commodore
Models
SR6140R, SR6120R
SR9140D, SR9120D
SR990D
Scientific Electronic Calculators

Owner's Manual
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## Special Applications

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<tr>
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Thank you for selecting our new scientific calculator. We prefer to call it a mini-computer because of its ability to handle an extensive range of complex assignments across a broad spectrum of basic and advanced mathematics.

It represents the finest achievement in solid state large scale integrated/Metal oxide silicon technology. Its ten digit mantissa with its two digit exponent—able to handle values as small as 1.0 x 10^-100 up to 9.999999999 x 10^100—affords far greater precision than is known to most of the physical constants in the universe.

Nonetheless, this mini-computer may also be regarded as simply a high-speed numeric answer machine. Its commonsense logic is the key to your mastery of it. You are able to enter basic assignments just as you would write them down on paper. For example, 4 x 5 = , is entered just as you see it. Higher math arguments are accomplished on your mini-computer by again entering examples as they are commonly written. Thus, the Log of 9-th Log of 4 is indexed: 9 Log 4 Log 4 = .

This emphasis on academic principles is a consistent theme which runs throughout the logic of your new mini-computer.

Students will appreciate the fact that most math concepts have been programmed into the logic system. Among these basic tenets are such principles as any number raised to the zero power equals one; and zero raised to any power (except zero) equals zero. As can be seen, results will be precisely displayed for immediate comprehension.

Professionals will enjoy the added features of the machine such as the EE1 and EE2 keys which enable the automatic integer increase and decrease of an exponent.
in short, our mini-computer was designed by professionals for professionals and students alike. It has been developed as an easy-to-understand, easy-to-operate machine. Please read through the pages of this manual carefully. Become familiar with the keyboard and its characteristics. Work through the examples. They have been designed to give you a thorough understanding of all functions. Proficiency is gained by practice. Once you discover how easy your mini-computer is to operate, it will become an essential, enjoyable aid to you in every area of computation.

A special note concerning display capacity and machine logic.
This book has been prepared to illustrate the operation of a 14-digit machine.
In the event you have selected a machine with a 12- or 9-digit capacity, you are of course restricted to an entry limited by the number of digits in the mantissa and results will be truncated in accordance with the capacity of the display. This in no way alters the accuracy of your machine as the extra digits are retained within the unit’s logic for continued computation. Thus, you can work all of the problems in this manual.

The treatment of numbers between +1 and −1 differs among models. In all instances both entry and result are accurate. However, some models will express these values in scientific notation.

**Example A.** .002 X 2.− 03
**Example B.** .002 X .002
Both results are identical.

**NUMERICAL ENTRY**

<table>
<thead>
<tr>
<th>0 through 9</th>
<th>+ / −</th>
<th>EE</th>
</tr>
</thead>
</table>

**sample display**

<table>
<thead>
<tr>
<th>Sign</th>
<th>Mantissa</th>
<th>Sign</th>
<th>Exponent</th>
<th>Exponent</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

(14 digits): − 0.123456789 90
(12 digits): − 102.34578 99
(9 digits): − 123.45 99

• **sign mantissa:** − or + , blank on display implies a positive number

• **mantissa:** 10 digit maximum in 14-digit display
8 digit maximum in 12-digit display.
5-digit maximum in 9-digit display.

**Special Case:** A result between 1 and −1 which has an exponent — 01 is displayed in floating notation with a leading zero. This affects the display only. The logic of the calculator realizes the true 10-digit result and the ten digit accuracy is retained in the machine.

**Enter:** See Displayed:

2 ÷ 3 = 0.666666666

Subsequent chain calculations will be computed using the true result retained internally in scientific notation:

6.666666666 ÷ 01
• **sign of exponent:** − or +, blank implies positive
• **exponent field:** two digits maximum

**Entry:** A number (the mantissa) is entered just as written using the keys 0 through 9. The sign of the mantissa can be entered at any time during a numerical entry by pressing the change sign key +/−. The sign of the exponent can be changed by pressing the change sign key after the EE key (enter exponent key) has been pressed. The exponent field is blank until EE is entered.

C
The clear entry/clear key. Pressing the C key during or immediately after a numerical entry will clear the display. Only prior entries are retained intact. Pressing the C key in all other cases clears your calculator; Memories are not cleared.

**Enter:**
2 + 3 C 4 = 6 C

In the above example, we wished to add 2 and 4 but entered 3 by mistake. Pressing C and entering 4, corrects the error and allows further computation. The final C clears the calculator.

---

**FOUR FUNCTION ARITHMETIC**

| + | − | × | ÷ |

**Example:**

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 +/− − 3</td>
<td>− 3.</td>
<td>Enter −3 and multiply</td>
</tr>
<tr>
<td>1.2 EE +/− 2</td>
<td>1.2 ÷ 02</td>
<td>Enter 1.2 × 10⁻²</td>
</tr>
<tr>
<td>=</td>
<td>=</td>
<td>Perform multiplication and display result</td>
</tr>
</tbody>
</table>

**CHAIN CALCULATIONS**

**Example:**

Calculate $\frac{3 \times 4}{5} + .3$

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3 \times$</td>
<td>3.</td>
<td>Enter 3 and multiply</td>
</tr>
<tr>
<td>4</td>
<td>4.</td>
<td>Enter 4</td>
</tr>
<tr>
<td>$\div$</td>
<td>12.</td>
<td>The multiplication $3 \times 4$ is performed, the result, 12, is displayed and divide is entered.</td>
</tr>
<tr>
<td>5</td>
<td>5.</td>
<td>Enter 5</td>
</tr>
</tbody>
</table>
Enter: Read: Explanation:

\[ \div \quad 2.4 \quad \text{The result of the division} \]
\[ 12 \div 5 \text{ is displayed and} \]
\[ \text{divide is entered} \]

\[ .3 \quad 0.3 \quad \text{Enter .3} \]

\[ = \quad 8 \quad \text{The result of} \]
\[ \frac{3 \times 4}{5} \div 0.3 \]
\[ \text{which is 8 in display} \]

**CORRECTING OPERATIONS**

**Example:** Calculate \(3 \times 4\)

Enter: Read: Explanation:

\[ 3 \div \quad 3 \quad \text{Enter 3. We wish to multiply} \]
\[ \text{but entered} \div \text{by mistake.} \]

\[ \times \quad 3 \quad \text{Enter the correct function key} \]

\[ 4 \quad 4 \quad \text{Now enter 4} \]

\[ = \quad 12 \quad \text{The result of} 3 \times 4 \text{is displayed} \]

In this manner any of the "four function" keys
\((+\,-\,\times\,\div)\) can be over written by another;
the final entry will be executed. For example:

Enter: Read: Explanation:

\[ 3 \times \div \]

\[ \div \,-\,4 \div \quad -1 \quad \text{The last function} \]
\[ \text{pressed,} \quad (-) \text{is} \]
\[ \text{executed.} \]

Use of the \(F\) Function Key.

