method



a) Configuration Using Auto-power-off

b) Configuration Using no Auto-power-off

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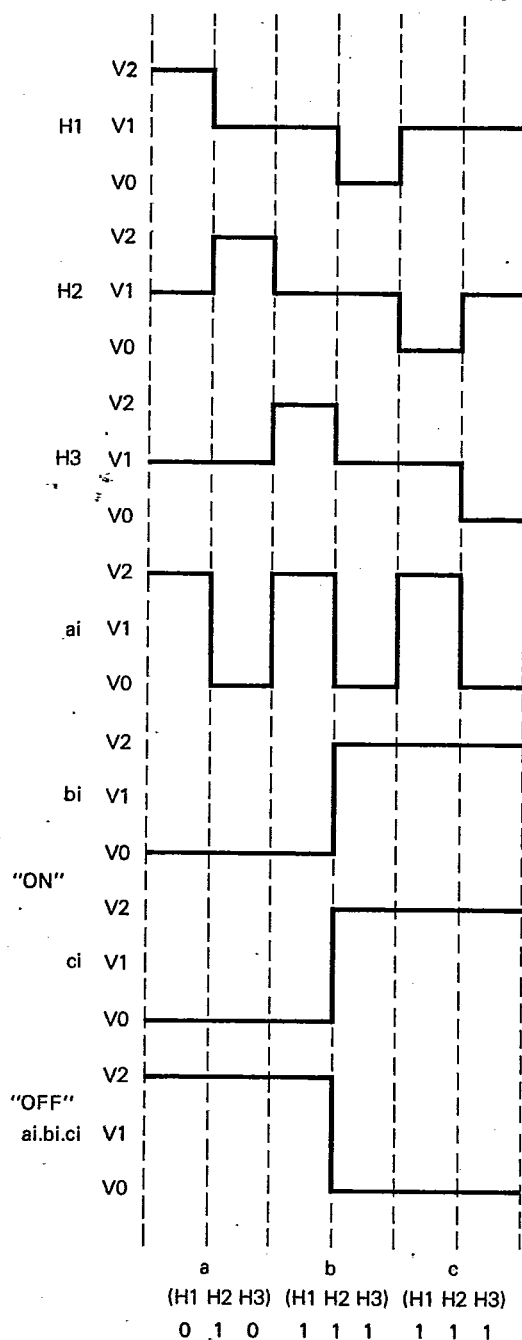
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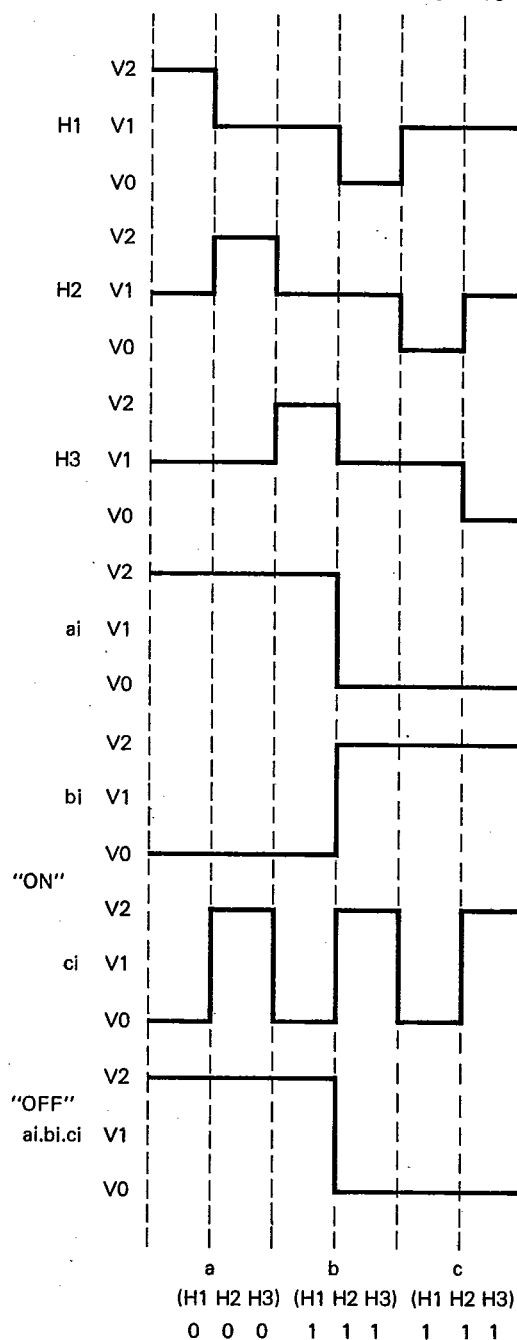
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Display Example

