MM5758 scientific calculator

general description

The single-chip MM5758 Scientific Calculator is another MOS/LSI product from National Semiconductor using a metal-gate, P-channel enhancement/depletion mode technology to achieve low system cost. A complete calculator performs a wide range of complex scientific problems, yet consists of only the MM5758, two display driver ICs, the NSA5101 LED display, a keyboard and power supply *(Figure 1)*. No discrete components are required.

An internal power-on clear circuit automatically clears all registers, including the storage memory and four-register operational stack, when power is initially applied to the chip.

The MM5758 performs trigonometric, logarithmic, exponentiation, power and square root functions simply by pressing a key. It computes and displays numbers over a range of $\pm 9.9999999 \times 10^{\pm 99}$. A four-register operational stack simplifies computation of problems with multi-nested terms and reverse polish entry notation provides a logical and consistent method of keying in even the most complex problems.

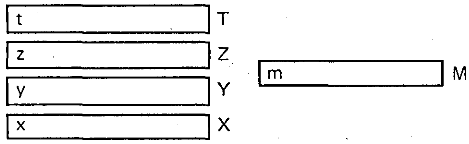
The displayed output has an eight digit mantissa with a two digit exponent; both the mantissa and exponent display an additional sign digit. Sign information is presented to the display by the calculator chip during a single digit time, but the NSA5101 display physically separates the two as shown in *Figure 2*.

All computed results greater than 99999999. or less than 0.1 are automatically converted to scientific notation. Trailing zero suppression of the mantissa allows convenient reading of the left justified display and conserves power. The exponent digits are blanked if no exponent is displayed. The most-significant-digit of the exponent is not blanked, even if it is a zero, when an exponent is being displayed. A low battery indication, activated by sensing circuitry in the DS8868, is included in the mantissa sign digit.

A Ready output signal is used to indicate calculator status. It is useful in providing synchronization information during testing and when the MM5758 is used with other logic; e.g., with the MM5766 Programmer.

Thirty-six keys are arranged within a four-by-eleven matrix (Table 1 and *Figure 2*). Dual function keys are not required.

The user has access to five registers designated X, Y, Z, T and M. X is the display and entry register and the bottom of a "push-up" operational stack that includes registers Y, Z and T.

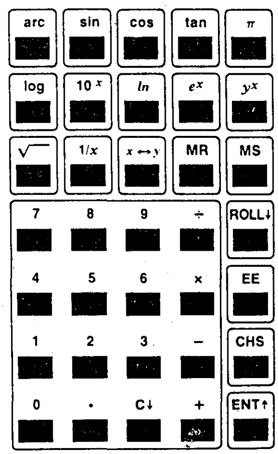


The contents of the storage register M are replaced with the contents of the X-register by using the "STO" key. The memory recall key, "RCL," copies M into register X without disturbing the value of M. M is cleared automatically at power-on or by storing a zero. All registers contain eight mantissa digits, two exponent digits and the sign information for each.

features

- Enters, computes and displays numbers as large as $\pm 9.9999999 \times 10^{99}$ and as small as $\pm 1 \times 10^{-99}$
- Complete slide-rule capability
  - Arithmetic functions: $+, -, \times, \div, 1/x, \sqrt{x}$
  - Logarithmic functions: ln x, log x, e^x, 10^x
  - Power function: Y^x
  - Trigonometric functions: sin x, cos x, tan x, arc sin x, arc cos x, arc tan x
  - Other functions: π, exchange, change sign
- Reverse polish notation
- Four-register operational stack with roll capability
- Independent two key storage register
- Floating point input and output
- Power-on clear
- Designed-in low system cost
- Automatic display cutoff

sample keyboard



absolute maximum ratings

Voltage at Any Pin Relative to V_{SS} (All other pins connected to V_{SS})	V_{SS} + 0.3V to V_{SS} − 12V
Ambient Operating Temperature	0°C to +70°C
Ambient Storage Temperature	−55°C to +150°C
Lead Temperature (Soldering, 10 seconds)	300°C

operating voltage range

$7.2\ V \leq V_{SS} - V_{DD} \leq 8.8V$

V_{SS} is always the most positive supply voltage.

