



# Complex Standards

## MM5736 MOS/LSI 6 digit calculator

### general description

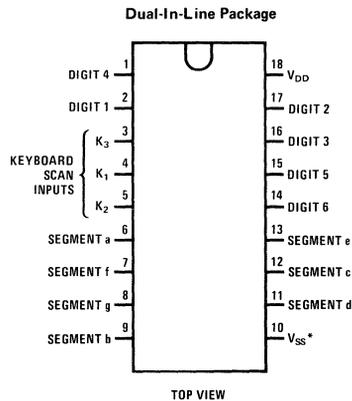
The MM5736 employs three working registers to provide add, subtract, multiply and divide functions. It includes on-chip key debounce and interfaces directly with the keyboard matrix as shown in Figure 2 and 3. A one-of-six output provides the strobe signals necessary to enable the appropriate digit for display; segment data for each digit appears during the appropriate strobe. See Figure 1 for digit and segment timing. Leading zero blanking has been incorporated to conserve battery life. Average battery life is estimated to be between 10 and 20 hours depending upon battery quality, operating schedule and the average number of digits displayed.

With the addition of a single-pole slide switch, a decimal point may be lit at an appropriate digit in the display; e.g., the third digit will present a dollars and cents format for users who generally use the calculator to balance checkbooks or keep track of supermarket expenditures. (Figures 2 and 3 indicate this feature using the NSN66A LED display, which has a decimal point between the second and third digits.)

### features

- Six digit display
- Four functions (+, -, X, ÷)
- Chain operations
- Auto summing, convenient counting by any radix, and auto squaring
- Floating negative sign indicator for true credit balance
- Three different error indications
- Leading zero blanking
- On-chip oscillator uses no external components
- Effective keyboard bounce protection
- Interfaces with keyboard directly
- 9.0V battery operation with a typical power dissipation less than 30 mW—resulting in a battery life in excess of 15 operating hours with normal use

### connection diagram



\*V<sub>SS</sub> always most positive supply.

Order Number MM5736N  
See Package 16

## absolute maximum ratings

|  |                         |
|--|-------------------------|
| Operating Temperature                          | 0°C to +70°C Ambient    |
| Storage Temperature                            | -55°C to +150°C Ambient |
| Voltage on Any Pin Relative to V <sub>SS</sub> | +0.3V to -12V           |
| Lead Temperature (Soldering, 10 seconds)       | 300°C                   |

## dc electrical characteristics

V<sub>SS</sub> - 6.5V ≤ V<sub>DD</sub> ≤ V<sub>SS</sub> - 9.5V (V<sub>SS</sub> is always the most positive potential)

| PARAMETER                                     | CONDITIONS  | MIN                                | TYP  | MAX  | UNITS          |
|---|---|------------------------------------|------|--|----------------|
| Supply Current                                | V <sub>DD</sub> = V <sub>SS</sub> - 9.5V,<br>T <sub>A</sub> = 25°C  |                                    | 3.7  | 6.0  | mA             |
| Keyboard Scan Input Levels<br>(K1, K2, K3)    |   |                                    |      |  |                |
| Logical High Level                            | V <sub>DD</sub> = V <sub>SS</sub> - 6.5V  | V <sub>SS</sub> - 2.5              |      | V <sub>SS</sub> - 5.0                          | V              |
| Logical Low Level                             | V <sub>DD</sub> = V <sub>SS</sub> - 9.5V  |                                    |      | V <sub>SS</sub> - 6.0                          | V              |
| Digit Buffer Output Levels<br>(D1 Through D6) |   |                                    |      |  |                |
| Logical High Level                            | I <sub>OUT</sub> = -1.2 mA  | V <sub>SS</sub> - 1.5              |      | V <sub>SS</sub>                                | V              |
| Logical Low Level                             | V <sub>DD</sub> = V <sub>SS</sub> - 6.5V<br>V <sub>DD</sub> = V <sub>SS</sub> - 9.5V  | V <sub>DD</sub><br>V <sub>DD</sub> |      | V <sub>SS</sub> - 6.0<br>V <sub>SS</sub> - 7.0 | V<br>V         |
| Segment Output Current<br>(Sa Through Sg)     |   |                                    |      |  |                |
| Source Current                                | T <sub>A</sub> = 25°C<br>V <sub>OUT</sub> = V <sub>SS</sub> - 3.8V, V <sub>DD</sub> = V <sub>SS</sub> - 6.5V<br>V <sub>OUT</sub> = V <sub>SS</sub> - 4.2V, V <sub>DD</sub> = V <sub>SS</sub> - 7.25V<br>V <sub>OUT</sub> = V <sub>SS</sub> - 7.8V, V <sub>DD</sub> = V <sub>SS</sub> - 9.5V | -3.0                               | -7.3 | -15  | mA<br>mA<br>mA |