NO "8" ON OR OFF WAVEFORM
T1 T2 T3 T4 T5 T6



NO "5" ON OR OFF WAVEFORM
T1 T2 T3 T4 T5 T6



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Display Format
Numericals Font

1 2 3 4 5 6 7 8 9 0

Sign Font

M

MEMORY LOADING

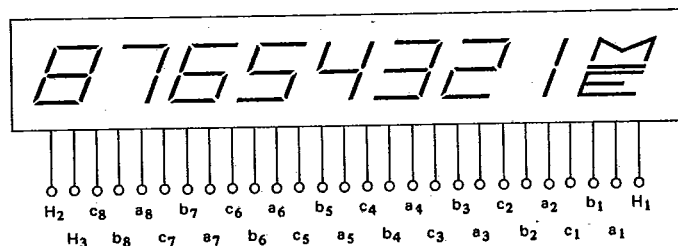
E

ERROR

—

MINUS

LCD Connection

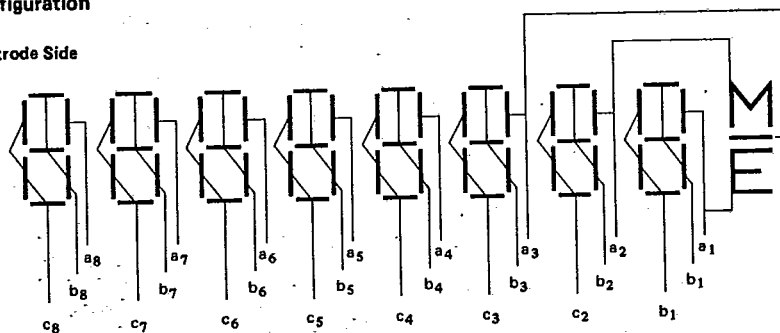


LCD Driving System

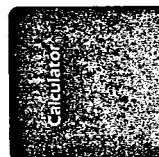
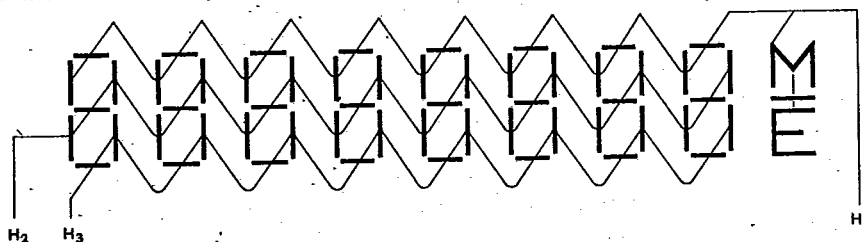
1/2 bias, 1/3 duty

Display Configuration

Segment Electrode Side



Common Electrode Side



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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 be added on, such as tax or interest. Depression of the = key adds this amount to the principal.

Change Sign Key (+/-)

First push of "-" key will read as "-". A second push will cause the "-" sign to disappear.
During digit entry, this changes the sign of the entered factor.

Power ON/ALL Clear Key (ON/AC)

The first push, as power, on, displays "0"
In the middle of a digit entry, a second push, as all-clear will clear all registers and 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 being displayed in the entry register.

Memory Plus Key "M+"

Adds the current display to the contents of memory.
M+ will terminate a number entry.

Memory Minus Key "M-"

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

Memory Recall And Clear Key (R_M C_M)

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

Memory Clear Key (CM)

Clears the memory.

Memory Recall Key (RM)

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

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.

Error Conditions

Error Detection

- * System errors occur when:
 - a. The integral part of any calculation result exceeds 16 digits.
 - b. The integral part of any memory calculation result exceeds 8 digits, or the integral part of any addend or subtrahend to memory exceeds 8 digits.
 - c. The integral part of a mark-up and mark-down calculation result exceeds 8 digits.
 - d. Division by zero is attempted.
 - e. The extraction of the square root of a negative number is attempted.
- * Rough estimate calculation results occur when:
The integral part of the result of any one of standard four functions; percentage, square, reciprocal, or power calculations, exceed 8 digits and is equal to 16 digits or less.

Error Indication

- * System error:
"0" is indicated in the first digit position and "E" in the sign-digit position.
- * Rough estimate calculation results:
The high-order 8 digits of a calculation result are indicated together with "E". The location of the decimal point corresponds to the result of calculation times 10^{-8} , and no zero shift is performed.



