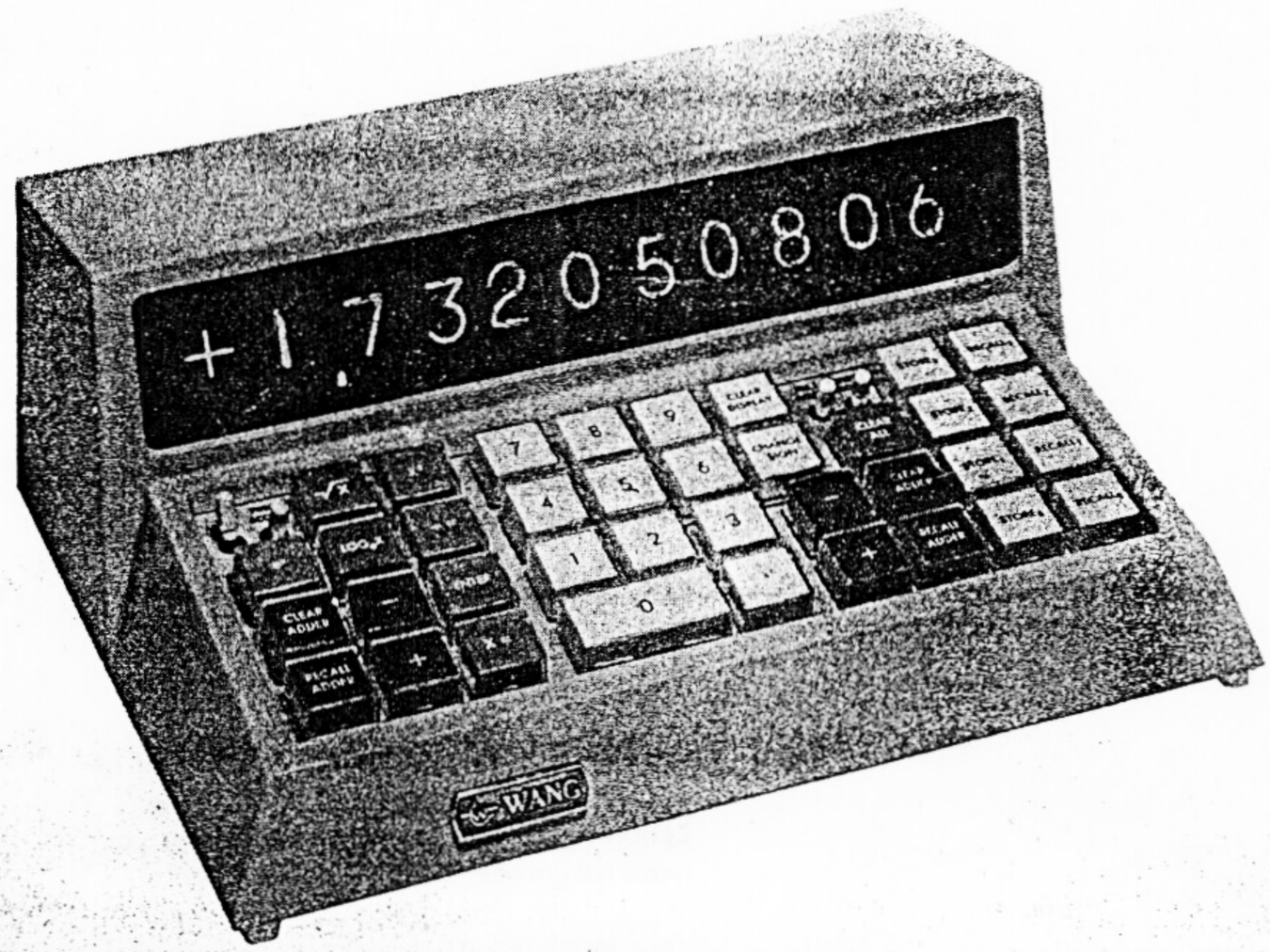
INSTRUCTION
MANUAL



300 SERIES

WANG Electronic Calculators

WANG LABORATORIES, INC.
836 NORTH STREET, TEWKSBURY, MASS. 01876
TEL. 617 851-7311 TWX 710 343-6769

NOTICE TO CUSTOMERS

Upon receipt of your Wang Calculator shipments, please contact your local Wang Laboratories representative whenever you need assistance in making attachments.