Your mini-computer has 39 keys, one of which
is a special function key marked "F." The
application of this key enables you to increase
the performance range of your machine by
releasing twelve additional operations.

Twelve of the 39 keys are inscribed with upper
case functions. If any one of these keys is
pressed the lower case function is executed.
However, if the \(F\) key is indexed immediately
prior to pressing one of the "double function"
keys, the upper case function is performed.

**Example:**

Enter: Read: Explanation:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>144</td>
<td>144.</td>
</tr>
<tr>
<td>X^2</td>
<td>20736.</td>
<td>Square 144.</td>
</tr>
<tr>
<td>b</td>
<td>144</td>
<td>144.</td>
</tr>
<tr>
<td>(F\ square)</td>
<td>12</td>
<td>Obtain square root of 144.</td>
</tr>
</tbody>
</table>
USING THE MEMORY

Store: STO 1  STO 2

The store keys refer to the two memory registers which store data for future use. When STO 1 is pressed, the value currently on the display will be copied into Memory Register 1. Similarly, when the key is entered as a prefix to the Memory STO 2, the register is activated and the displayed data is copied into Memory Register 2. Any data stored in the register prior to pressing the respective STO key will be lost. This is referred to as “writing over.”

Recall: RCL 1 and RCL 2

These keys are used to recall data stored in their associated memory registers. The value stored in memory is copied onto the display; the value on display prior to recall is unaltered. To recall data in STO 2, press key sequence F RCL 2.

Example:

Enter:  Read: Explanation:
5 5. Enter 5
STO 1 5. Copies 5 into memory register 1
6 6. Enter 6
F STO 2 6. Copies 6 into memory register 2

Enter:  Read: Explanation:
RCL 1 5. The content of Memory 1 (5) is copied onto the display. Five remains in Memory 1.
F RCL 2 6. The content of Memory 2 (6) is copied onto the display. Six is retained in Memory 2.

Clear:

An individual memory register can be cleared by entering the key sequences:

C STO 1 Clears memory register 1.
F C STO 2 Clears memory register 2.

The C key need not be entered if 0. is on the display. However, you must still press the appropriate storage register keys to replace the existing data with a zero value. Both memory registers are cleared at power on.

CHAIN CALCULATIONS USING MEMORY

Examples:

Enter:  Read:
1 5. Enter 1
STO 1
2 2. Enter 2
RCL 1 2. The content of Memory 2 is displayed and stored in Memory 1 for future recall.
Enter:

1. \(3 + 5 + \text{RCL 1} = \)

Read:

18.

The value in Memory 1 (10) is added to 6 and the result is displayed. Memory 1 is unaffected.

2. \(3 \times 5 \times 4 \div 6 = \text{STO 2} \)

Read:

10.

The result of the calculation is displayed and stored in Memory 2 for future recall.

3. \(3 \times 4 \div \text{RCL 2} = \)

Read:

1.2

The value stored in Memory 2 (10) is included in the calculation and the result is displayed. Memory 2 is unaltered.

4. \(3 \times \)

Enter the "Z" multiplier 3

5. \(4 \times \)

Enter 4 and multiply

6. \(3 \div \)

Calculate & display 4 \(e^{-3}\) and add

7. \(3 \times \text{e}^x \)

Calculate & display \(e^3\)

8. \(3 \times \text{e}^x \)

Calculate \(Z = 4 \cdot e^{-3} \cdot e^3\) and end second level of calculation

9. \(y^x 3 \)

Enter Z as the base 3 or the power

10. \(= \)

Calculate \(3 \cdot Z^3\)

CHAINING WITH PARENTHESIS KEYS

The open and close parenthesis keys provide another level of priority in arithmetic calculations.

For example let’s solve the equation: \(y = 3 \cdot Z^3\) where \(Z = 4 \cdot e^{-3} \cdot e^3\) and \(t = 3\)
Example:
Calculate the product of two sums:
\((a+b) \times (c+d) = (2+3) \times (4+5)\)

Enter: Read: Explanation:
\[\begin{align*}
2 & + & 2. & \text{2 add entered} \\
3 & \times & 5. & \text{2 + 3 calculated and displayed} \\
\text{\(\boxed{}\)} & 5. & \text{Second level of calculation initiated} \\
4 & + & 4. & \text{4 add entered} \\
5 & 5. & \text{5 entered} \\
\text{\(\boxed{}\)} & 9. & \text{4 added to 5. Second level calculation terminated} \\
\Rightarrow & 45. & \text{(2+3) multiplied by (4+5)}
\end{align*}\]

**RECIPROCAL KEY**
\(1/x\) The reciprocal or inverse function key computes the inverse of a number on the display and instantly displays the result.

**POWER AND ROOT KEYS**
\(x^2\) The Square key raises the number currently on display to the second power.
\(\sqrt{x}\) The Square Root key takes the square root of the number currently on display.

**EXAMPLES:**
1. Calculate the hypotenuse of a triangle whose sides measure 3 and 4

![Diagram of a triangle with sides 3, 4, and 5]

Enter: Read: Explanation:
\[\begin{align*}
3 & \times & 3. & \text{Calculate } 3^2 \text{ and add} \\
4 & \times & 16. & \text{Calculate } 4^2 \\
\Rightarrow & 25. & \text{Calculate } (3^2 + 4^2) \\
\boxed{} & 5. & \text{The hypotenuse measures 5}
\end{align*}\]
With the power key, a number raised to any power (or root) can be calculated. The base is entered first, then the power key, and finally the power (or root) to which the base is to be raised. Powers are calculated using the formula $y^x = e^{x \ln y}$, $\sqrt[y]{x} = e^{\left(\frac{\ln x}{y}\right)}$.

Therefore, negative bases are not permitted. Any attempt to raise a negative base to a power will result in an error condition. In addition to performing all commonly encountered powers and roots accurately and quickly, your calculator will correctly perform those calculations: $0^x = 1$, $x^0 = 1$, $0^x = 0$ for $x \neq 0$.

Chain calculation involving $y^x$ key

Calculate $3x^3 - x^3 + 4$ for $x = 4$

Enter: Read: Explanation:

3 \times \quad 3. \quad \text{Enter 3 and multiply}

4 \quad 4. \quad \text{Enter 4 as the base}

5 \quad 5. \quad \text{Enter 5 as the power}

- \quad 3072. \quad \text{Calculate and display } 3(4)^3 \text{ and enter subtract}

4 \quad 4. \quad \text{Enter 4, the base}

Binary to decimal conversion:

Convert the binary number 11011 to decimal. 11011 in base 2 is equal to $2^4 + 2^3 + 2^1 + 2^0$ in decimal.

