



T-49-13-02

**UM3135**



PRELIMINARY

**8-Digit 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 plus 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 form available.

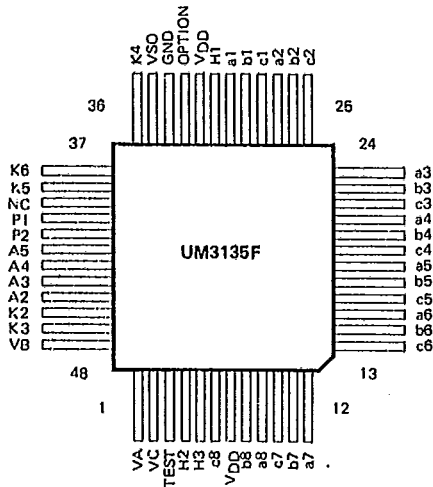
**General Description**

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

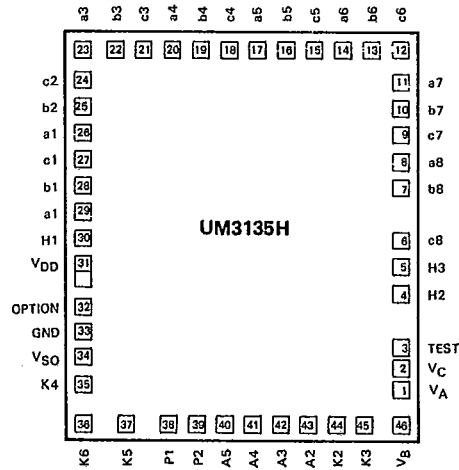
and encoding of keyboard inputs. It is designed for LCD operation with a 1.5V power supply. Low power dissipation, low system cost, and single power supply make the UM3135 ideal for battery or solar cell operated, hand-held calculators.



**Pin Configuration**



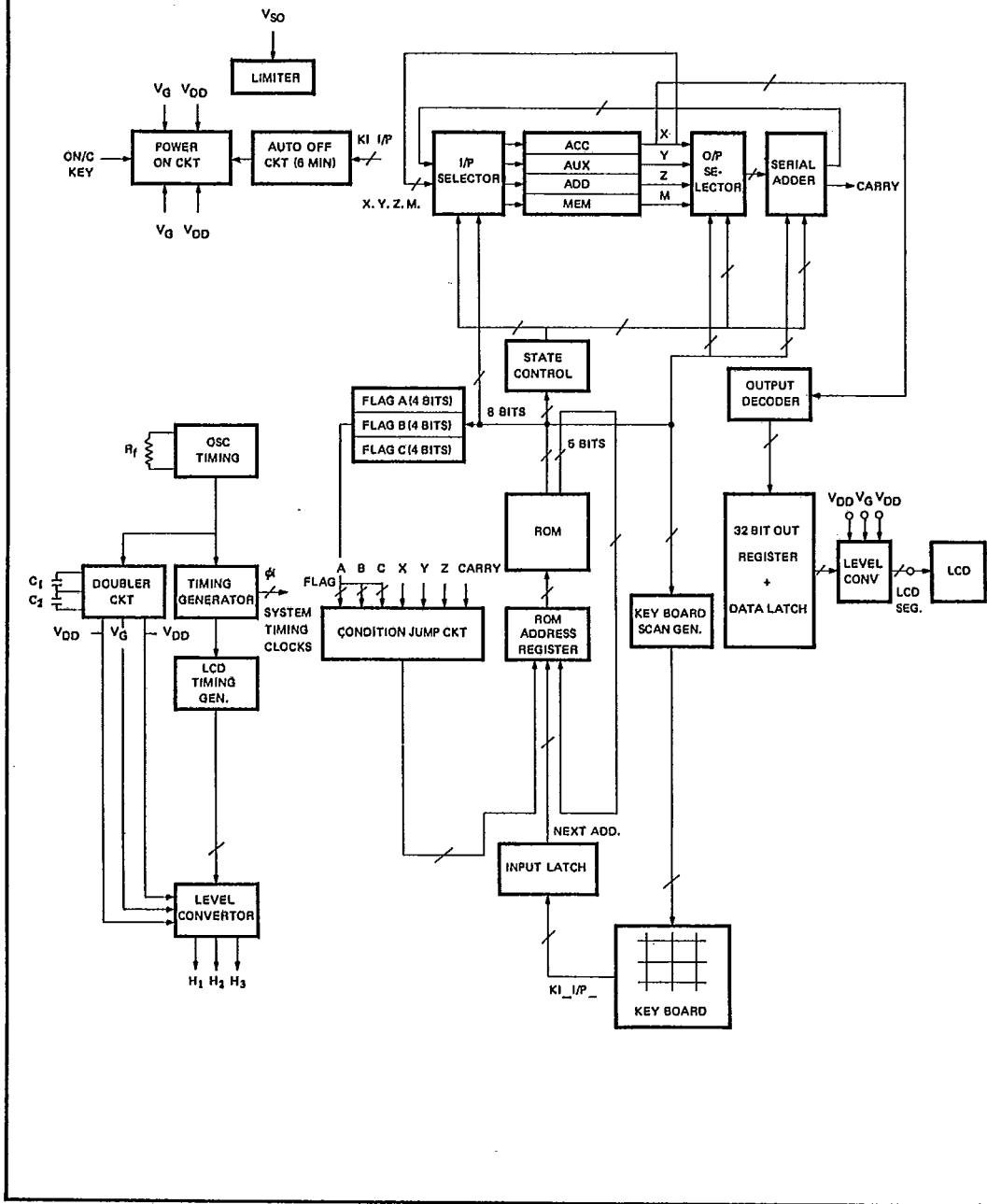
**Pad Configuration**





T-49-13-02

Block Diagram





**UM3135**

T-49-13-02

**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:  $T_{stg}$  (package form) . . .  $-55 \sim +125^{\circ}C$   
 Storage Temperature:  $T_{stg}$  (chip form) . . . .  $-40 \sim +90^{\circ}C$