Your local Wang Laboratories representative will be pleased to give demonstrations in the proper use of the equipment to personnel in your organization.

The section on Safe Operating Conditions provides information especially important to persons who are about to use the Wang Calculator for the first time.

FOREWORD

To Users of the Wang Electronic Calculator:

Your new electronic calculator is a modern instrument designed and built to help you perform business, statistical, or scientific calculations with unparalleled power and simplicity of use.

As soon as you are acquainted with its straightforward operating procedures, you will fully enjoy the many advantages of your Wang Electronic Calculator: features such as speed, quietness, light weight, compactness, flexibility and economy.

Scientists, engineers, statisticians, and users in the financial community, have tested the use of this calculator. They agree that it is truly a powerful instrument to meet modern calculation requirements.

In this manual, you are presented a description of how to operate your Wang Electronic Calculator. You should find here answers to your questions concerning the innovations inherent to this instrument.

If you have a specific calculation of interest and would like to compare notes on the best way for finding the answer with your Wang Electronic Calculator, send us a note describing the problem. You will receive free by return mail, our suggestions on the operation.

In the meantime, we wish you every success and satisfaction in the use of your Wang Electronic Calculator.

An Wang

Dr. An Wang
President

CONTENTS

CONTENTS (continued)

I. INTRODUCTION

This series of solid-state Electronic Calculators consists of several models. Each consists of a central computing package and one or more remotely located desk-top keyboard consoles.

Model Number	Range of Applications
300	Business to simple engineering calculations.
310	Statistical and business calculations.
320	Scientific, engineering, statistical and business calculations.
320 with KT keyboard	320 with capability for sin θ , cos θ , arcsin X and arctan X.
360	320 with four additional random-access storage registers.
360 with KT keyboard	360 with capability for sin θ , cos θ , arcsin X and arctan.
300S	300 with one electronic package working with four keyboards simultaneously.
310S	310 with similar features.
320S	320 with similar features.
CP-1	Card Programmer acceptable to the electronics of 300, 310, 320, 360, 300S, 310S, and 320S models.

The Wang Electronic Calculator revolutionizes point-of-work calculations. Its unprecedented operating speed, data accuracy and work simplicity have won approval from the country's leading universities, research laboratories, aerospace design engineers, consulting engineers, statisticians, and financial users. Following is a summary of the unique characteristics of the 300 Series Wang Electronics Calculators:

- It performs by single keystrokes all these operations: $+$, $-$, $\times$, $\div$, $\sqrt{x}$, X^2.
- By its unique log-generator, it also instantaneously computes $\text{Log}_e X$ and e^x by single keystrokes. Ten-digit answers with a floating decimal point are instantly displayed.
- Intermediate answers can be stored and recalled at random.
- Two independent adders aid a wide range of calculations with step-saving economies.
- Duplex accumulation switches control the automatic summation of products, multipliers, and/or entries. ΣX^2 and ΣX are accumulated simultaneously for statistical calculations.
- Simultaneous electronic package can operate with up to four keyboard consoles all at once, reducing the cost per work station to a price as low as $1070.

Models with four extra random-access storage registers further increase data handling efficiency.