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Error Release

- * **System error:**
A system error can be released by depressing the ON/AC key.
- * **Rough estimate calculation result:**
A rough estimate calculation error can be released by depressing the ON/AC or CE key. A calculation result is not cleared by CE key but is retained.

Operation Characteristics

Constant Operation

The UM3135 has an implied constant mode on +, -, x, / and % operations. The constant calculation is performed automatically by the = key, % key, or % and = 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.

Number Entry

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

Memory Protection

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

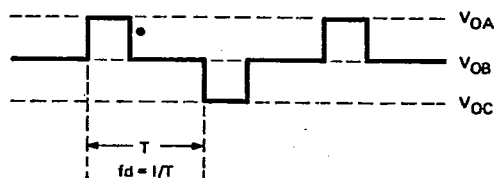
Memory Indication

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

Auto-Power-Off

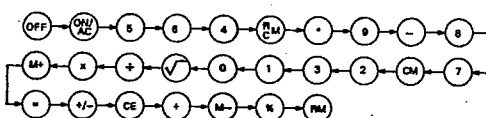
If any key is not depressed for a specific period of time, the power supply will automatically turn off. This time interval is 131, 072 words (Approx. 7 minutes and 12 seconds at $f_d = 100\text{Hz}$; the display time of a word is equal to 3.3 mS when $f_d = 100\text{Hz}$)

Output waveform example



Double Key Depression

The order of priority, when two keys are depressed simultaneously is as follows:

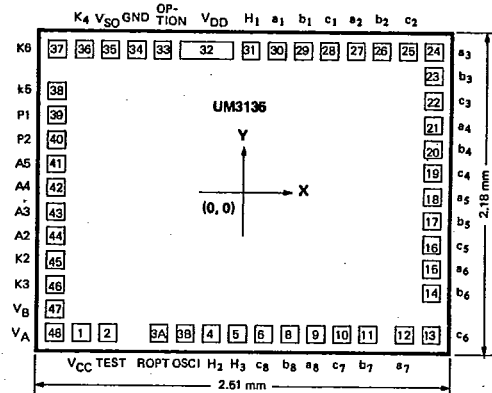


When the OFF and ON/AC keys are depressed simultaneously, the OFF key is given priority.

Key Bounce Protection

- * Front edge: Down to 1 word and up to about 3 words.
 - * Back edge: 12 words
- The display time of a word is equal to 3.3mS when display frequency $f_d = 100$ Hz

Bonding Diagram

unit: μm

Pad No.	Designation	X	Y
1	VCC	-930	-896
2	TEST	-774	-896
3A	ROPT	-558	-896
3B	OSCI	-376	-896
4	H2	-218	-896
5	H3	-64	-896
6	c8	+92	-896
8	b8	248	-896
9	a8	404	-896
10	c7	506	-896
11	b7	716	-896
12	a7	916	-896
13	c6	1084	-896
14	b6	1084	-666
15	a6	1084	-512
16	c5	1084	-354
17	b5	1084	-198
18	a5	1084	-44
19	c4	1084	112
20	b4	1084	268
21	a4	1084	424
22	c3	1084	580
23	b3	1084	736
24	a3	1084	892
25	c2	926	892
26	b2	770	892
27	a2	614	892
28	c1	464	892
29	b1	312	892
30	a1	162	892
31	H1	8	892
32	VDD	-206	892
33	OPTION	-416	892
34	GND	-602	892
35	VSO	-758	892
36	K4	-942	892
37	K6	-1088	892
38	K5	-1088	678
39	P1	-1088	520
40	P2	-1088	344
41	A5	-1088	190
42	A4	-1088	32
43	A3	-1088	-124
44	A2	-1088	-280
45	K2	-1088	-428
46	K3	-1088	-594
47	VB	-1088	-740
48	VA	-1088	-896

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**UM3135****Arithmetic Operations**