**\*Comments**

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings 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 and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

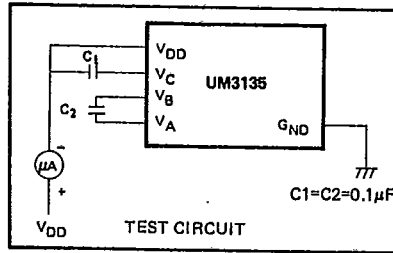
\*Maximum voltage on any pin with respect to GND.

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

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions	Note
$V_{DD}$	Supply Voltage	1.2	1.5	1.8	V		
$V_{IL}$	Input Voltage			0.4	V		1
$V_{IH}$		$V_{DD} - 0.4$			V		1
$I_{IH}$	Input Current	1.5	1.8	2.5	$\mu A$	$V_{IN} = V_{DD}$	1
$I_{IL}$				1	$\mu A$	$V_{IN} = 0V$	1
$V_{OH}$	Output Voltage	$V_{DD} - 0.15$			V	No load	2
$V_{OL}$				0.15	V	$I_{OUT} = 15 \mu A$	2
$V_{OA}$		1.2	1.5		V		3
$V_{OB}$		-0.2	0.0	0.2	V		3
$V_{OC}$				-1.5	-1.2	V	
$V_{IH}$	Output Voltage (High)	1.2	1.5		V		4
$V_L$	Output Voltage (Low)		-1.5	-1.2	V		4
$I_{OH}$	Output Current (High)	20	40		$\mu A$	$V_H = 1.2V$	
$-I_{OL}$	Output Current (Low)	10	20		$\mu A$	$V_L = -1.2V$	
$I_{DD}$	Supply Current			0.8	$\mu A$	Display off	4
$I_{DD1}$				4	6	$\mu A$	$V_{DD} = 1.5V$ , Display on
$V_{clamp}$	Built-in Limiter Clamp Voltage		1.55		V	$I_{SO} = 10 \mu A$ , chip off	

**Note:**

1. Applies to terminals K2 - K6.
2. Applies to terminals P1, P2 and A2 - A5.
3. Applies to terminals HI ( $i = 1-3$ ), ai, bi and ci ( $i = 1-8$ )
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.



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

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Condition
$f_{OSC}$	Oscillator Frequency	58	71		KHz	
$f_{DISP}$	Display Frequency	55	67		Hz	$V_{DD} = 1.5V$ , Display on





UM3135

T-49-13-02

Pin Description

Pin No.	Symbol	I/O	Description
1	V <sub>A</sub>	O	Connected As Voltage Doubler
2	V <sub>C</sub>	O	Connected As Voltage Doubler
3	TEST	I/O	Test Pin
4	H2	O	H2 O/P Signal to LCD (Common)
5	H3	O	H3 O/P Signal to LCD (Common)
6	C8	O	C8 O/P Signal to LCD (Segment)
7	V <sub>DD</sub>	I	Power Supply Terminal
8	b8	O	b8 O/P Signal to LCD (Segment)
9	a8	O	a8 O/P Signal to LCD (Segment)
10	c7	O	c7 O/P Signal to LCD (Segment)
11	b7	O	b7 O/P Signal to LCD (Segment)
12	a7	O	a7 O/P Signal to LCD (Segment)
13	c6	O	c6 O/P Signal to LCD (Segment)
14	b6	O	b6 O/P Signal to LCD (Segment)
15	a6	O	a6 O/P Signal to LCD (Segment)
16	c5	O	c5 O/P Signal to LCD (Segment)
17	b5	O	b5 O/P Signal to LCD (Segment)
18	a5	O	a5 O/P Signal to LCD (Segment)
19	c4	O	c4 O/P Signal to LCD (Segment)
20	b4	O	b4 O/P Signal to LCD (Segment)
21	a4	O	a4 O/P Signal to LCD (Segment)
22	c3	O	c3 O/P Signal to LCD (Segment)
23	b3	O	b3 O/P Signal to LCD (Segment)
24	a3	O	a3 O/P Signal to LCD (Segment)
25	c2	O	c2 O/P Signal to LCD (Segment)
26	b2	O	b2 O/P Signal to LCD (Segment)
27	a2	O	a2 O/P Signal to LCD (Segment)
28	c1	O	c1 O/P Signal to LCD (Segment)
29	b1	O	b1 O/P Signal to LCD (Segment)
30	a1	O	a1 O/P Signal to LCD (Segment)
31	H1	O	H1 O/P Signal to LCD (Common)
32	V <sub>DD</sub>	I	Power Supply Terminal
33	OPTION	I	Auto-Power-Off Option
34	GND	I	Ground
35	V <sub>SO</sub>	I	Solar Cell (Input Terminal)
36	K4	I	Key I/P Signal
37	K6	I	Key I/P Signal
38	K5	I	Key I/P Signal
39	NC	-	Not Connected
40	P1	O	P1 O/P Strobe Signal To Key
41	P2	O	P2 O/P Strobe Signal To Key
42	A5	O	A5 O/P Strobe Signal To Key
43	A4	O	A4 O/P Strobe Signal To Key