dc electrical characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Current (I_{DD})	V_{DD} = V_{SS} −8.8V, T_A = 25°C		12.0	20.0	mA
Keyboard Scan Input Levels (K1 through K4)					
Logical High Level		V_{SS}−2.5			V
Logical Low Level				V_{DD}+1.5	V
Display Reset Input Levels					
Logical High Level		V_{SS}−1.5			V
Logical Low Level				V_{DD}+1.5	V
Encoded Digits Output Current (D_A through D_D)					
Logical High Level (I_{OH})	V_{OUT} = V_{DD} + 1.0V	−0.5		−2.50	mA
Logical Low Level (I_{OL})	V_{OUT} = V_{DD}			−50	µA
Low Voltage Indicator Level (V_{IH}) (Digit D_A must be forced to a V_{IH} voltage level during the IDLE digit time to cause Segment S_b to be turned "ON" at digit time D1.		V_{DD}+2.8		V_{SS}	V
Segment and Decimal Point Output Current (Sa through Sg, DP)					
Logical High Level (I_{OH})	V_{OUT} = V_{DD} + 5.4V	−550			µA
Logical Low Level (I_{OL})	V_{OUT} = V_{DD} + 1.5V			−10	µA
Ready Output Levels					
Logical High Level (V_{OH})	I_{OUT} = −0.4 mA	V_{SS}−1.0			V
Logical Low Level (V_{OL})	I_{OUT} = 10µA			V_{DD}+1.0	V

ac electrical characteristics

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Word Time *(Figure 3)*		0.5	1.3	2.2	ms
Digit Time *(Figure 3)*		42	108	183	µs
Interdigit Blanking Time *(Figure 3)*		3.5	8.0	14.0	µs
Keyboard Scan Inputs (K1 through K4) Low to High Transition Time (during Interdigit Blanking Time), (t_{PDH})	C_{LOAD} = 100 pF			14.0	µs
Ready Output Propagation Time *(Figure 4)*					
Low to High Level (t_{PDH})	C_{LOAD} = 100 pF	30		115	µs
High to Low Level (t_{PDL})	C_{LOAD} = 100 pF	30		120	µs
Key Bounce-out Stability Time. (The time a keyboard scan input, K1, K2, K3 or K4, must be continuously connected to a digit to be accepted as a key closure, or lower than the maximum Logical Low Level to be accepted as a key release.) *(Figure 5)*		3.5	9.1	15.4	ms
Display Cutoff Time (The time after the last valid key closure at which all digits except the most-significant-digit of the mantissa will be blanked.)			50		second
Calculation Times					
Square Root			0.50	0.90	second
LOG X or LN X			0.85	1.50	second
10^x or e^x			1.00	1.75	second
Y^x			1.80	3.10	second
SIN X, COS X or TAN X			1.30	2.20	second
ARC SIN X or ARC COS X			1.40	2.40	second
ARC TAN X			0.85	1.50	second

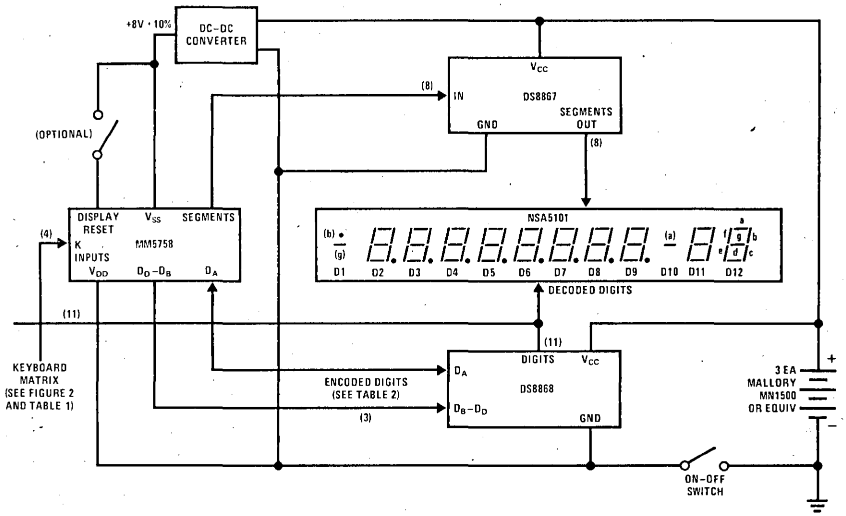


FIGURE 1. Block Diagram of Complete Handheld Scientific Calculator Using MM5758.