Enter: Read: Explanation:

2 \quad 2. \quad \text{Enter 2, the base}

0 \quad 1. \quad \text{Calculate & display } 2^0 \text{ and add}

2 \quad 2. \quad \text{Enter 2, the base}

1 \quad 3. \quad \text{Calculate & display } 2^3 + 2^1 \text{ Enter and add}

2 \quad 2. \quad \text{Enter 2, the base}

3 \quad 11. \quad \text{Calculate and display } 2 + 2 + 2 \text{ and add}

2 \quad 6. \quad \text{Terminate calculation & display result}

11011 \text{ base } 2 = 27 \text{ base } 10
What are the monthly payments on a $20,000 mortgage at 9% annually extending over 20 years?

formula: \[ PMT = \frac{PV \times i}{1 - (1 + i)^{-n}} \]

Where PV is the Principal (present value) of the mortgage
i is the monthly interest expressed as a decimal
n is the number of months
PMT is the monthly payment

Enter: \[ \frac{.09}{12} + \]
Read: 0.0075
Calculate the monthly interest (9% for 12 months)

\[ 1 + \]
1.0075
Calculate \((1 + i)\) and enter it as the base

\[ 240 \div \]
240.
Enter the number of months, change the sign, calculate \((1 + i)^{-n}\) and subtract 1

\[ = \frac{+/-}{1} = \]
0.833587156
Store \(1 - (1 + i)^{-n}\) in memory

Enter: \[ RCL 1 \]
Read: 170.045191
The dollar amount necessary to amortize a $20,000 mortgage in 20 years at 9% annual interest

③ Hypotenuse Calculations

Given a right triangle, three meters on one side and four on the other, find the hypotenuse. The equation is:

\[ R = \sqrt{A^2 + B^2} \]
\[ A = \text{side 1} \quad B = \text{side 2} \]

Find R, if \(A = 3\) and \(B = 4\)

Enter: \[ 3 \]
Read: 3. Enter 3, the base

Enter: \[ 2 \]
Read: 9. Calculate & display \(3^2\)
Enter: \( y \)
Read: 4
Explanation: Enter 4, the base

\[ 2 = 25 \]

Enter 25 as the base

\[ \sqrt[3]{25} \]

Calculate and display the second root of 25.

See Example 1 for alternate solution.

\[ \sqrt[3]{1,000} = 10 \]

Example:

\( \) Find the radius of a sphere whose volume is 2144 cubic meters.

Equation: \( R = \frac{3V}{4\pi} \)

Enter: \( 2144 \times 2144 \)
Read: 2144
Explanation: Enter the Volume - multiply

\[ 3 \div \]

By 3 divide

\[ 4 \div \]

By 4 divide

\[ \pi = 511.842297 \]

By \( \pi \)

Enter: \( \sqrt[3]{511.842297} \)
Read: \( \frac{3V}{4\pi} \) as the base

\[ 3 = 7.999178546 \]

Calculate the cubic root of \( \frac{3V}{4\pi} \) and display result

The sphere has a radius of approximately 8 meters.

TRANSCENDENTAL FUNCTIONS

Your scientific calculator will perform common and natural (Naperian) logarithmic and inverse logarithmic functions. It also calculates the three trigonometric functions and their inverses. Each of these keys operates on the value currently on display.

**Logarithmic Functions**

\( \log \) Calculates the common logarithm \((\log_{10})\) of \( x \).

\( 10^x \) Calculates the common antilogarithm of \( x \).

\( \ln \) Calculates the natural logarithm \((\log_e)\) of \( x \).

\( e^x \) Calculates the natural antilogarithm of \( x \).
Examples:

1. Natural logarithm \( \ln \) and inverse natural logarithm function, \( e^x \)
   Calculates \( e^{\ln x} \) and \( \ln e^x \)

Enter: \hspace{1cm} \text{Read:} \hspace{1cm} \text{Explanation:}

2 \ln + 0.69314718 Calculate \( \ln 2 \) and enter +
3 \ln 1.098612289 Calculate \( \ln 3 \)
= 1.791759469 Display result of \( \ln^2 + \ln^3 \)
F e^x 6. Calculate the inverse function.

The above calculation demonstrates the equation \( \ln (a) + \ln (b) = \ln (ab) \).
To calculate the hyperbolic arc tan of .5:

2. Equation: \( \arctanh X = \frac{1}{2} \ln \left( \frac{1 + X}{1 - X} \right) \)

Enter: \hspace{1cm} \text{Read:} \hspace{1cm} \text{Explanation:}

1 - .5 = 0.5 Store (1-.5) in Memory 1
STO 1
1 + .5 = 1.5 Calculate (1+.5), enter divide
= 25

Enter: \hspace{1cm} \text{Read:} \hspace{1cm} \text{Explanation:}

RCL 1 = 3. Calculate \( (1+.5) \)

\[
\ln \frac{(1+.5)}{(1-.5)}
\]

\[
\times \ 2 = 0.549306144
\]

\[
\text{arc} \tan = \frac{1}{2} \left( 1 + .5 \right)
\]

Calculate the hyperbolic sine of .5

Equation: \( \sinh x = \frac{e^x - e^{-x}}{2} \)

Enter: \hspace{1cm} \text{Read:} \hspace{1cm} \text{Explanation:}

.5 e^x 1.648721271 Calculate and display the exponential function of .5, \( e^x \) and enter −
.5 +/− e^x .606530659 Calculate and display the exponential of −.5
= 1.042190811 Perform subtraction, display result, and enter +
2 = 0.521095305 Divide by 2 and display the result, the \( \sinh .5 \)
Trigonometric Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sin</td>
<td>Calculates sine of x.</td>
</tr>
<tr>
<td>F sin⁻¹</td>
<td>Calculates inverse sine of x.</td>
</tr>
<tr>
<td>cos</td>
<td>Calculates cosine of x.</td>
</tr>
<tr>
<td>F cos⁻¹</td>
<td>Calculates inverse cosine of x.</td>
</tr>
<tr>
<td>tan</td>
<td>Calculates tangent of x.</td>
</tr>
<tr>
<td>F tan⁻¹</td>
<td>Calculates inverse tangent of x.</td>
</tr>
</tbody>
</table>

Your calculator will find the sine, cosine, tangent, arc sine, arc cosine and arc tangent of any number on display in either degrees or radians. The calculator is in degree mode when turned on. Pressing the \( \text{DEG} \) key shifts your calculator to radian mode, lights a decimal point in the exponent field, and converts the value on display from degrees to radians. Pressing \( \text{DEG} \) again shifts the calculator back to degree mode and converts the display in degrees.

Input range for sine, cosine and tangent is \( \pm 90^\circ \).

Example: Radian Mode

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \cos )</td>
<td>0.5</td>
</tr>
<tr>
<td>F cos⁻¹</td>
<td>120</td>
</tr>
<tr>
<td>45</td>
<td>45.</td>
</tr>
</tbody>
</table>

Example: Degree Mode

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sin )</td>
<td>0.5</td>
</tr>
<tr>
<td>F sin⁻¹</td>
<td>30</td>
</tr>
</tbody>
</table>

Radian indicator
Polar/Rectangular Coordinate Conversion

Polar/rectangular coordinate conversion requires two input values and has two output values. After entering the first value, press \( \boxed{\text{F} \ x \rightarrow \ y} \), then enter the second value. They operate on both degrees or radian mode. Note that polar/rectangular coordinate calculations cannot be chained.