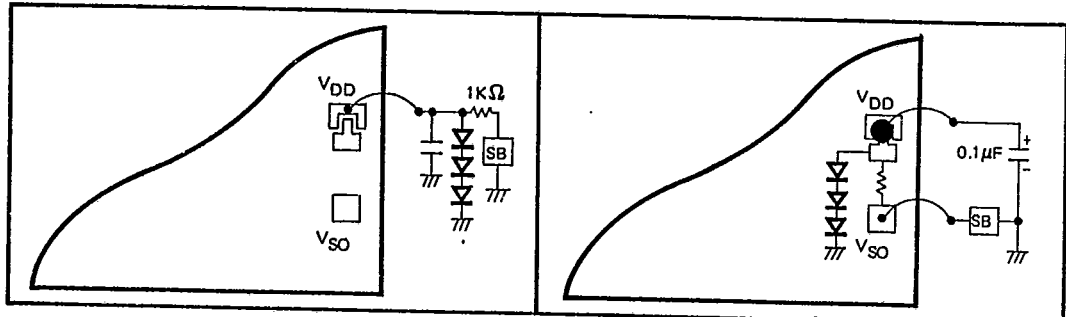
UM3135

T-49-13-02

Pin Description (Continued)

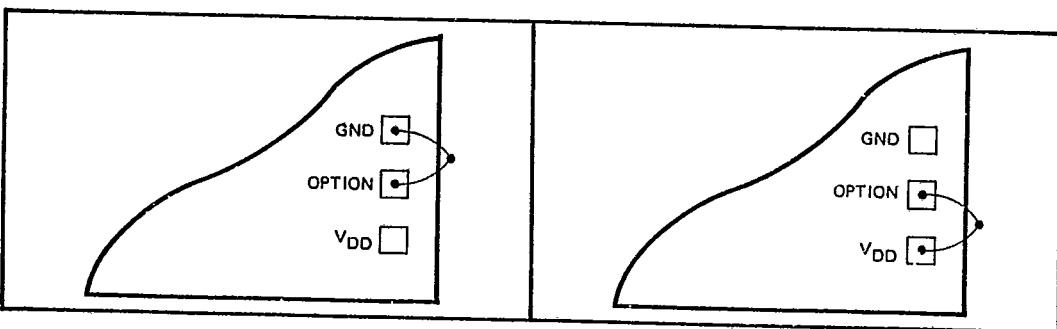
Pin No.	Symbol	I/O	Description
44	A3	O	A3 O/P Strobe Signal To Key
45	A2	O	A2 O/P Strobe Signal To Key
46	K2	I	Key I/P Signal
47	K3	I	Key I/P Signal
48	V <sub>B</sub>	O	Connected As Voltage Doubler

Voltage Regulator Bonding Options



a) Configuration Using External Voltage Limiter for UM3135-1F      b) Configuration Using Internal Voltage Limiter for UM3135F

Auto-power-off Bonding Options



a) Configuration with Auto-power-off      b) Configuration with No Auto-power-off