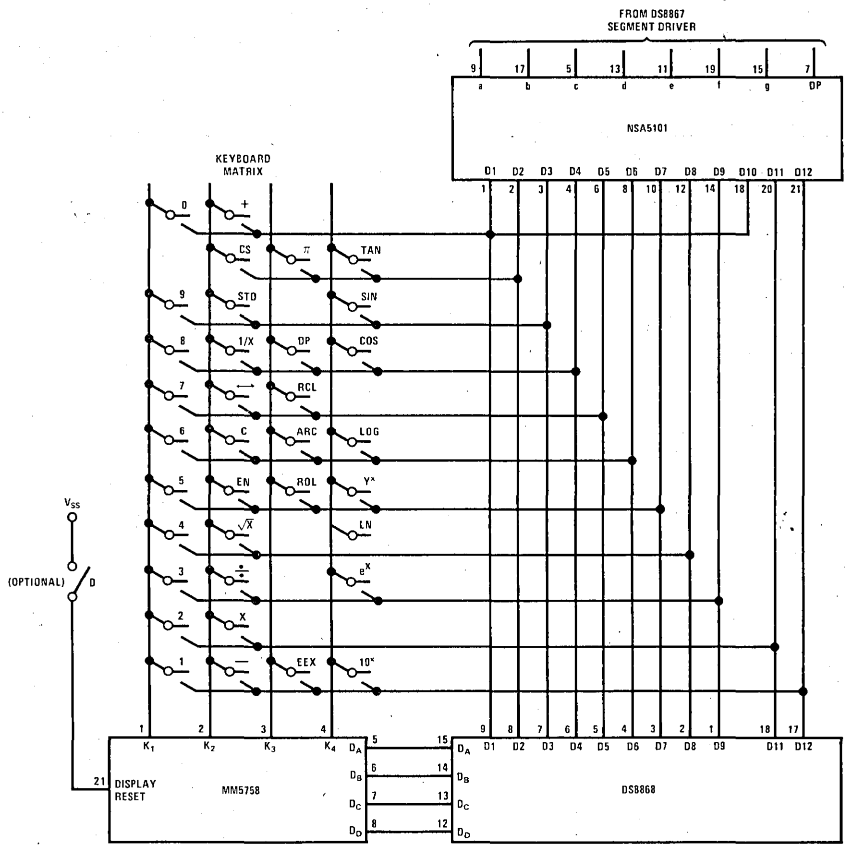


FIGURE 2. Digits Interconnection Detail For Scientific Calculator.

SCALING OF DISPLAYED NUMBERS

Computed results are displayed in either floating point or scientific notation. Answers in the range between 0.1 and 99999999. are displayed in floating point format; otherwise scientific notation is used. For example: 123.4 is displayed as written; whereas, 123.4 million would appear as 1.234×10^8. The smallest magnitude displayed is $\pm 1.0 \times 10^{-99}$, and the largest $\pm 9.9999999 \times 10^{99}$. Number entries are always displayed in the manner entered until "ENT" is depressed, after which they appear scaled.

KEYBOUNCE AND NOISE REJECTION

The MM5758 is designed to interface with most low-cost keyboards, which are often the least desireable from a false or multiple entry standpoint.

When a key closure is sensed by the calculator, an internal timeout is started. Any voltage perturbations of significant magnitude which occur on the Key Input Lines (K1, K2, K3 or K4) during the timeout will reset the timer to zero. A key is accepted as valid after a noise-free timeout period; noise that persists indefinitely will inhibit key entry. Key releases are checked in the same manner.

The internal timeout period (Key Bounceout Stability Time) is normally seven word times. By forcing digit D_B to a Logical High State during Digit Timing State D12 time (Table II), the Stability Time is reduced to four word times.

AUTOMATIC DISPLAY CUTOFF

If no key is depressed for approximately 50 seconds, an internal automatic display cutoff circuit will modify the encoded digit output sequence sent to the DS8868 Decoder/Driver to be the blanking input code (Table II) during all digit times except the most-significant of the mantissa (D2). Thus, in the cutoff power saving mode, only one digit is displayed. The blanking code has been selected to also be the minimum power case for the DS8868.

Any of the D11 ("CS," "π" or "TAN") keys will restore the display; to restore the display without modifying the status of the calculator use the "CS" key twice, or momentarily force the Display Reset high. The automatic display cutoff feature can be disabled by hardwiring the Display Reset pin to V_{SS}.

READY SIGNAL OPERATION

The Ready signal indicates calculator status. When the calculator is in an "idle" state the output is at a Logical High Level (near V_{SS}). When a key is closed, the internal key entry timer is started. Ready remains high until the time-out is completed and the key entry is accepted as valid, then goes low as indicated in *Figures 4 and 5*. It remains at a Logical Low Level until the function initiated by the key is completed and the key is released and timed out. The low to high transition indicates the calculator has returned to an idle state and a new key can be entered.

TABLE I. Keyboard Matrix

SWITCH INPUTS	DIGIT TIMING STATES										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D11	D12
K1	0		9	8	7	6	5	4	3	2	1
K2	+	CS	STO	1/X	↔	C	EN	$\sqrt{X}$	÷	X	–
K3		π		•	RCL	ARC	ROL				EEX
K4		TAN	SIN	COS		LOG	Y^x	LN	e^x		10^x

TABLE II. Digits Timing State Truth Table

ENCODED DIGITS				DECODED DIGIT STATES (DS8868)											
D_D	D_C	D_B	D_A	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
H	H	L	L	ON											
H	H	H	H		ON										
L	H	H	H			ON									
H	L	H	H				ON								
L	H	L	H					ON							
H	L	H	L						ON						
H	H	L	H							ON					
L	H	H	L								ON				
L	L	H	H									ON			
H	H	H	L										ON		
L	L	L	H											ON	
H	L	L	L												ON
L	L	L	L												