\( \boxed{\text{D}} \) This key converts rectangular coordinates, \( x \) and \( y \) to polar form. The resulting magnitude is displayed first. Pressing \( \boxed{\text{F} \ x \rightarrow \ y} \) displays the angle.

Formulas:
\[
R = \sqrt{x^2 + y^2} \\
\theta = \tan^{-1}(y/x)
\]

The \( x \) value is entered first.

Example:
A projectile is assumed to have a straight path at the first few seconds of flight. Find the distance traveled if it has a horizontal traverse of 30 feet and a vertical traverse of 40 feet. Also, find the angle of attack.

\[
\theta \quad \text{40°} \\
\text{30°} \quad \text{x}
\]

Conversion to Radian

\( C \):

- \( 0 \)
- \( 120 \)

\( \boxed{\text{d/r}} \) 2.094395102 - 120° converted to \( 2\pi \) rad. Radian mode initiated

\( \boxed{\text{cos}} \) - 0.5

\( \boxed{\text{F} \ \cos^{-1}} \) 2.094395102

\( \boxed{\text{d/r}} \) 120. Convert back to degrees. Initial degree mode

\( \boxed{\text{tan}} \) 1.

\( \boxed{\text{F} \ \tan^{-1}} \) 0.785398163

\( \boxed{\text{d/r}} \) 45. Convert back to degrees and initiate degree mode

29
Enter: 30  Read: 30.  Explanation: Horizontal distance

Enter: 40.  Read: 40.  Explanation: Vertical distance

Enter: 50.  Read: 50.  Explanation: Distance traveled

Enter: 53.13010235  Read: 53.13010235  Explanation: Angle of attack

This key converts a polar pair value to rectangular coordinates. The resulting x coordinate is displayed first. Pressing \( x \rightarrow y \) displays the y coordinate.

Formulas: 
\[
x = R \cos \theta \\
y = R \sin \theta
\]

R is entered first.

Example:

A result in polar coordinates of a radius of 5 at an angle of 37° is to be converted to rectangular coordinates. The transformation is 
\[
X = R \cos \theta, \quad Y = R \sin \theta.
\]

A converted polar/rectangular coordinate value can be restored as shown by the following example:

Example:

Convert the pair of rectangular coordinates 
\( x = 3, \ y = 4 \) to Polar coordinates

Enter: 3  Read: 3.009075116  Explanation: 3 has been entered

Enter: 4  Read: 3.009075116  Explanation: The radius is 5

Enter: 53.13010235  Read: 53.13010235  Explanation: \( \theta = 53.13010235 \)
We can now convert back. Let's first convert this angle to radians.

Enter: \( \frac{d}{r} \)  \( 0.927295218 \)  Read:  
- \( R \)  3.  Explanation:  
\*x value displayed

\( F \)  \( \times \rightarrow y \)  4.  \*y value displayed

\( F \)  \( \times \rightarrow y \)  3.  \*x recovered

Examples:

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5  ( EE ) 48</td>
<td>5.5 46</td>
<td>Increase exponent *Shift decimal left</td>
</tr>
<tr>
<td>EE*1</td>
<td>0.55 47</td>
<td>*Shift decimal left</td>
</tr>
<tr>
<td>EE*1</td>
<td>0.055 48</td>
<td>*Shift decimal left</td>
</tr>
<tr>
<td>EE*1</td>
<td>0.0055 49</td>
<td>*Shift decimal right</td>
</tr>
<tr>
<td>EE*1</td>
<td>0.55 47</td>
<td>*Shift decimal right</td>
</tr>
<tr>
<td>EE*1</td>
<td>5.5 46</td>
<td>*Shift decimal right</td>
</tr>
</tbody>
</table>

Example: What is the time constant of an RC circuit with a 4 picofarad capacitor and a resistance of 7.5 Megohms? \( \tau = RC \)

\( C = .4 \) pf  \( R = 7.5 \) Meg\( \Omega \)

Enter:  
<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 ( EE ) ( EE )</td>
<td>12 4</td>
<td>*Time constant</td>
</tr>
<tr>
<td>( \times )</td>
<td>7.5</td>
<td>*Time constant</td>
</tr>
<tr>
<td>( EE )</td>
<td>6</td>
<td>*is 0.03 ms</td>
</tr>
<tr>
<td>( EE )</td>
<td>0.03</td>
<td>*is 0.03 ( \mu s )</td>
</tr>
<tr>
<td>EE*1</td>
<td>30. ( EE )</td>
<td>*Time constant</td>
</tr>
<tr>
<td>EE*1</td>
<td>06</td>
<td>*is 30. ( \mu s )</td>
</tr>
</tbody>
</table>
MEAN AND STANDARD DEVIATION

**Calculations**

\( X \)

Mean and Standard deviation can be calculated with these two keys. The series of values to be averaged is entered by the \( X \) key. The mean standard deviation is calculated when the \( \overline{X} \rightarrow \) key is pressed. The mean is displayed first and the standard deviation can be recovered by pressing the exchange key \( \overline{X} \rightarrow Y \). The standard deviation provides a measure of the distribution of values about the mean. The second memory register is used for accumulating and must be cleared before the mean calculation is begun.

The \( X \) key has an added advantage. It may be used as a summation \( \Sigma \) key for accumulation in the STO 2 memory for all examples except standard deviation. During standard deviation problems the \( X \) key automatically occupies the STO 2 memory to plot distribution entries. (For a detailed explanation of memory accumulation refer to description of \( \Sigma I \) key.)

**Example:**

The following represents a portion of the inventory received by Company X:

<table>
<thead>
<tr>
<th>Lot #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Parts</td>
<td>147</td>
<td>130</td>
<td>184</td>
<td>201</td>
<td>127</td>
<td>150</td>
<td>121</td>
</tr>
</tbody>
</table>

Based on this chart, what is the average number of parts per lot and how certain is this average?

**Enter:**
- 147
- 130
- 164
- 201
- 127
- 150
- 121

**Read:**
- 147
- 130
- 164
- 201
- 127
- 150
- 121

**Explanation:**
- Clear Memory 2
- Enter first # of parts
- Enter second
- Enter third
- Enter fourth
- Enter fifth
- Enter sixth
- Enter seventh

**\( \overline{X} \rightarrow \)** 148.5714286 The average # of parts per lot

**\( F X \rightarrow Y \)** 27.57327899 The standard deviation
shaded area represents 68.27% of lot

\[ -1\sigma = \hat{1}20.98\hat{1}485 \quad +1\sigma = \hat{1}76.1447076 \]

With 68.27% certainty, Company X can assume that they will receive between 120.981486 and 176.1447076 parts per lot on normal distribution.

**STANDARD DEVIATION**

\[
\sigma^2 = \frac{\sum (x_i - \bar{x})^2}{n - 1} \quad \text{with} \quad \bar{x} = \frac{\sum x_i}{n}
\]

\( \bar{x} \) is the mean and \( \sigma \) measures how far apart from the mean are the extremes. \( \sigma \) gives an idea of the distribution spread of the sample.