	Key Operation	Display	Memory
Entry	1 2 3 4 5 6 7 8 9 0	12345678.	
Four Fundamental Arithmetic Calculations	$a + b =$ $a - b =$ $a \times b =$ $a \div b =$	$a + b$ $a - b$ $a \cdot b$ $a \div b$	
Square Root Calculations	$a \sqrt{}$ $a +/\- \sqrt{}$ ON/AC $a \times b \sqrt{}$	$\sqrt{a}$ OE O $\sqrt{b}$	
Percent Calculations	$a \times b \%$ $a + \%$ $a \times b \%$ $a - \%$ $a \div b \%$ $a + b \%$ $a - b \%$	$a \cdot \sqrt{b}$ $a \cdot b/100$ $a + (a \cdot b/100)$ $a \cdot b/100$ $a - (a \cdot b/100)$ $100 \cdot a/b$ $a + (a \cdot b/100)$ $a - (a \cdot b/100)$	
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 $k \cdot b/100$ $k \cdot c/100$ $100 \cdot a/k$ $100 \cdot c/k$ $a + k$ $b + k$ $a - k$ $b - k$	
Repeated Calculations	$a + b = =$ $a - b = =$ $a \div b = =$ $a \times b = =$	$a + 2b$ $a - 2b$ $(a/b)/b$ $(a \cdot b) \cdot a$	
Power Calculations	$a \times =$ $a \times =$ $a \times =$ $a \div =$ $a \div =$	a^2 a^4 a^3 $1/a$ $1/a^2$	
Mixed Calculations (at $ [(a+b) \cdot c/d] \cdot e > 10^8$)	$a + b \times c \div d =$ $\times e =$ CE	$(a+b) \cdot c/d$ $(a+b) \cdot c/d \cdot e/10^8 E$ $(a+b) \cdot c/d \cdot e/10^8$	
Memory Calculations	$a M+$ $a M-$ RM CM $a + b M+$ $c \times d M+$ RM $e M+$ ON/AC	$a M$ $b M$ $a - b M$ $a - b$ $a + b M$ $c \cdot d M$ $a + b + c \cdot d M$ $0 M$ $0 E$ 0	a $a - b$ $a - b$ 0 $a + b$ $a + b + c \cdot d$ $a + b + c \cdot d$ $a + b + c \cdot d$ 0

(at $|a+b+c \cdot d + e| > 10^8$)