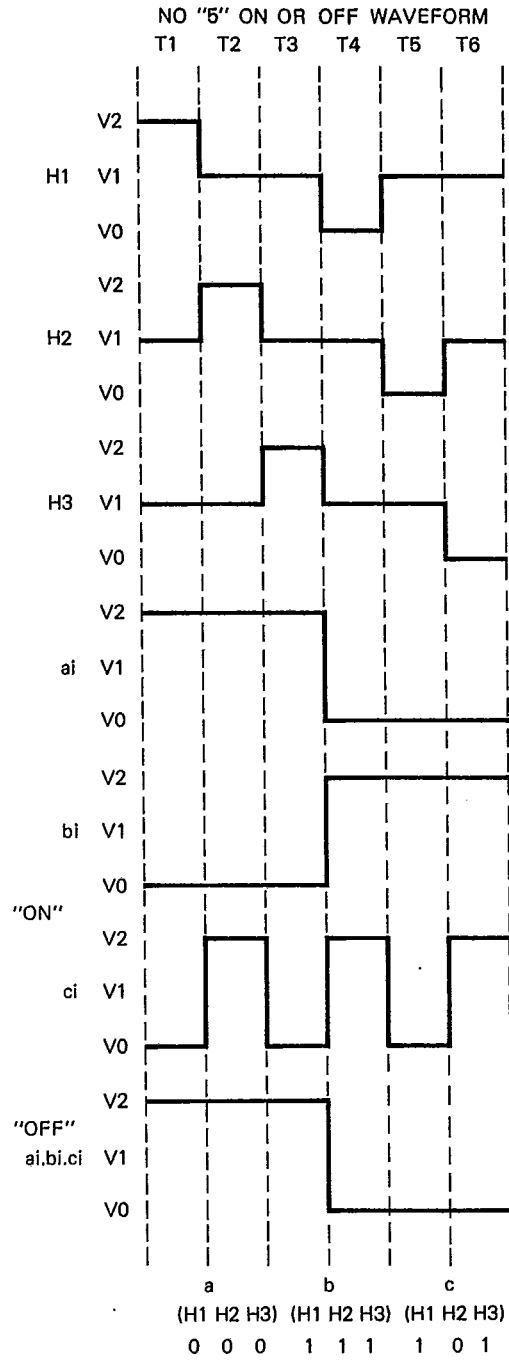
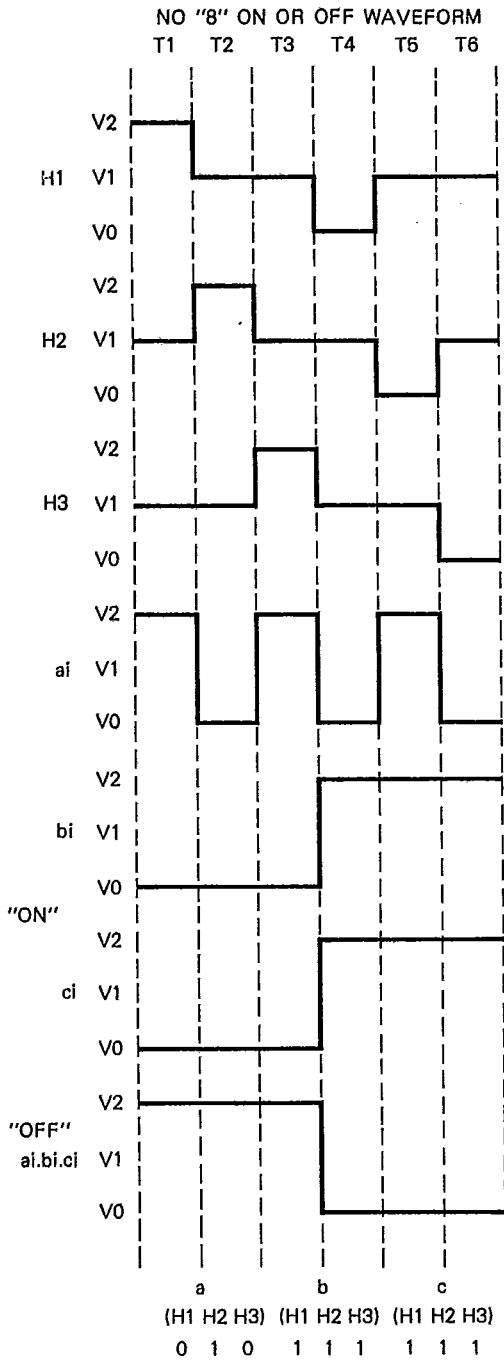


UM3135

T-49-13-02

Timing Waveforms

LCD Display Driver Waveform





UM3135

T-49-13-02

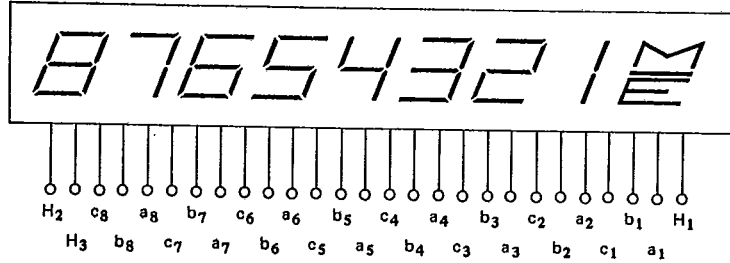
Display Format  
Numerical Font

1 2 3 4 5 6 7 8 9 0

Sign Font

M                      E                      —  
MEMORY LOADING      ERROR                      MINUS

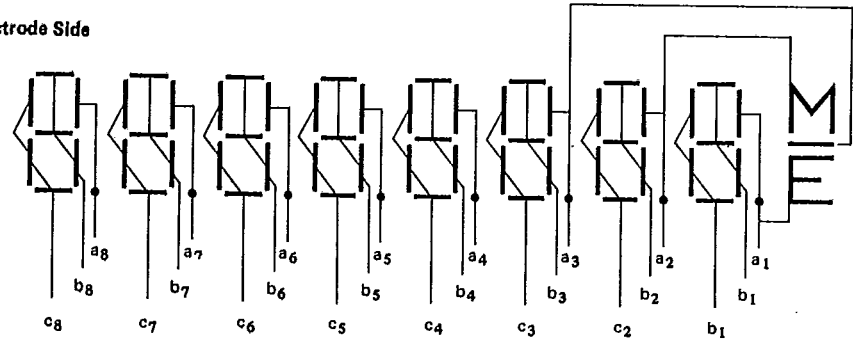
LCD Connection



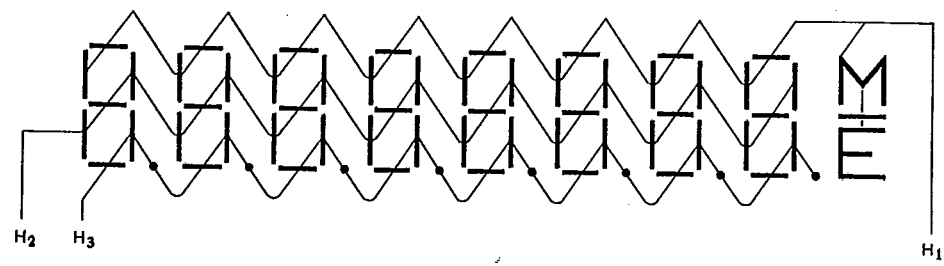
LCD Driving System  
1/2 bias, 1/3 duty

Display Configuration

Segment Electrode Side



Common Electrode Side





**UM3135**

T-49-13-02

**Functional Description**

**Equals Key (=)**

Performs previous 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 (+)**

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.