ON = DS8868 output buffer will sink ≥ 110 mA @ $V_{OUT} \leq 0.4V$

H = Logical High State (~ V_{SS})

L = Logical Low State (~ V_{DD})

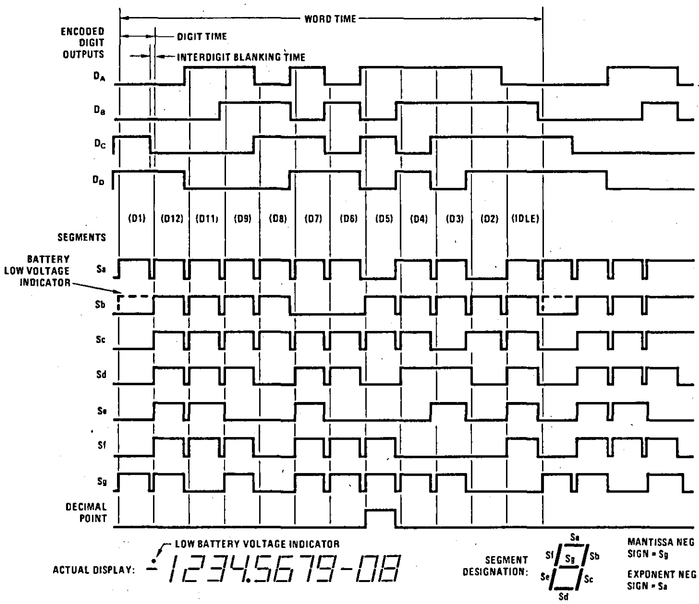


FIGURE 3. Display Timing Diagram

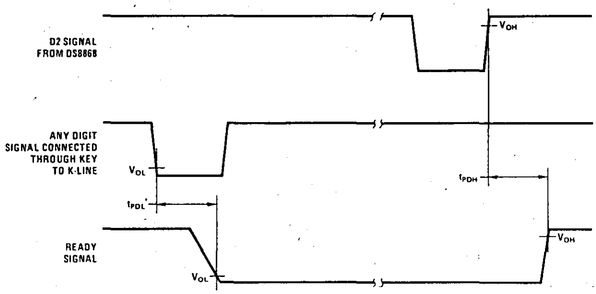


FIGURE 4. Ready Timing

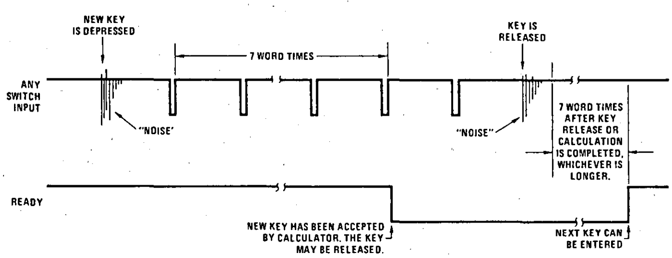


FIGURE 5. Functional Description of Ready Signal and Key Entry.

ERROR INDICATION

In the event of an operating error, the MM5758 will display all zeros and decimal points. Improper operations or calculations are summarized in Table III. All square root computations are of the absolute value of X; therefore, the square root of a negative number is not considered an invalid operation.

An error condition is reset by pressing "C." All registers in the stack are lost and replaced with zeros. M is saved.

TABLE III. Conditions for Error Indication

FUNCTION	CONDITION (REGISTER X ≡ X)
÷ or 1/X	$\lvert X\rvert = 0$
Y^x	$Y < 0$, $X \log Y > 99$
e^x	$\lvert X\rvert > 230$
10^x	$\lvert X\rvert > 99$
LOG X or LN X	$X \leq 0$
SIN X, COS X, TAN X	$X < 0$ or $X > 90$
ARC SIN X or ARC COS X	$X < 0$ or $X > 1$
ARC TAN X	$X < 0$

KEY OPERATIONS

Clear Key, "C"

Clears X, pushes Y down to X, Z to Y, T to Z and places a zero in T. Subsequent depressions perform the same operation; thus, four "C" depressions will clear a completely full stack. If the display indicates an error condition exists, the "C" key clears X, Y, Z and T. Storage memory M is not affected by any "C" operation.

Number Entries

The first numeral of a number entry following any function, other than "EN," raises the stack and T is lost. Numerals are entered and displayed from left to right. Following "EN" the first number entry is placed in X without affecting the rest of the stack. Ninth and subsequent entries of the mantissa are ignored; third and subsequent entries of the exponent are entered as a new least-significant-digit, and the previous most-significant-digit is lost.

Decimal Point, "."

Places a decimal point on the right side of the least-significant-digit being displayed during entry of the mantissa. It is invalid during exponent entry and clears the X-register to zero (starting a new number entry).