**Example:**

You throw darts and note the points obtained on 8 throws: 21, 17, 13, 25, 9, 19, 8, 10. What is your average mark and your standard deviation?

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>( \bar{x} )</td>
<td>21 ( \bar{x} ) enter ( x ), ( x )</td>
</tr>
<tr>
<td>17</td>
<td>( \bar{x} )</td>
<td>17 ( \bar{x} )</td>
</tr>
<tr>
<td>17</td>
<td>( \bar{x} )</td>
<td>17 ( \bar{x} )</td>
</tr>
<tr>
<td>6</td>
<td>( \bar{x} )</td>
<td>6 ( \bar{x} )</td>
</tr>
<tr>
<td>10</td>
<td>( \bar{x} )</td>
<td>10 ( \bar{x} )</td>
</tr>
<tr>
<td>10</td>
<td>( \bar{x} )</td>
<td>10 ( \bar{x} )</td>
</tr>
</tbody>
</table>

Now by pressing \( x \rightarrow y \) you will display the number of throws: 8. Now press \( x \rightarrow y \) again to get back in the standard deviation computing mode:

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>( \bar{x} )</td>
<td>15 get ( x )</td>
</tr>
<tr>
<td>( x \rightarrow y )</td>
<td>6.56622247</td>
<td>get ( \sigma )</td>
</tr>
</tbody>
</table>

Your average mark is 15 and you deviate from it by a 6.57 spread. Note that such spread does not measure the simple arithmetic deviation but the "normalized" one obtained by the difference of squares between \( \bar{x} \) and \( x \).
SPECIAL APPLICATIONS

POLAR/RECTANGULAR COORDINATES

CONVERSION

A point "A" may be identified either by its rectangular coordinates \( x, y \) or its polar coordinates \( r, \theta \):

We have: \( x^2 + y^2 = r^2 \) and \( x = r \cos \theta, y = r \sin \theta \). Your mini computer identifies the first entry as \( x \) or \( r \), the second as \( y \) or \( \theta \). The second entry is separated from the first one by using the \( \text{F} \) \( x \leftarrow y \) (exchange) key.

Examples:

Enter: \( 3 \times \) \( \text{F} \) \( x \leftarrow y \) \( 0 \).

Enter: \( 4 \) \( y \) \( 4 \).

Enter: \( \text{P} \) key (to Polar) \( 5, (r) \).

Enter: \( \text{F} \) \( x \leftarrow y \) 53.13010235 degrees (\( \theta \)).

Now, your mini computer acts as if you had entered 5 \( r \) first and then \( \theta : 53.13010235 \) second. Press: \( \text{P} \) (to rectangular) read:

Enter: \( 3 \times \) \( x \leftarrow y \) and read: 4 \( y \).

Your minicomputer also calculates the hypotenuse of a rectangular triangle:

We discussed calculating the hypotenuse of a right triangle by using the "X" square and square root keys on page 21. The rectangular coordinate key offers a short cut:

\[ 5' = 4' + 3' \]

Enter: \( 3 + 4 \) \( \text{P} \) \( 5 \) \( + \) key entry may be replaced by exchange key; See example above.
SPHERICAL COORDINATES

\[ x = r \sin \phi \cos \theta \]
\[ y = r \sin \phi \sin \theta \]
\[ z = r \cos \phi \]

Entering \( x \) and \( y \) will give \( \theta \) and \( r \sin \phi \).
Entering \( r \sin \phi \) and \( z \) will give \( y \) and \( r \).

RECTANGULAR TO SPHERICAL CONVERSION

Enter as in following example:

<table>
<thead>
<tr>
<th>Enter</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3.</td>
<td>enter ( x )</td>
</tr>
<tr>
<td>( \rightarrow ) ( x \rightarrow y )</td>
<td>0.</td>
<td>allow for next entry</td>
</tr>
<tr>
<td>4</td>
<td>4.</td>
<td>enter ( y )</td>
</tr>
<tr>
<td>( \rightarrow ) ( z \rightarrow r )</td>
<td>5.</td>
<td>get intermediate result ( r \sin \phi )</td>
</tr>
<tr>
<td>( \rightarrow ) ( x \rightarrow y )</td>
<td>53.13010235</td>
<td>get ( \theta )</td>
</tr>
<tr>
<td>7</td>
<td>7.</td>
<td>enter ( z )</td>
</tr>
<tr>
<td>( \rightarrow ) ( x \rightarrow y )</td>
<td>5.</td>
<td>recall intermediate result</td>
</tr>
<tr>
<td>( \rightarrow ) ( r \rightarrow )</td>
<td>8.602325267</td>
<td>get ( r )</td>
</tr>
<tr>
<td>( \rightarrow ) ( x \rightarrow y )</td>
<td>35.53767779</td>
<td>get ( \phi )</td>
</tr>
</tbody>
</table>

SPHERICAL/RECTANGULAR CONVERSION

Enter: \( x \rightarrow y \) \( 8.602325267 \) allow for next entry
35.54 \( \rightarrow \) \( \phi \) \( 35.54 \) enter \( \phi \)
53.13 \( \rightarrow \) \( z \) \( 53.13 \) enter \( z \)
2.999366402 \( \rightarrow \) \( x \) get \( x \)
3.999140319 \( \rightarrow \) \( y \) get \( y \)

ELECTRICAL ENGINEERING

Example:

Find the current \( I_s \) flowing through a MOS device operating in the saturation region:

\[ I_s = \mu \cdot \frac{t_{ox} \cdot \varepsilon_0 \cdot W \cdot (V_g - V_t)^2}{t_{ox} \cdot L} \]

where \( \mu \) = substrate mobility factor
\( t_{ox} \) = oxide thickness
\( W \) = device width
\( L \) = device length
\( V_g \) = gate/source voltage
\( V_t \) = threshold voltage
Example: \( \mu = 190 \text{ cm}^2/\text{volt sec} \)
\[
\begin{align*}
\epsilon_{ox} &= 3.9 \\
W &= 2.0 \text{ mil} \\
L &= 3 \text{ mil} \\
L_{ox} &= 1100 \text{ Å} = 1.1 \times 10^{-4} \text{ cm} \\
V_{\mu} &= 8 \text{ V} \\
V_f &= 1 \text{ V} 
\end{align*}
\]

<table>
<thead>
<tr>
<th>Enter:</th>
<th>Read:</th>
<th>Explanation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>190</td>
<td>190.</td>
<td>enter (\mu)</td>
</tr>
<tr>
<td>(\times)</td>
<td>190.</td>
<td></td>
</tr>
<tr>
<td>3.9</td>
<td>3.9</td>
<td>enter (\epsilon_{ox})</td>
</tr>
<tr>
<td>(\times)</td>
<td>741.</td>
<td></td>
</tr>
<tr>
<td>8.85</td>
<td>8.85</td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>8.85 -00</td>
<td></td>
</tr>
<tr>
<td>+/-</td>
<td>8.85 -00</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>8.85 -14</td>
<td>enter (\epsilon_{o})</td>
</tr>
<tr>
<td>(\times)</td>
<td>6.55785 -11</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>(\times)</td>
<td>1.31157 -10</td>
<td>enter (W)</td>
</tr>
<tr>
<td>({)</td>
<td>1.31157 -10</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>(V_0)</td>
</tr>
<tr>
<td>(-)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Enter: \(7\). \((V_0 - V_f)^2\)