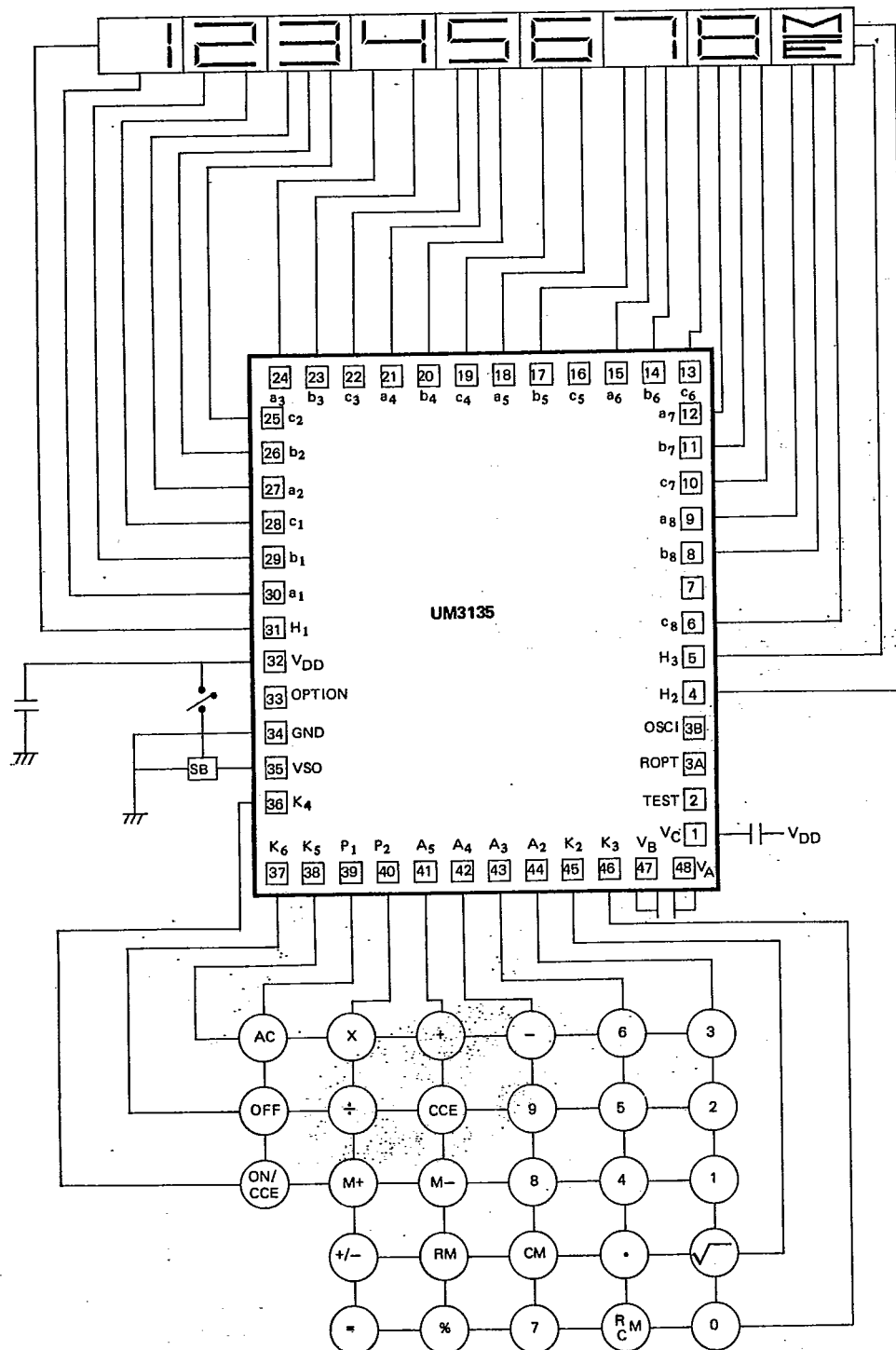
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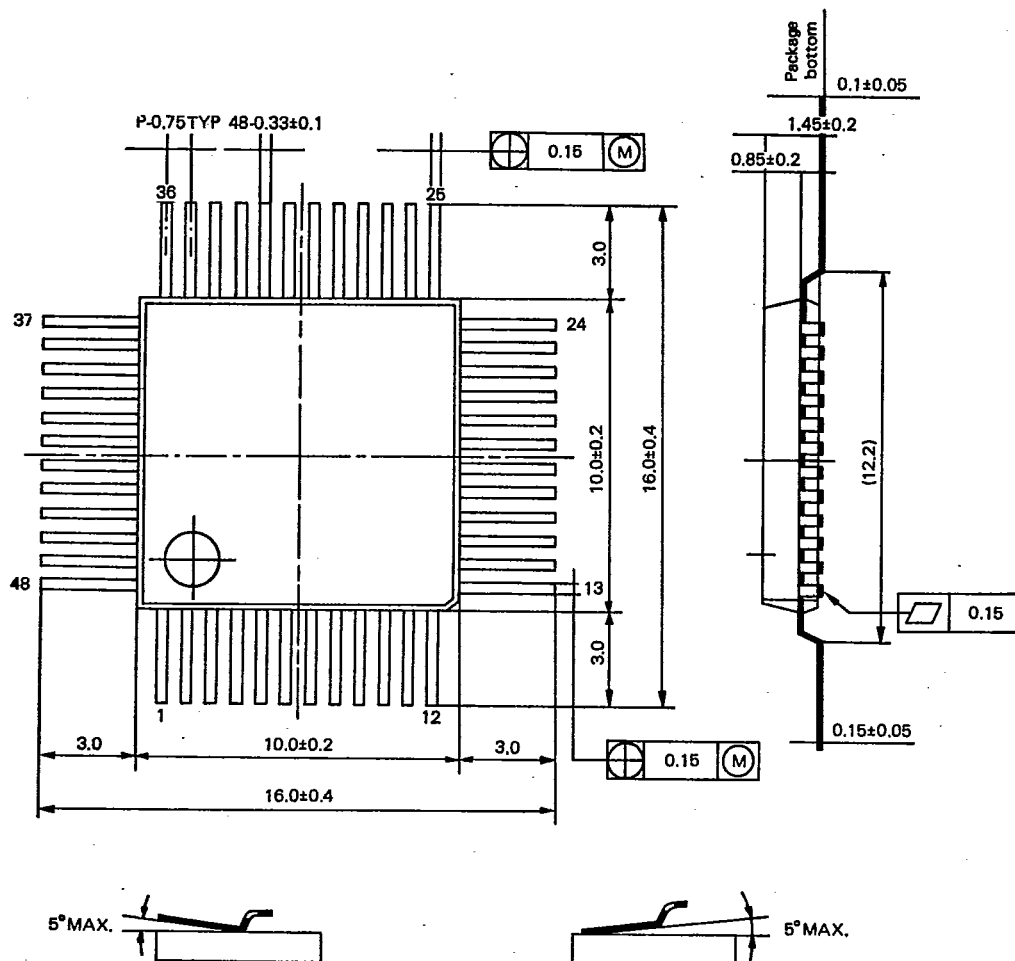
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**UM3135****Packaging Information**

48 Pin Quad In Line, Plastic



Unit: mm

Ordering Information

Part No.	Package	Remarks
UM3135H	Chip	
UM3135F	48 FP	RC of Oscillator Built in
UM3135F-1	48 FP	Capacitor of Oscillator Built in