Change Sign Key, "CS"

Changes the sign of X. In the exponent entry mode, it changes the exponent sign. It does not terminate entry and therefore can be depressed at any time during the entry mode. Multiple depressions are allowed.

Enter Key, "EN"

Register T is lost, Y and Z are pushed up and X is copied into Y.

THE FOUR FUNCTION KEYS, "+," "–," "x," and "÷"

Add key, "+"	:	$Y + X \rightarrow X$	$Z \rightarrow Y$, $T \rightarrow Z$, $0 \rightarrow T$
Subtract key, "–"	:	$Y - X \rightarrow X$	
Multiply key, "x"	:	$Y \cdot X \rightarrow X$	
Divide key, "÷"	:	$Y \div X \rightarrow X$	

Pi Key, "π"

Register T is lost; X, Y and Z are pushed up in the stack and the constant 3.1415927 is placed in X.

Exchange Key, "←→"

Registers X and Y are exchanged; other registers are not affected.

Inverse Trigonometric Key, "ARC"

Preceding one of the three trigonometric keys, "SIN," "COS" or "TAN," it conditions the calculator to determine the angle in degrees of the value in register X. "ARC" followed by any key other than one of the trigonometric keys will be ignored.

Enter Exponent Key, "EEX"

Puts calculator in exponential entry mode. "EEX" must be preceded by a number (mantissa), or it will be ignored. A decimal point is an invalid entry that changes X to zero.

Trigonometric Keys, "SIN," "COS," and "TAN"

Assumes the value of X is an angle in degrees and computes the indicated trigonometric function, replacing X with the result. Register T is replaced by a zero; M, Z and Y are not affected. Following "ARC," the trigonometric keys determine the angle represented by the function in X, and replace X with that value in degrees. T is replaced by a zero; M, Z and Y are unchanged.

Reciprocal Key, "1/X"

A non-zero value of X is replaced by its reciprocal. Registers Y, Z, T and M are unaltered.

Square Root Key, "$\sqrt{X}$"

The absolute value of X is replaced by its square root. Registers Y, Z, T and M are not altered.

Logarithmic Keys, "LN" and "LOG"

These keys replace the value of X by its natural or common logarithm, respectively. Registers Z and T become zero. Registers Y and M are not affected.

Power Key, "Y^X"

Determines the value of Y raised to the power of X and replaces X with that result. Registers Y, Z and T become zero. M is not affected.

Exponential Keys, "e^x" and "10^x"

The constants 2.7182812 or 10.0 are raised to the power of X, respectively, and placed in X. Register T becomes zero; Y, Z and M are not affected.

Memory Keys, "STO" and "RCL"

The memory store key, "STO," copies the value of X (including sign) into storage register M, without altering the stack. The recall key, "RCL," transfers Z to T, Y to Z and X to Y, then copies M into X. Storage register M is not changed and T is lost. Both "STO" and "RCL" terminate an entry mode.

Roll Stack Key, "ROL"

Repositions the data within the operational stack by transferring X to T, Y to X, Z to Y and T to Z. After four successive depressions each of the four data positions has been viewed and returned to its original location.

Range and Accuracy of Functions

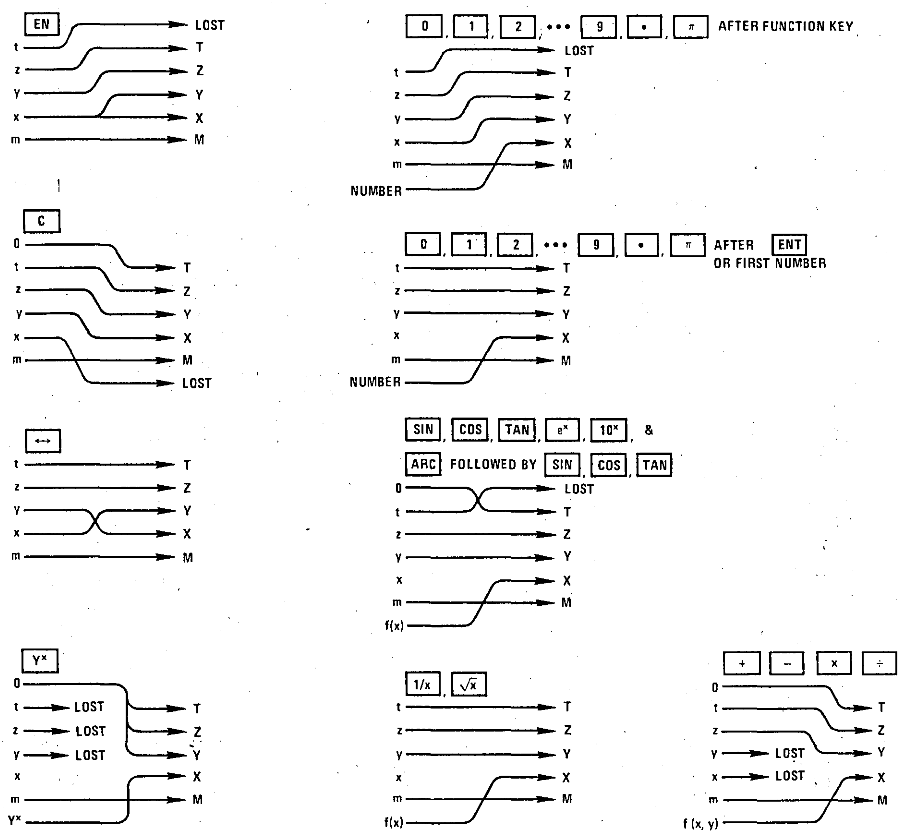
The smallest magnitude that can be displayed is $\pm 10^{-99}$ and the total range is $\pm 9.9999999 \times 10^{99}$. Table IV summarizes range and accuracy of the MM5758 functions.