**Off Key (Off)**

Press this key to turn off the power supply.

**On/CCE**

When off, pushing this key will turn on the power and display "0". During digit entry, pushing this key will clear the entry. Otherwise, pushing this key will clear all registers, excluding the memory register.

**Memory Minus Key (M-)**

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

**Memory Recall And Clear Key (MRC)**

The first push of the MR key transfers the contents of the memory register to the display register. The second push, as MC key, clears the memory.

**Memory Clear Key (MC)**

Clears the memory.

**Memory Recall Key (MR)**

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.





UM3135

T-49-13-02

**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 or 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 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.

**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 the 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 of nine digits or more are ignored.

**Memory Protection**

On the detection of any error, the memory contents that were present before the error was detected are protected.

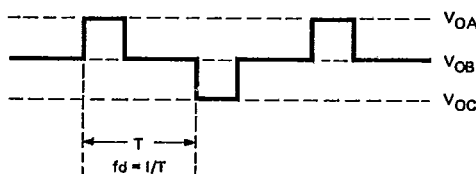
**Memory Indication**

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

**Auto-Power-Off**

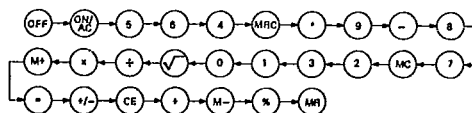
If no keys are depressed for a specific period of time, the power supply will automatically turn off. This time interval is 131,072 words (Approx. 11 minutes at  $f_d = 67\text{Hz}$ . The display time of a word is equal to 5 ms when  $f_d = 67\text{Hz}$ )

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 3.3 ms when the display frequency  $f_d = 100\text{ Hz}$





UM3135

T-49-13-02

Arithmetic Operations

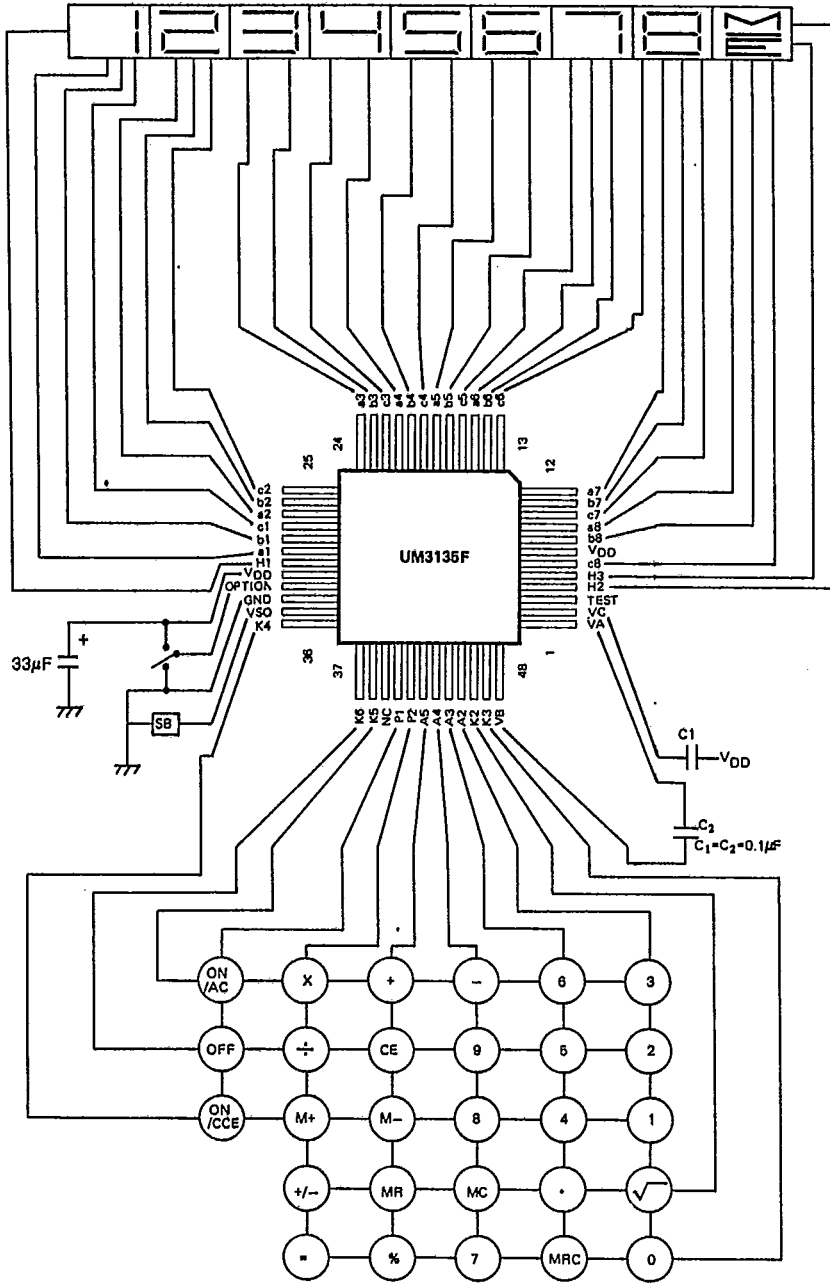
	Key Operation	Display	Memory
Entry	1 2 3 4 5 6 7 8 9 0	12345678.	
Four Fundamental Arithmetic Calculations	a + b = a - b = a x b = a ÷ b =	a + b a - b a · b a ÷ b	
Square Root Calculations	a √ a +/- √ ON/AC	√a OE O	
Percent Calculations	a x b % a + b % a - b % a ÷ b % a + b % a - b %	√b a · √b a · b/100 a + (a · b/100) a · b/100 a - (a · b/100) 100 · a/b a + (a · b/100) a - (a · b/100)	
Constant Calculations	k x b = a ÷ k = c = k x b % c % a ÷ k % c % a + k = b = a - k = b =	k · b k · c a/k c/k k · b/100 k · c/100 100 · a/k 100 · c/k a + k b + k a - k b - k	
Repeated Calculations	a + b = = a - b = = a ÷ b = = a x b = =	a + 2b a - 2b (a/b)/b (a · b) · a	
Power Calculations	a x = x = a x = = a ÷ = = a + = = a - = =	a <sup>2</sup> a <sup>4</sup> a <sup>3</sup> 1/a 1/a <sup>2</sup>	
Mixed Calculations (at  [(a+b) · c/d] · e  > 10 <sup>8</sup> )	a + b x c ÷ d = x e =	(a + b) · c/d ( (a + b) · c/d ) · e/10 <sup>8</sup> E ( (a + b) · c/d ) · e/10 <sup>8</sup>	
Memory Calculations (at  a+b+c · d+e  > 10 <sup>8</sup> )	CE a M+ b M- MR MC  a + b M+ c x d M+ MR e M+ ON/AC	a M b M a - b M a - b a + b M c · d M a + b + c · d M 0 M 0 E 0	a a - b a - b 0 a + b a + b + c · d a + b + c · d a + b + c · d 0