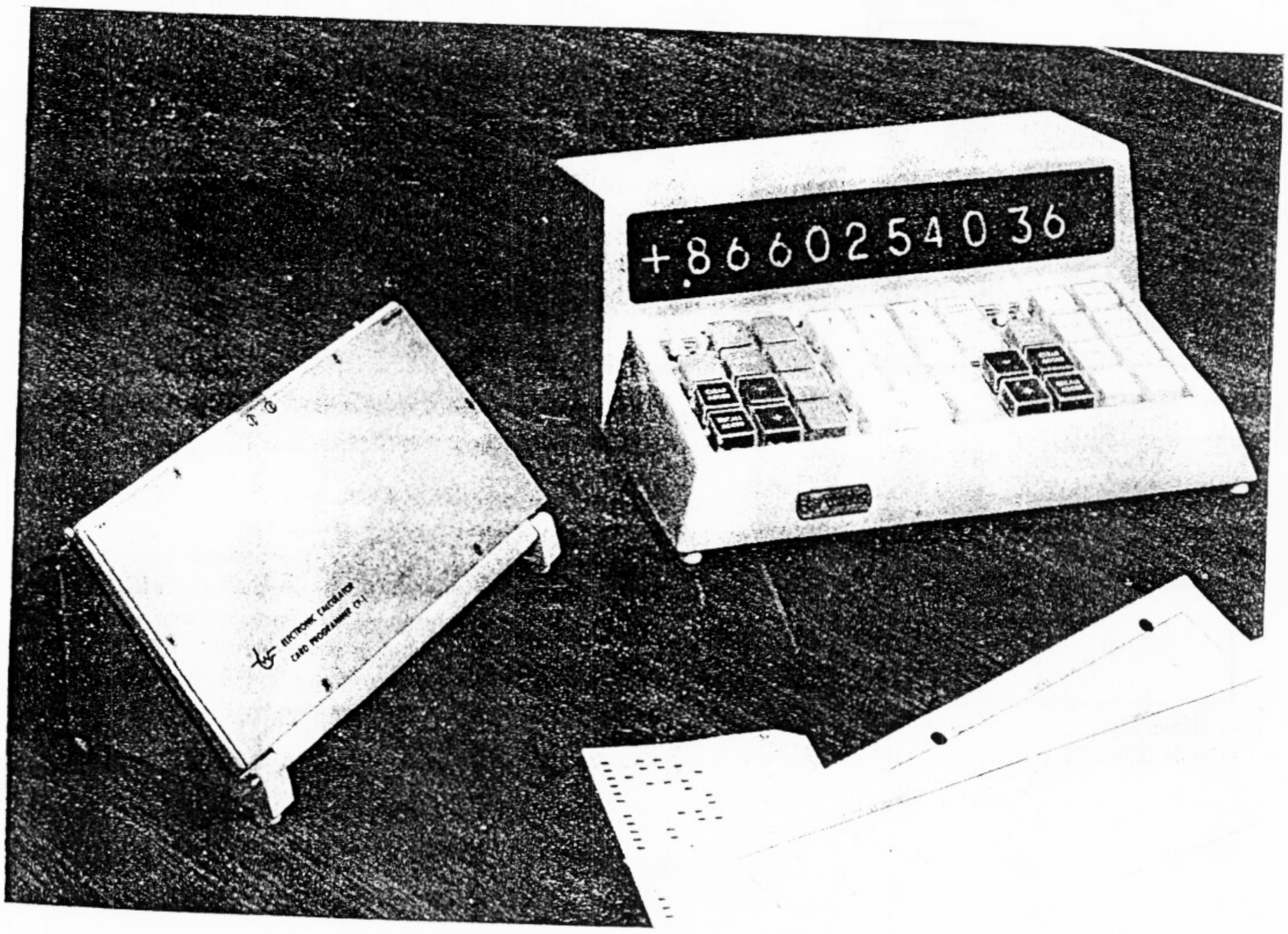
Trignometric-Scientific keyboards provide single keystroke calculations of sin θ , cos θ , arcsin X and arctan X.

By the addition of CP-1 Card Programmer, keyboard operations of each model are further automated. Only numerical inputs need to be indexed, giving results of true man-machine interaction.