TABLE IV.

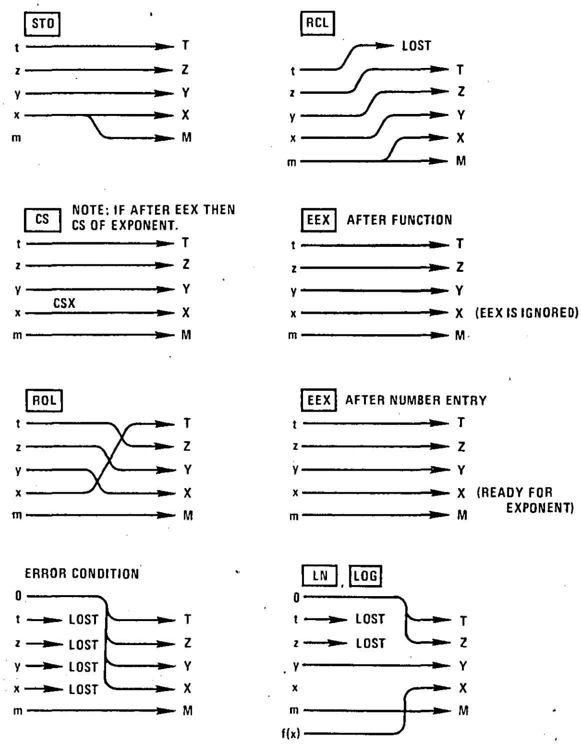
FUNCTION	RANGE	ACCURACY
+, −, x, ÷, 1/X	$\pm 1 \times 10^{-99} \leq X \leq \pm 9.9999999 \times 10^{99}$	±1 in first non-zero digit from LSD
$\sqrt{X}$	$\lvert \pm 1 \times 10^{-99} \rvert \leq X \leq \lvert \pm 9.9999999 \times 10^{99} \rvert$	±2 in first non-zero digit from LSD
LOG X	$0 < X \leq +9.9999999 \times 10^{99}$	7 digits
LN X	$0 < X \leq +9.9999999 \times 10^{99}$	7 digits
10^x	$\pm 1 \times 10^{-99} \leq X \leq +99$	5 digits
e^x	$\pm 1 \times 10^{-99} \leq X \leq +230$	5 digits
Y^x	$Y > 0$, with X and Y values such that the results will be $+1 \times 10^{-99} \leq X \leq +9.9999999 \times 10^{99}$	5 digits
SIN, COS, TAN	$0 \leq X \leq +90$	7 digits
ARC SIN, ARC COS	$0 \leq X \leq +1$	5 digits
ARC TAN	$0 \leq X \leq 9.9999999 \times 10^{99}$	5 digits

*Error in last useable digit is less than 5

Summary of Stack Operations



Summary of Stack Operations (con't)



SAMPLE PROBLEMS

Problem No. 1 1.345 + 7120 − 14251 = ?

		STACK REGISTERS				
KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
POWER ON	0.	0	0	0	0	Power on clears all registers and memory
1	1					
.	1.					
3	1.3					
4	1.34					
5	1.345					
ENTER	1.345	1.345				Copy X in Y
7	7					
1	71					
2	712					
0	7120					
+	7121.345	0				Add X and Y
1	1	7121.345				
7	17					
CLR	7121.345	0				Clear entry, pushes down stack
1	1	7121.345				
4	14					
2	142					
5	1425					
1	14251	7121.345	0	0	0	
−	−7129.655	0	0	0	0	Subtract X from Y Note: It is not necessary to clear calculator for the next problem.