## ac electrical characteristics

| PARAMETER   | CONDITIONS                 | MIN  | TYP | MAX  | UNITS |
|---|----------------------------|------|-----|------|-------|
| Word Time (Figure 1)  |                            | 0.42 |     | 1.60 | ms    |
| Digit Time (Figure 1)   |                            | 70   |     | 267  | μs    |
| Interdigit Blanking Time<br>(Figure 1)  |                            |      | 4.0 |      | μs    |
| Digit Output Transition Rise<br>and Fall Times  | C <sub>LOAD</sub> = 100 pF |      | 2.0 |      | μs    |
| Keyboard Sensing Inputs<br>(K1, K2, K3)   | C <sub>LOAD</sub> = 100 pF |      |     |      |       |
| High to Low Transition<br>Time After Key Release  |                            |      | 4.0 |      | μs    |
| Key Bounce – Output<br>Stability Time   |                            | 2.8  | 7.0 | 11.4 | ms    |
| (The time a keyboard sensing input must be continuously higher than the minimum logical high level to be accepted as a key closure, or lower than the maximum logical low level to be accepted as a key release.) |                            |      |     |      |       |

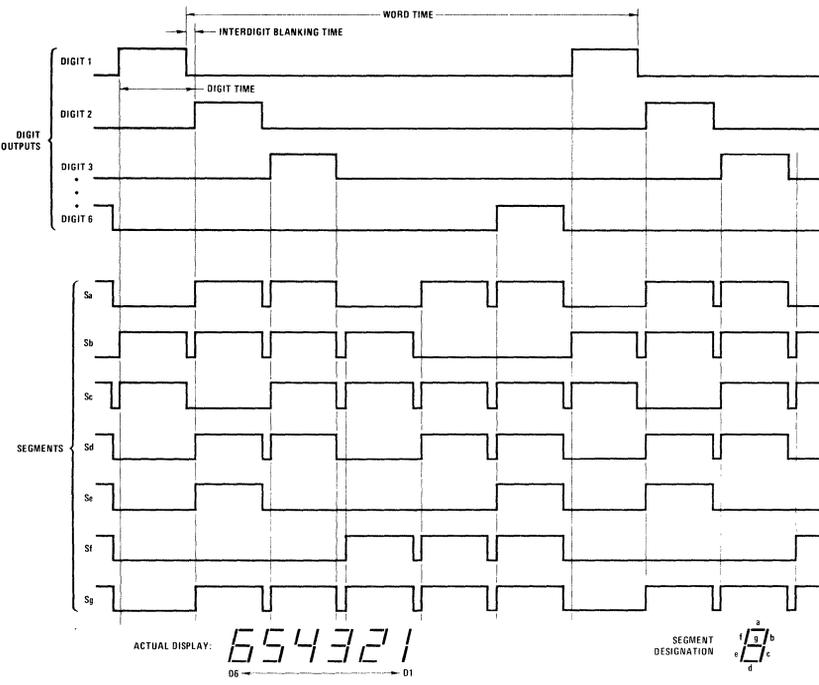


FIGURE 1. Timing Diagram

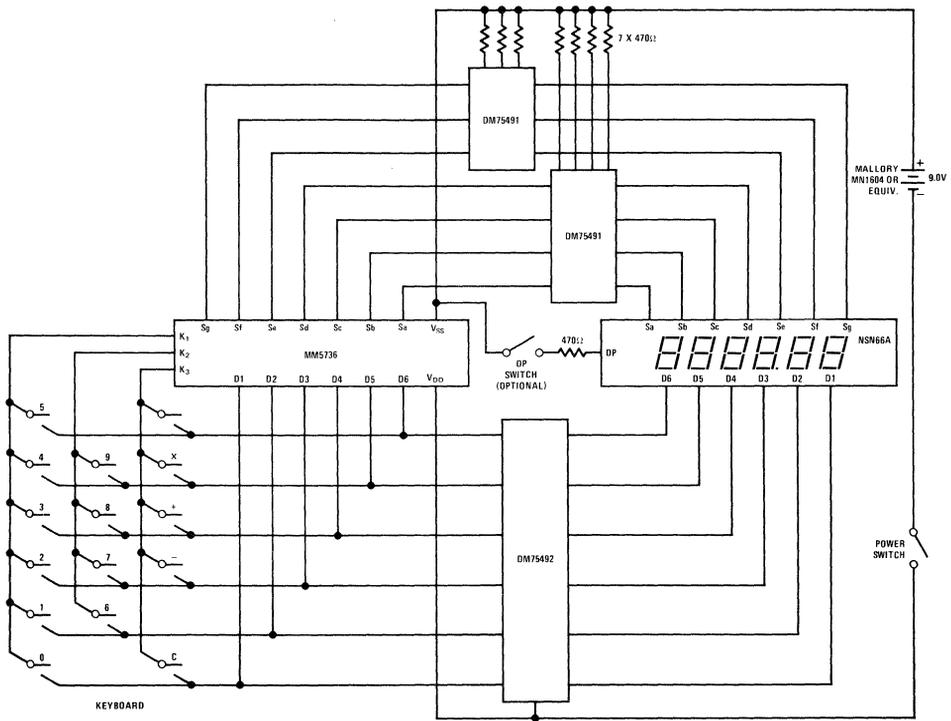


FIGURE 2. Recommended Calculator Configuration with MM5736

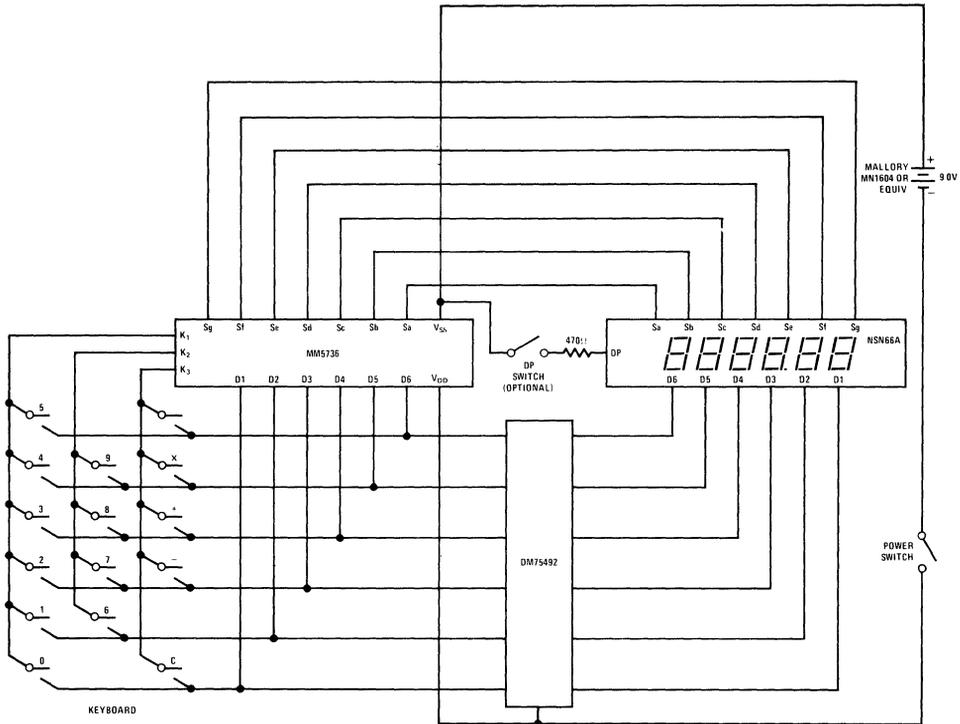


FIGURE 3. Optional Calculator Configuration with MM5736

## keyboard bounce and noise rejection characteristics

The MM5736 calculator is designed to interface with low cost keyboards. These keyboards are usually the least desirable from a noise and false entry standpoint. When a key closure is sensed by the calculator, an internal timeout is started. Any perturbations which occur during the timeout will reset the timer to zero so that a key is only accepted as valid after a noise-free time out period. Noise that persists indefinitely will inhibit key entry. Key releases are checked in the same manner.