UM3135

Application Circuit (Package Form Using Internal Voltage Limiter)

T-49-13-02

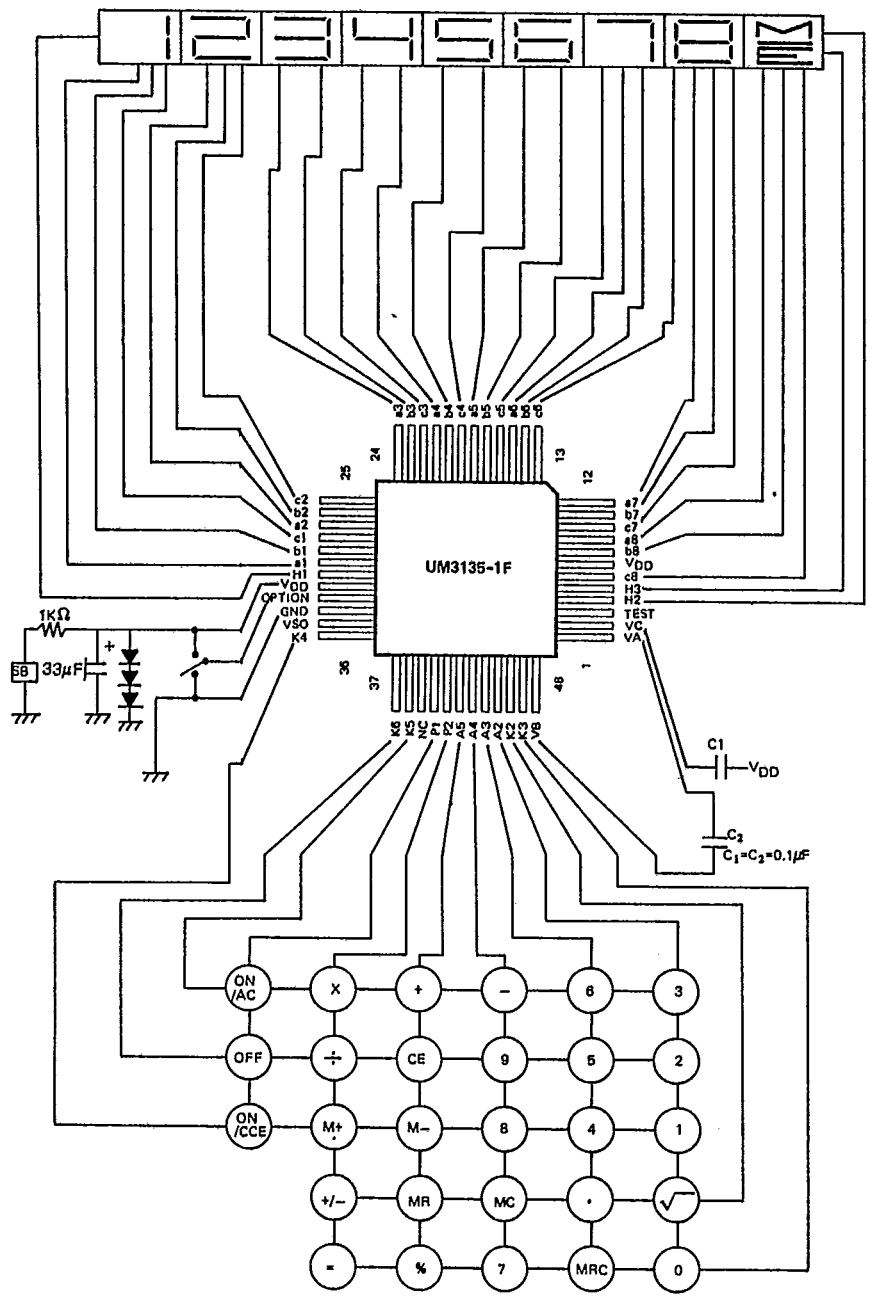




UM3135

T-49-13-02