Enter: \(49\).

\[=\] 6.426693 -09

\[=\] 6.426693 -09

\[\{\] 6.426693 -09

\[1.1\] \(1.1\) enter \(L_{ox}\)

\[EE\] \(1.1\) 00

\[5\] \(1.1\) 05

\[+/\] \(1.1\) -05

\[\times\] 0.000011

\[.3\] \(.3\) enter \(L\)

\[\times\] 0.000033

\[2\] \(2\)

\[\{\] 0.0000086 \(V_f\)

\[\] 9.737413636 -04 get \(I_o\)

\[EE\; EE\] 973.7413636 -06 twice to get result in micro amperes
ELECTRICAL IMPEDANCE

Using the \( \boxed{\text{P}} \) key to compute expressions of the form \( \sqrt{\text{VA}^2 + \text{B}^2} \) in a variety of problems.

Example: Electronics

In the Resistance Inductance Capacitance (RLC) circuit below what is the:

a) Reactance of the inductor
b) Reactance of the capacitor
c) Impedance of the circuit
d) Phase angle

\[ \begin{align*}
1000 \ \Omega \\
\text{60 Hz} \\
4 \ \text{mH} \\
2.5 \ \mu\text{F}
\end{align*} \]

\( x_L = \text{Reactance of the inductor} = 2 \pi fL \)

\( x_C = \text{Reactance of the capacitor} = \frac{1}{2 \pi fC} \)

\( Z = \sqrt{R^2 + (x_L - x_C)^2} = \text{Impedance} \)

\( \phi = \text{Arctan} \left( \frac{x_L - x_C}{R} \right) \)

Enter: \[ \begin{align*}
2 \\
\times \\
= \\
\times \\
60 \\
\times \\
\times \\
2.5 \\
\div \\
6 \\
+/- \\
= \\
1/x \\
+/- \\
+ \\
( \\
2 \\
\times \\
= \\
3.141592654
\end{align*} \]

Read: \[ \begin{align*}
2. \\
2. \\
3.141592654 \\
6.283185307 \\
60. \\
376.9911184 \\
2.5 \\
2.5 \ 00 \\
2.5 \ 06 \\
2.5 \ -06 \\
9.424777961 \ -04 \\
1061.032954 \\
-1061.032954 \\
-1061.032954 \\
2.0 \\
2.0 \\
3.141592654
\end{align*} \]

Explanation:
Enter: \hspace{1cm} Read: \hspace{1cm} Explanation:

6.283185307

60. \hspace{0.5cm} Enter F in HZ

378.9911184

4. \hspace{0.5cm} 4.

EE \hspace{0.5cm} 4. \hspace{0.5cm} 00

3 \hspace{0.5cm} 4. \hspace{0.5cm} 03

4 - 03 \hspace{0.5cm} Enter L in mH

1.507964474 \hspace{0.5cm} Get \( x_L \)

- 1059.52499 \hspace{0.5cm} Get \( x_L - x_C \)

0. \hspace{0.5cm} Allow for next entry

1000 \hspace{0.5cm} 1000 \hspace{0.5cm} Enter R in Ohms

1059.52499 \hspace{0.5cm} Position registers to compute right

- \hspace{0.5cm} P \hspace{0.5cm} 1456.912215 \hspace{0.5cm} Get Z in Ohms

46.65551839 \hspace{0.5cm} Get \( \phi \) in degrees

---

**VECTOR ADDITION**

The vectors are represented in rectangular coordinates by:

\[
\begin{align*}
x &= x_1 + x_2 \\
y &= y_1 + y_2
\end{align*}
\]

and in polar coordinates by:

\[
\begin{align*}
\vec{x} &= R_1 \angle \theta_1 \\
\vec{y} &= R_2 \angle \theta_2 \\
\vec{z} &= R_3 \angle \theta_3
\end{align*}
\]

With:

\[
\begin{align*}
R_1 &= x_1^2 + y_1^2 \\
R_2 &= x_2^2 + y_2^2 \\
R_3 &= x_3^2 + y_3^2
\end{align*}
\]

and: \( \theta = \tan y/x \) for each vector.

**Example:** Add the two vectors \( \vec{X} = 6 \angle 20^\circ \) and \( \vec{Y} = 4 \angle 30^\circ \)

Enter: \hspace{1cm} Read: \hspace{1cm} Explanation:

C \hspace{0.5cm} 0.

STO 1 \hspace{0.5cm} 0.

STO 2 \hspace{0.5cm} 0.

6 \hspace{0.5cm} 6. \hspace{0.5cm} enter R₁
Enter: Read: Explanation:

F x→y 0. allow next entry
20 20. enter β,

←R 5.638155725 get x,

×t 5.638155725 store x,

F x→y 2.05212086 get y,

F STO 2 2.05212086 store y,
4 4. enter R,

F x→y 5.638155725 allow next entry
30 30. enter θ,

←R 3.464101815 Get x,

×t 3.464101815 add x, + x, = x,

F RCL 2 2.05212086 recall y,

F x→y 2 get y,

+ 4.05212086 add x, + y, = y,

RCL 1 9.10225734 recall x, + x,

F x→y 4.05212086 position registers in right sequence

←P 9.963471892 get R,

F x→y 23.99755566 get δ, (decimal degrees)

SUMMATION KEY

S1 The summation key, when pressed, adds the number on display to the value stored in Memory 1. Both, negative and positive numbers can be accumulated in Memory 1. It is good practice to clear Memory 1 before using the S1 key with the key sequence

G STO 1

Example:

What is the total of 110, 120, 111, 142, 1310, 321?

Enter: Read: Explanation:

C STO 1 0. Clear Memory 1
110 S1 110. 110. added to Mem. 1
120 S1 120. 120. added to Mem. 1
111 S1 111. 111. added to Mem. 1
142 S1 142. 142. added to Mem. 1
1310 S1 1310. 1310. added to Mem. 1
321 S1 321. 321. added to Mem. 1

RCL 1 2114. Display the result of the summation
APPENDIX A

Error Condition
An error condition results when an improper operation is performed or when the result of an operation overflows or underflows the absolute range of the calculator.

When an error condition occurs the letter "E" is displayed.
Press the clear key to clear the error condition.