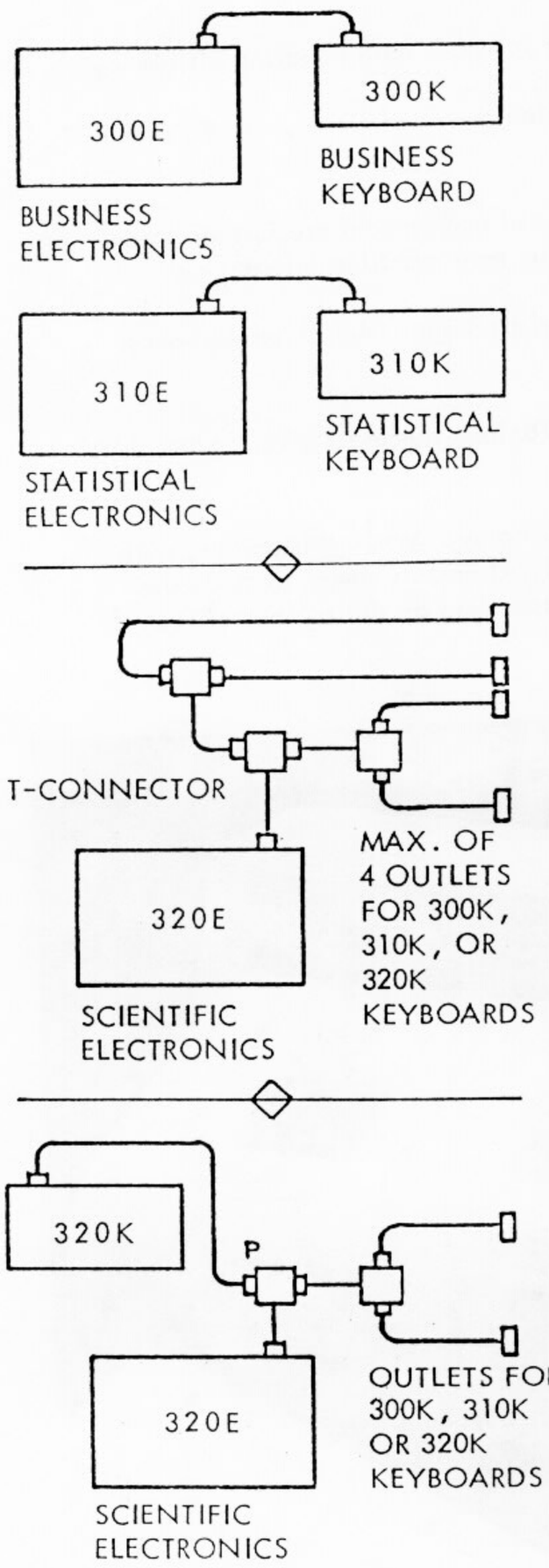
The trig-function keyboards may be placed 50' from the central package. All other keyboards may be extended as far as 200' away from the electronics.

The ten-digit readout has a floating decimal point. Lighted 5/8-inch numerals give a glare-free display.

A flashing signal light indicates over-cycling of the ten-digit display. When this occurs, with multiplications and divisions, the readout continues to be valid. User only needs to move the decimal point ten places to the right (or 20, 30 places, etc. depending on the number of times 1010 is exceeded) when writing the answer.



II. CALCULATOR CONFIGURATION



A. Individual Unit: Consists of connecting a desired keyboard to compatible electronic package. To operate, plug in the system to 115V AC power with standard three wire grounded outlet. Turn on the power and and keyboard switches, prime the keyboard with "Clear All" key. Unit is now ready for use.

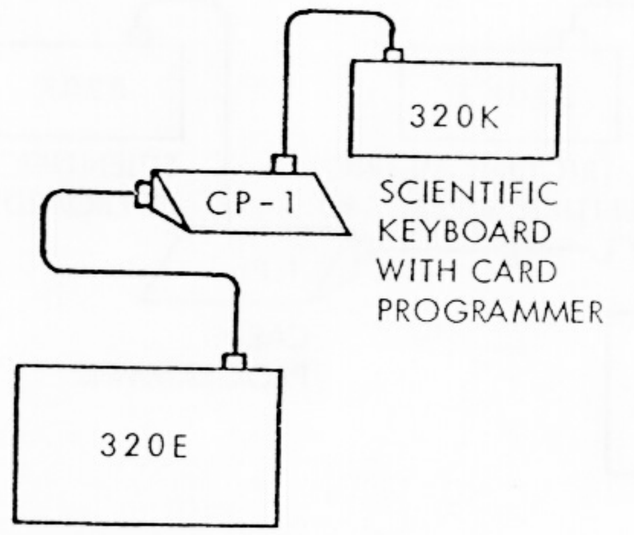
B. Four-to-One Linkage: The "E" electronic package can support an installation with up to four keyboards operating one at a time, non-simultaneously. Plug-in "T" connectors provide first and second-tier branching plus keyboard lockout safety. Extensions are made with standard length cables in 25-foot incremental lengths to outlet points as far as 200' in any direction from the central package. Remote outlets may be wall mounted, by use of mounting boxes and special cover plates.