Application Circuit (Package Form Using External Voltage Limiter)

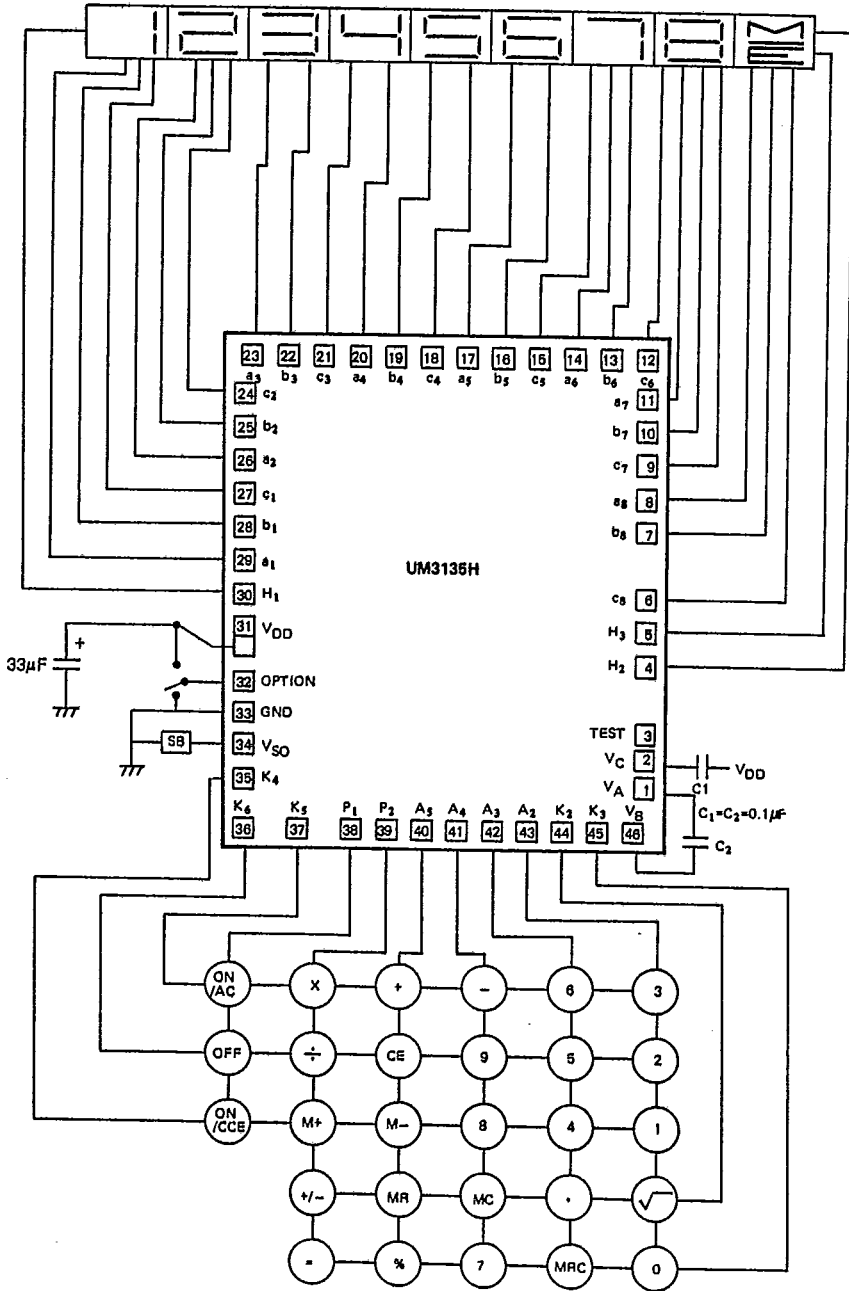




UM3135

T-49-13-02

Application Circuit (Chip Form Using Internal Voltage Limiter)