Improper Operation:

\[
\begin{align*}
X & \, \div \, Y & \text{where } Y = 0 \\
Y^{-1} & & \text{where } y < 0 \\
F & \sqrt{Y} & \text{where } X < 0 \\
F & \sqrt{X} & \text{where } X < 0 \\
1/x & & \text{where } X = 0 \\
X^{-0} & & \text{number of entries is 0} \\
\ln & X & \text{where } X \leq 0 \\
\log & X & \text{where } X \leq 0 \\
F & \sin^{-1} X & \text{where } |X| > 1 \\
E & \cos^{-1} X & \text{where } |X| > 1 \\
X & F \, \rightarrow \, Y & Y \rightarrow R & \text{where } X = 0
\end{align*}
\]

Overflow
Occurs when a computed result is greater than 9,999,999,999 \times 10^{99}

Underflow
Occurs when a computed result is less than 1.0 \times 10^{-99}

APPENDIX B

OPERATING ACCURACY
The precision of your calculator depends upon the operation being performed. Basic addition, subtraction, multiplication, division and reciprocal assignments have a maximum error of ± one count in the tenth or least significant digit.

While countless computations may be performed with complete accuracy, the accuracy limits of particular operations depend upon the input argument as shown below.

<table>
<thead>
<tr>
<th>Function</th>
<th>Input Argument</th>
<th>Mantissa Error (Max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>\sqrt{x}</td>
<td></td>
<td>2 counts in D_{10}</td>
</tr>
<tr>
<td>ln x</td>
<td></td>
<td>1 count in D_{9}</td>
</tr>
<tr>
<td>\log x</td>
<td></td>
<td>1 count in D_{9}</td>
</tr>
<tr>
<td>e^x</td>
<td></td>
<td>3 counts in D_{10}</td>
</tr>
<tr>
<td>y^x</td>
<td></td>
<td>1 count in D_{x}</td>
</tr>
<tr>
<td>\sin \phi</td>
<td>0^{\circ} \leq</td>
<td>8 counts in D_{10}</td>
</tr>
<tr>
<td>\cos \phi</td>
<td></td>
<td>\leq 360^{\circ} \text{ or}</td>
</tr>
<tr>
<td>tan \phi</td>
<td>0^{\circ} \leq</td>
<td>4 counts in D_{9}</td>
</tr>
<tr>
<td>\sin^{-1} x</td>
<td>10^{-6} \leq</td>
<td>E &lt; 5 \times 10^{-5}</td>
</tr>
<tr>
<td>\cos^{-1} x</td>
<td></td>
<td>\leq 1</td>
</tr>
<tr>
<td>tan^{-1} x</td>
<td></td>
<td>E &lt; 5 \times 10^{-4}</td>
</tr>
</tbody>
</table>

Dn = Nth display digit assuming a left justified 10 digit result.
### APPENDIX C

#### INTERNATIONAL SYSTEM OF UNITS (SI)

**LETTER SYMBOLS FOR QUANTITIES & UNITS**

**ELECTRICAL ENGINEERING QUANTITIES**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Qty. Symbol</th>
<th>SI Unit</th>
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<td>A</td>
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<td>V</td>
<td>volt</td>
<td>V</td>
<td>V</td>
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<td>Wb/m</td>
<td>Wb/m</td>
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<td>V</td>
<td>V</td>
<td>V/v</td>
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<td>mΩ</td>
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<td>S</td>
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<td>F</td>
<td>F</td>
<td>F/F</td>
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<td>H</td>
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<td>W</td>
<td>W/W</td>
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<td>var/var</td>
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<td>VA</td>
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<td>kg/m³</td>
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<td>m³/kg</td>
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<td>V/m</td>
<td>V/m</td>
<td>V/m</td>
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<td>F/m²</td>
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<td>(numeric)</td>
<td>(numeric)</td>
<td>(numeric)</td>
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<td>Wb</td>
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<td>Wb/m³</td>
<td>Wb/m³</td>
<td>Wb/m³</td>
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<td>A/m</td>
<td>A/m</td>
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<td>(relative)</td>
<td>χ</td>
<td>(relative)</td>
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<td>(relative)</td>
<td>μ</td>
<td>(relative)</td>
<td>μ</td>
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<td>V, E, H, ω, and F indicate alternate symbols.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>...U dots indicate reserve symbols.</td>
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###APPENDIX C

#### INTERNATIONAL SYSTEM OF UNITS (SI)

**CONVERSION FACTORS**

**Conversion TO Metric Measures**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Given</th>
<th>Multiply by</th>
<th>To Obtain</th>
<th>Symbol</th>
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<td></td>
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<td></td>
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<tr>
<td>in</td>
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<td>millimeters</td>
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<td>meters</td>
<td>m</td>
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<td>km</td>
</tr>
<tr>
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<td>μm</td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>square meters</td>
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<td>cubic meters</td>
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<td>liters</td>
<td>l</td>
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<td>l</td>
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<tr>
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<td>gallon (U.K.)</td>
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<td>liters</td>
<td>l</td>
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<td>cm³</td>
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<td>m³</td>
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<td>m³</td>
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<td>5·000·</td>
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<td>km/h</td>
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<td>grams</td>
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<td>lb/ft³</td>
<td>pounds per cubic foot</td>
<td>6·242×10⁻⁴·</td>
<td>kilograms per cubic meter</td>
<td>kg/m³</td>
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### APPENDIX C

#### Conversion TO Metric Measures

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<th>Conversion</th>
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<th>Multiply by</th>
<th>To Obtain</th>
<th>Symbol</th>
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<td>dynes</td>
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<td>10^-5</td>
<td>newtons</td>
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<td>WORK, ENERGY — POWER</td>
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<td>ft lb.</td>
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<td>1.360</td>
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<td>watts</td>
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<td>watts</td>
<td>W</td>
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<td>PRESSURE</td>
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<tr>
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<td>pascals</td>
<td>Pa</td>
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<td>millibar</td>
<td>100.0</td>
<td>pascals</td>
<td>Pa</td>
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<td>mgH₂O</td>
<td>millimeter of H₂O</td>
<td>133.3</td>
<td>pascals</td>
<td>Pa</td>
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<td>in H₂O</td>
<td>inch of H₂O</td>
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<td>kilopascals</td>
<td>kPa</td>
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</tr>
<tr>
<td>cm H₂O</td>
<td>centimeter of H₂O</td>
<td>0.01</td>
<td>kilopascals</td>
<td>kPa</td>
<td></td>
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</tbody>
</table>
| L
| ft³          | cubic foot | 3.382 | cubic meters | m³ |        |
| L            | liter | 3.382 | cubic meters | m³ |        |
| LIGHT       |        |       |             |           |        |
| ftc          | foot lambert | 10.76 | lumen | lm  |        |
| ftl          | foot candela | 3.436 | candela per sq meter | cd/m² |        |
| Symbol      | To Obtain | Divide by | Given | Symbol |
| TEMPERATURE |        |       |             |           |        |
| °F          | °Fahrenheit | (°F - 32) 9 | °Celsius | °C |        |
| °C          | °Celsius | 9 5 | °Fahrenheit | °F |        |
| * Indicates exact value | 5 unit when rounding | | | | |