Problem No. 2 $(3.73 \times 10^{-7}) \times (-15 \times 10^{24}) \div 27357.3 = ?$

STACK REGISTERS

KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
3	3	−7129.655	0	0	0	The new number entry pushes the answer of the last problem up in the stack
.	3.					
7	3.7					
3	3.73					
EEX	3.73					Prepare for exponent entry
7	3.73 07					
CHS	3.73 −07					Change sign of exponent
ENTER	3.73 −07	3.73 −07	−7129.655			
1	1					
5	15					
CHS	−15					Change sign of mantissa
EEX	−15					
2	−15 02					
4	−15 24					
x	−5.595 18	−7129.655	0	0	0	Multiply X and Y
2	2	−5.595 18	−7129.655	0	0	
7	27					
3	273					
5	2735					
7	27357					
.	27357.					
3	27357.3					
÷	−2.0451579 14	−7129.655	0			Divide Y by X
CLR	−7129.655	0				Clear Answer
CLR	0.	0	0	0	0	Clear answer from problem 1 Note: This is not necessary. It is done here to avoid confusion of stack operation in the next problem.

Problem No. 3 $\sqrt{10.3\,(3^2+4^2)\,(5^2+6^2)}$

STACK REGISTERS

KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
10.3	10.3	0	0	0	0	
ENTER	10.3	10.3				The "Roll" key can be used to examine the stack. It is not necessary for the solution.
3	3	10.3				
ENTER	3.	3	10.3			Register contents displayed:
ROLL	3.	10.3	0	3		Y
ROLL	10.3	0	3	3		Z
ROLL	0.	3	3	10.3		T
ROLL	3.	3	10.3	0		X
x	9.	10.3	0	0		3^2
4	4	9	10.3	0		
ENTER	4.	4	9	10.3		
x	16.	9	10.3	0		4^2
+	25.	10.3	0	0		(3^2+4^2)
x	257.5	0	0	0	0	$10.3\,(3^2+4^2)$
5	5	257.5	0	0	0	
ENTER	5.	5	257.5			
x	25.	257.5	0			5^2
6	6	25.	257.5			
ENTER	6.	6	25	257.5		
x	36.	25	257.5	0		6^2
+	61.	257.5	0			(5^2+6^2)
x	15707.5	0				$10.3\,(3^2+4^2)\,(5^2+6^2)$
$\sqrt{X}$	125.32956	0	0	0	0	$\sqrt{10.3\,(3^2+4^2)\,(5^2+6^2)}$

Problem No. 4 $1 + \frac{1}{2!} X + \frac{1}{3!} X^2 = ?, \quad X = -0.15$

STACK REGISTERS

KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
1	1	125.32956	0	0	0	
ENTER	1.	1	125.32956			
2	2					2!
$\frac{1}{X}$	0.5					$\frac{1}{2!}$
0.15 CHS	−0.15	0.5	1	125.32956		X
STO	−0.15				−0.15	Store X for use later in the problem
X	−7.5 −02	1	125.32956	0		$\frac{1}{2!}$ X
+	0.925	125.32956	0			$1 + \frac{1}{2!}X$
3	3	0.925	125.32956			
ENTER	3.	3	0.925	125.32956		
2	2					
X	6.	0.925	125.32956	0		3!
$\frac{1}{X}$	0.1666666	0.925	125.32956	0	−0.15	$\frac{1}{3!}$
RCL	−0.15	0.1666666	0.925	125.32956	−0.15	X
ENTER	−0.15	−0.15	0.1666666	0.925		Answer to last problem is lost here
X	2.25 −02	0.1666666	0.925	0		X^2
X	3.7499985 −03	0.925	0			$\frac{1}{3!}X^2$
+	0.9287499	0				$1 + \frac{1}{2!}X + \frac{1}{3!}X^2$
CLR	0					
RCL	−0.15	0	0	0	−0.15	Notice that the clear does not affect the memory register. Memory is changed only by storing another value or by power off.

Problem No. 5 $\pi(21) = ? \quad 21^2(\pi) = ?$

STACK REGISTERS

KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
π	3.1415927	−0.15	0	0	−0.15	
21	21	3.1415927	−0.15			
X	65.973446	−0.15	0			π(21)
21	21	65.973446	−0.15			
ENTER	21.	21	65.973446	−0.15		
X	441.	65.973446	−0.15	0		21^2
π	3.1415927	441	65.973446	−0.15		
X	1385.4423	65.973446	−0.15	0	−0.15	$21^2(\pi)$

Problem No. 6 Example using Exchange and Reciprocal keys.

STACK REGISTERS

KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
5	5	1385.4423	65.973446	−0.15	−0.15	
ENTER	5.	5	1385.4423	65.973446		
1	1					
EXCH	5.	1				
÷	0.2	1385.4423	65.973446	0		
5	5	0.2	1385.4423	65.973446		
$\frac{1}{X}$	0.2	0.2	1385.4423	65.973446		Compare the answers obtained by exchanging X and Y. In this case, they are identical.
EXCH	0.2	0.2	1385.4423	65.973446		
EXCH	0.2	0.2	1385.4423	65.973446		
−	0.	1385.4423	65.973446	0		Compare by subtracting zero error
$\frac{1}{X}$	0.0.0.0.0.0.0.0.	0	0	0		Divide by zero. Error clears all registers.
CLR	0.	0	0	0	−0.15	After clearing an error, all registers are zero. Memory is not disturbed.