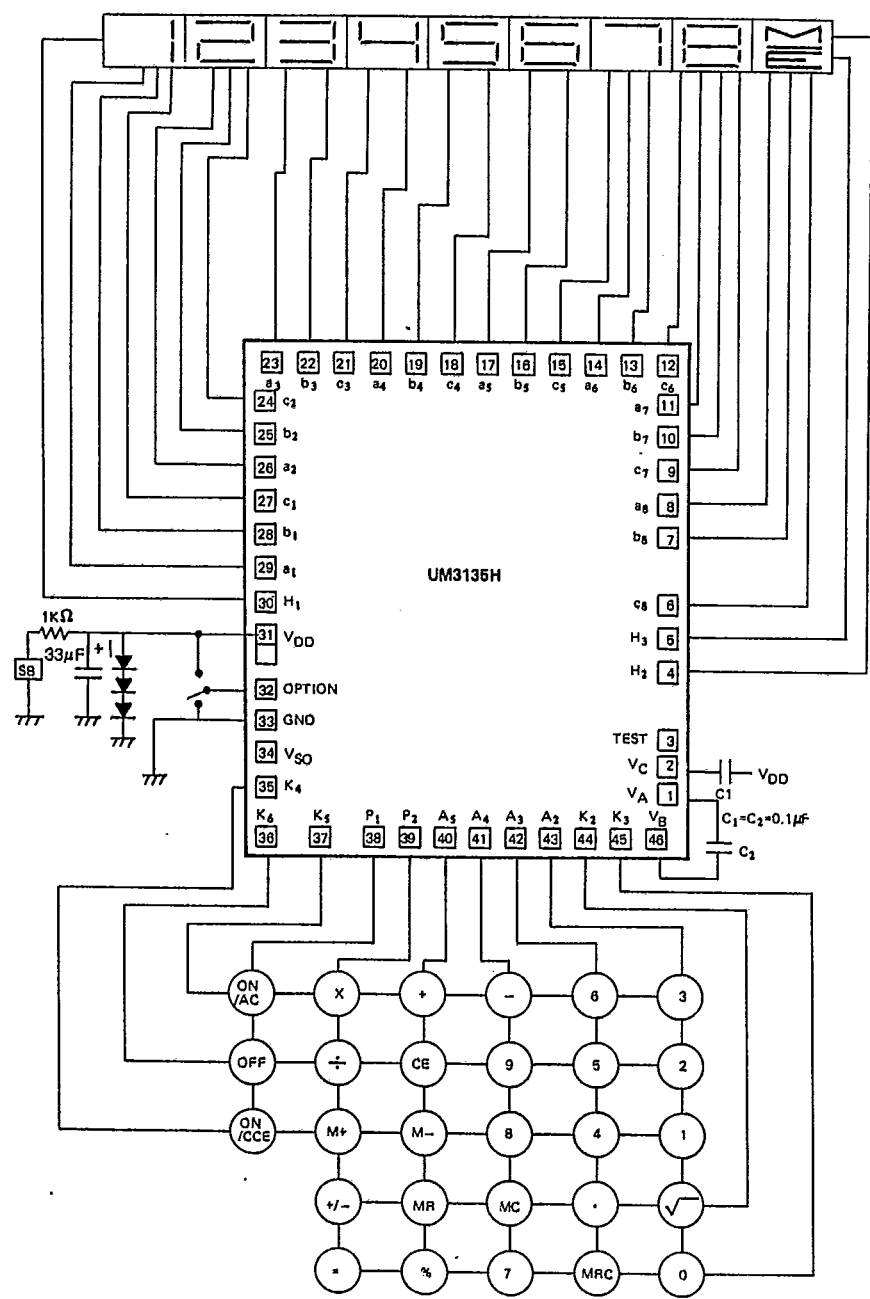




UM3135

T-49-13-02

Application Circuit (Chip Form Using External Voltage Limiter)

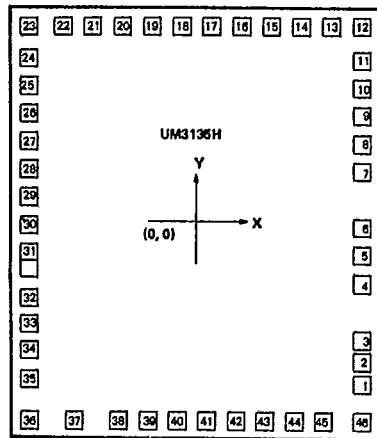




UM3135

T-49-13-02

Bonding Diagram



Unit:  $\mu\text{m}$

No.	Designation	X	Y	No.	Designation	X	Y
1	V <sub>A</sub>	885	-928	24	c2	-900	928
2	V <sub>C</sub>	885	-772	25	b2	-900	772
3	TEST	885	-440	26	a2	-900	617
4	H2	885	-248	27	c1	-900	465
6	H3	885	-92	28	b1	-900	314
6	c8	885	64	29	a1	-900	162
7	b8	885	220	30	H1	-900	8
8	a8	885	376	31	V <sub>DD</sub>	-900	-199
9	c7	885	532	32	OPTION	-900	-416
10	b7	885	688	33	GND	-900	-601
11	a7	885	845	34	V <sub>SO</sub>	-900	-757
12	c6	885	1090	35	K4	-900	-942
13	b6	730	1090	36	K6	-900	-1090
14	a6	574	1090	37	K5	-688	-1090
15	c5	418	1090	38	P1	-531	-1090
16	b5	262	1090	39	P2	-359	-1090
17	a5	106	1090	40	A5	-178	-1090
18	c4	-50	1090	41	A4	-10	-1090
19	b4	-206	1090	42	A3	166	-1090
20	a4	-362	1090	43	A2	343	-1090
21	c3	-518	1090	44	K2	501	-1090
22	b3	-674	1090	45	K3	666	-1090
23	a3	-900	1090	46	V <sub>B</sub>	885	-1090



Ordering Information

Part No.	Package	Remarks
UM3135H	Chip	
UM3135F	48 FP	Internal Voltage Limiter
UM3135-1F	48 FP	External Voltage Limiter