### APPENDIX C

#### OTHER QUANTITIES

<table>
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<tr>
<th>Quantity</th>
<th>Qty</th>
<th>SI</th>
<th>Unit</th>
<th>Symbol</th>
</tr>
</thead>
</table>

| length | m | meter | m |
| mass | kg | kilogram | kg |
| time | s | second | s |
| angular frequency | rad/s | rad/s |
| area | m² | square meter | m² |
| volume | m³ | cubic meter | m³ |
| velocity | m/s | meter per second | m/s |
| acceleration (linear) | m/s² | meter per second squared | m/s² |
| force | N | newton | N |
| torque | Nm | newton meter | Nm |
| pressure | Pa | pascal | Pa |
| temperature (absolute) | K | kelvin | K |
| temperature (Celsius) | °C | degree Celsius | °C |
| attenuation coefficient | Np/m | nepers per meter | Np/m |
| phase coefficient | rad/m | radians per meter | rad/m |
| propagation coefficient | 1/m | reciprocal meter | m |
| 1/s | Np/m | Np/m |
| radiometric intensity | W/m² | watt per square meter | W/m² |
| luminous intensity | cd | candela | cd |
| luminous flux | lm | lumen | lm |
| Illuminance | lx | lux | lx |

### PHYSICAL CONSTANTS

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</thead>
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<td>speed of light in vacuum</td>
<td>2.9979 x 10⁸ m/s</td>
</tr>
<tr>
<td>permeability of vacuum, dielectric constant</td>
<td>8.854 x 10⁻¹² F/m</td>
</tr>
<tr>
<td>Planck constant</td>
<td>6.626 x 10⁻³⁴ J/s</td>
</tr>
<tr>
<td>Coulomb constant</td>
<td>1.602 x 10⁻¹⁹ C</td>
</tr>
<tr>
<td>Faraday constant</td>
<td>9.648 x 10⁸ C/m</td>
</tr>
<tr>
<td>standard gravitational acceleration</td>
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<tr>
<td>normal atmospheric pressure</td>
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### FACTOR

<table>
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<th>Symbol</th>
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<td>T</td>
</tr>
<tr>
<td>10⁻⁸ daa</td>
<td>da</td>
</tr>
<tr>
<td>10⁻¹ micro</td>
<td>μ</td>
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### UNIT PREFIX

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</tr>
<tr>
<td>10⁻¹ deci</td>
<td>d</td>
</tr>
<tr>
<td>10⁻¹ centi</td>
<td>c</td>
</tr>
<tr>
<td>10⁻¹ femto</td>
<td>f</td>
</tr>
<tr>
<td>10⁻¹ milli</td>
<td>m</td>
</tr>
<tr>
<td>10⁻⁴atto</td>
<td>a</td>
</tr>
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</table>
APPENDIX D

Rechargeable Battery

AC Operation
Connect the charger to any standard electrical outlet and plug the jack into the Calculator. After the above connections have been made, the power switch may be turned "ON." (While connected to AC, the batteries are automatically charging whether the power switch is "ON" or "OFF.")

Battery Operation
Disconnect the charger cord and push the power switch, "ON," an interlock switch in the calculator socket will prevent battery operation if the jack remains connected. With normal use a full battery charge can be expected to supply about 2 to 3 hours of working time.

When the battery is low, figures on display will dim. Do not continue battery operation, this indicates the need for a battery charge.
Use of the calculator can be continued during the charge cycle.

Battery Charging
Simply follow the same procedure as in AC operation. The calculator may be used during the charge period. However, doing so increases the time required to reach full charge. If a power cell has completely discharged, the calculator should not be operated on battery power until it has been recharged for at least 3 hours, unless otherwise instructed by a notice accompanying your machine. Batteries will reach full efficiency after 2 or 3 charge cycles.

APPENDIX D

Disposable Battery Model (D)

Your calculator uses a standard nine-volt battery type 6F22 available at most drug, department and camera stores. To operate, disconnect the adaptor cord and turn power switch "ON" (an interlocking switch in the AC socket will prevent battery use if the plug remains connected). When the battery weakens, display will dim.

Experience has proven that batteries packed with machines age considerably. To protect your calculator, we have omitted the battery from the package. Please ask your dealer for a fresh, new power cell. In the event your brand new machine does not function, please check the battery first.

Please note, machines with disposable batteries will not recharge. See battery replacement details above.

AC Adapter Operation
It is recommended that you unplug and remove the battery from your machine before inserting the adaptor jack.

Use proper Commodore/CBM adapter-recharger for AC operation and recharging.

Adapter 840 or 707 North America
Adapter 708 England
Adapter 709 West Germany
APPENDIX E

Low Power
If battery is low calculator will:
a. Display will appear erratic
b. Display will dim
c. Display will fail to accept numbers

If one or all of the above conditions occur, you may check for a low battery condition by entering a series of 8's. If 8's fail to appear, operations should not be continued on battery power. Unit may be operated on AC power. See battery charging explanation. If machine continues to be inoperative see guarantee section.

CAUTION
A strong static discharge will damage your machine.

Shipping Instructions:
A defective machine should be returned to the authorized service center nearest you. See listing of service centers.

Temperature Range

<table>
<thead>
<tr>
<th>Mode</th>
<th>Temperature °C</th>
<th>Temperature °F</th>
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</thead>
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<tr>
<td>Operating</td>
<td>0⁰ to 50⁰</td>
<td>32⁰ to 122⁰</td>
</tr>
<tr>
<td>Charging</td>
<td>10⁰ to 40⁰</td>
<td>50⁰ to 104⁰</td>
</tr>
<tr>
<td>Storage</td>
<td>-40⁰ to 55⁰</td>
<td>-40⁰ to 131⁰</td>
</tr>
</tbody>
</table>

APPENDIX F

Guarantee

Your new electronic calculator carries a parts and labor guarantee for one year from date of purchase. We reserve the right to repair a damaged component, replace it entirely, or, if necessary, exchange your machine. If you own a portable calculator which uses an AC adapter, the adapter must be returned with your machine when service is required. In order to receive free service under this guarantee at a Commodore Service Center, you are required to pay all postage, shipping and insurance charges when returning your calculator to the Commodore Service Center and enclose a check or money order for $2.50 to cover handling charge, return postage and insurance. This guarantee is valid only when a copy of your original sales slip or similar proof of purchase accompanies your defective machine. This guarantee applies only to the original owner. It does not cover damage or malfunctions resulting from fire, accident, neglect, abuse or other causes beyond our control.

The guarantee does not cover the repair or replacement of plastic housings or transformers damaged by the use of improper voltage. Nor does it cover the replacement of expendable accessories and disposable batteries. The guarantee will also be automatically voided if your machine is repaired or tampered with by any unauthorized person or agency. In order to record your guarantee you must complete the registration card and mail it within ten days from date of purchase. This guarantee supersedes, and is in lieu of, all other guarantees whether expressed, or implied.
Guarantee Registration Card

Please complete this card and mail today to the office nearest you.

Your name: ____________________________
Company name: ________________________
Address: _______________________________
City: __________________ State: ______ Zip: ______
Model designation: ____________________ Serial number: __________
Name of retailer: ______________________
Address: ______________________________
Date of purchase: ______________________

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Commodore Business Machines (Canada) Ltd.
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