Problem No. 7 Example using "10^x" and "LOG" keys

KEY ENTRY	DISPLAY X	STACK REGISTERS Y	Z	T	MEMORY M	COMMENTS
1.2345678	1.2345678	0	0	0	−0.15	
STO	1.2345678				1.2345678	Store original value
10^x	17.161995					
LOG	1.2345678					
RCL	1.2345678	1.2345678				
EXCH	1.2345678					Compare answer to original value
EXCH	1.2345678					
4	4		1.2345678			Fill the stack
ENTER	4.	4		1.2345678		
3	3					
ENTER	3.	3	4			
2	2					
ENTER	2.	2	3	4		
1	1	2	3	4	1.2345678	
10^x	10.	2	3	0	1.2345678	Notice that "T" is lost (same for 10^x, e^x)
4	4	10.	2	3		
ENTER	4.	4	10.	2		
3	3					
ENTER	3.	3	4	10		
2	2					
ENTER	2.	2	3	4		
1	1					
LOG	2.2 −07	2	0	0	1.2345678	Notice that "Z" and "T" are lost (same for LOG, LN)

Problem No. 8 Example using "e^x" and "LN" keys

KEY ENTRY	DISPLAY X	STACK REGISTERS Y	Z	T	MEMORY M	COMMENTS
8.7654321	8.7654321	2.2 −07	2	0	1.2345678	
STO	8.7654321				8.7654321	Store original value
e^x	6408.8309					
LN	8.7654321		0			
RCL	8.7654321	8.7654321	2.2 −07			
−	0.0	2.2 −07	0	0	8.7654321	Compare answer to original. Error is 0.0

Problem No. 9 2^{10}

KEY ENTRY	DISPLAY X	STACK REGISTERS Y	Z	T	MEMORY M	COMMENTS
2	2	8.7654321	8.7654321	2.2 −07	8.7654321	
ENTER	2.	2		8.7654321		
10	10					
Y^x	1024.0037	0	0	0	8.7654321	Notice that "Y," "Z" and "T" are lost

Problem No. 10 Trigonometric computations

KEY ENTRY	DISPLAY X	STACK REGISTERS Y	Z	T	MEMORY M	COMMENTS
30	30	1024.0037	0	0	8.7654321	Enter X in degrees
SIN	0.5000002					Sine of 30° is computed
ARC	0.5000002					ARC sine is computed
SIN	29.999556					
4	4	29.999556	1024.0037			
ENTER	4.	4	29.999556	1024.0037		
3	3					
ENTER	3.	3	4	29.999556		
2	2					
ENTER	2.	2	3	4		
1	1					
SIN	1.7452415 −02	2	3	0	8.7654321	Notice that "T" is lost (same for SIN, COS, TAN)
4	4	1.7452415 −02	2	3	8.7654321	
ENTER	4.	4	1.7452415 −02	2		

Problem No. 10 (con't)

KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
		STACK REGISTERS				
3	3					
ENTER	3.	3	4	1.7452415 −02		
2	2					
ENTER	2.	2	3	4		
1	1					
ARC	1.					
SIN	89.999997	2	3	0	8.7654321	Notice that "T" is lost (same for ASIN, ACOS, ATAN)

Problem No. 11

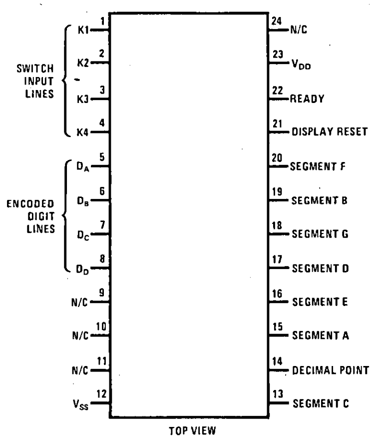
KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
		STACK REGISTERS				
30	30	89.999997	2	3	8.7654321	
COS	0.8660252			0		
ARC	0.8660252					
COS	29.999569	89.999997	2	0	8.7654321	

Problem No. 12

KEY ENTRY	DISPLAY X	Y	Z	T	MEMORY M	COMMENTS
		STACK REGISTERS				
45	45	29.999569	89.999997	2	8.7654321	
TAN	0.9999991			0		
ARC						
TAN	45.000629	29.999569	89.999997	0	8.7654321	

connection diagram

Dual-In-Line Package



Order Number MM5758N
See Package 22