Low cost conductor loaded elastomeric keyboards often have key-pressure versus contact resistance characteristics that can create almost continuous noise during "teasing" or low pressure key depressions. The MM5736 keyboard scanning circuitry can accept a series switch resistance up to 50 k $\Omega$  as a valid closure, which combined with the internal resettable debounce timer, insures reliable key operations under a variety of conditions and keyboards.

## range of the calculator

The MM5736 is capable of displaying six significant positive digits and five negative digits:

$$-99999 \leq \text{Display} \leq +999999$$

The display scans from right (LSD) to left (MSD). Digit 1 time (Figure 1) corresponds to LSD.

## error conditions

The following is a list of error conditions which are displayed by the MM5736. If any of these conditions occur, the machine automatically locks out all key entries except CLEAR.

| Error                           | Display |
|---------------------------------|---------|
| (1) Too many numbers entered    | EXXXXX  |
| (2) Negative solution too large | EEXXXX  |
| (3) Positive Solution too large | EXXXXX  |
| (4) Divide by 0                 | EEEEEE  |

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**key description****Clear Key:**

- a. Operation during number entry
1. First depression functions as a clear entry when followed by a number reentry.
  2. Second depression functions as a clear all.
- b. Operation after function key will clear all registers.
- c. Power on: Two depressions are required at power on to clear the machine.

**0 Through 9 Keys:**

- a. First entry clears the display register and enters the digit into the least significant digit.
- b. Second through sixth entry shifts the display register left one digit and enters the digit into the least significant digit.
- c. Seventh entry shifts the display register right one digit and displays an E in the most significant digit of the display register.

**Add Key:** Depression of this key will add the number entered to the accumulator and display the results. Further depressions without number entry will result in a repeated addition of the entry to the accumulator.

**Subtraction Key:** Depression of this key will subtract the number entered from the accumulator and display the results. Further depressions without number entry will result in repeated subtractions of the entry from the accumulator.

**Multiplication Key:** Depression of this key will result in a multiplication of the number entered by the accumulator with the results being displayed. If no entry is made, the number being displayed will be squared.

**Divide Key:** Depression of this key will result in a division of the accumulator by the number entered, with the results being displayed.

**examples****BALANCING A CHECK BOOK**

| Key   | Display |
|-------|---------|
| C     | 0       |
| 35323 | 35323   |
| +     | 35323   |
| 10018 | 10018   |
| -     | 25305   |
| 9595  | 9595    |
| -     | 15710   |
| 16000 | 16000   |
| -     | - 290   |
| 35000 | 35000   |
| +     | 34710   |

**examples (con't)****MULTIPLICATION**

| Key  | Display |
|------|---------|
| C    | 0       |
| 1000 | 1000    |
| +    | 1000    |
| 4    | 4       |
| x    | 4000    |

**DIVISION**

| Key  | Display |
|------|---------|
| C    | 0       |
| 1000 | 1000    |
| +    | 1000    |
| 3    | 3       |
| ÷    | 333     |

**CHAIN OPERATIONS**

| Key  | Display |
|------|---------|
| C    | 0       |
| 1500 | 1500    |
| +    | 1500    |
| 400  | 400     |
| -    | 1100    |
| 2    | 2       |
| x    | 2200    |
| 7    | 7       |
| ÷    | 314     |

**AUTO SQUARING**

| Key | Display |
|-----|---------|
| C   | 0       |
| 3   | 3       |
| +   | 3       |
| x   | 9       |
| x   | 81      |

**REPETITIVE ADD/SUBTRACT (AUTO SUMMING)**

| Key | Display |
|-----|---------|
| C   | 0       |
| 3   | 3       |
| +   | 3       |
| +   | 6       |
| +   | 9       |
| -   | 6       |
| -   | 3       |

**CLEAR ENTRY**

| Key | Display |
|-----|---------|
| C   | 0       |
| 3   | 3       |
| +   | 3       |
| 4   | 4       |
| C   | 0       |
| 5   | 5       |
| +   | 8       |
| C   | 0       |
| 9   | 9       |
| +   | 9       |