C. Keyboard On-Line Sequencing: "T" Connectors automatically sequence interlinked keyboards on a basis of first-on-first-serve. Operator turns off keyboard when not in use, and turns it on when ready to use. Display light-up indicates unit is on-line and ready for operation. Calculation is uninterrupted with positive lockout of all other keyboards. Upon completion, operator turns keyboard off to permit others to use the calculator.

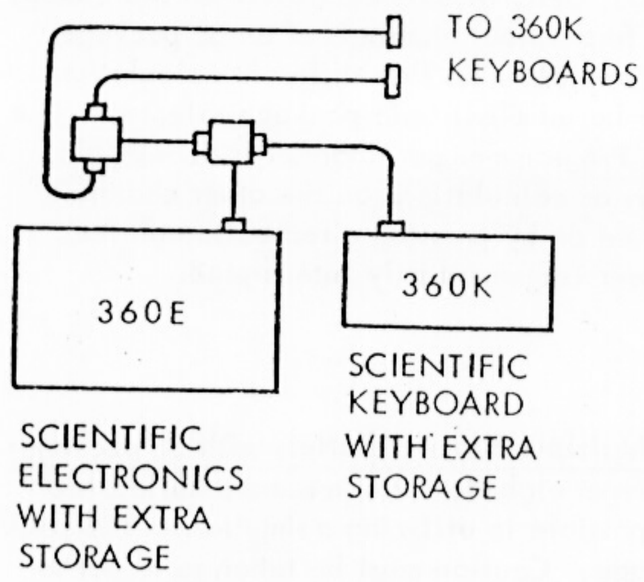
D. Keyboard Mixing: When a higher numbered model of electronic package is installed, it can take on keyboards of its own numbered series as well as other keyboards of a lower numbered series.

E. Priority Keyboard Outlet: Priority PT connector permits one of three interlinked keyboards to preempt the electronic package for immediate use and interrupt any unfinished work initiated on another keyboard. The "E" electronic package supports only a single priority keyboard on the first tier of a PT connector, with two additional normal outlets possible.

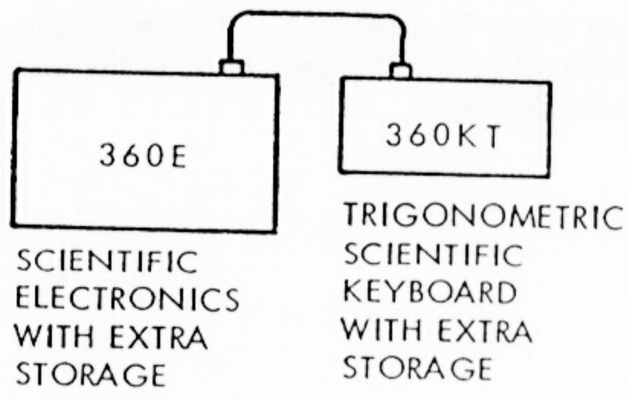
CALCULATION CONFIGURATION (cont.)



F. CP-1 Card Programmer: The "E" electronic package can support a single CP-1 Card Programmer linked in series with a keyboard (300K, 310K, 320K). The CP-1 automates key depressions up to 80 steps per card. Pre-scored tab cards are prepared on a Portapunch device or with a firm paper-clip point. Two digit numerical codes translate keyboard operations to signal commands, as shown in Table 1. Recommended for Models 300, 310, 320, 360. Use on a simultaneous model would tend to slow down answers on other channels. The CP-1 Programmer is plugged in direct to the output channel of an electronic package; or, when multi-keyboard connections are desired, it is attached to a first-tier T-Connector. In this case, two other keyboard connections are feasible by means of a second T-Connector. This relationship also applies to each output channel of the simultaneous electronic package. Extension cable to the CP-1 is limited to 50 feet maximum.

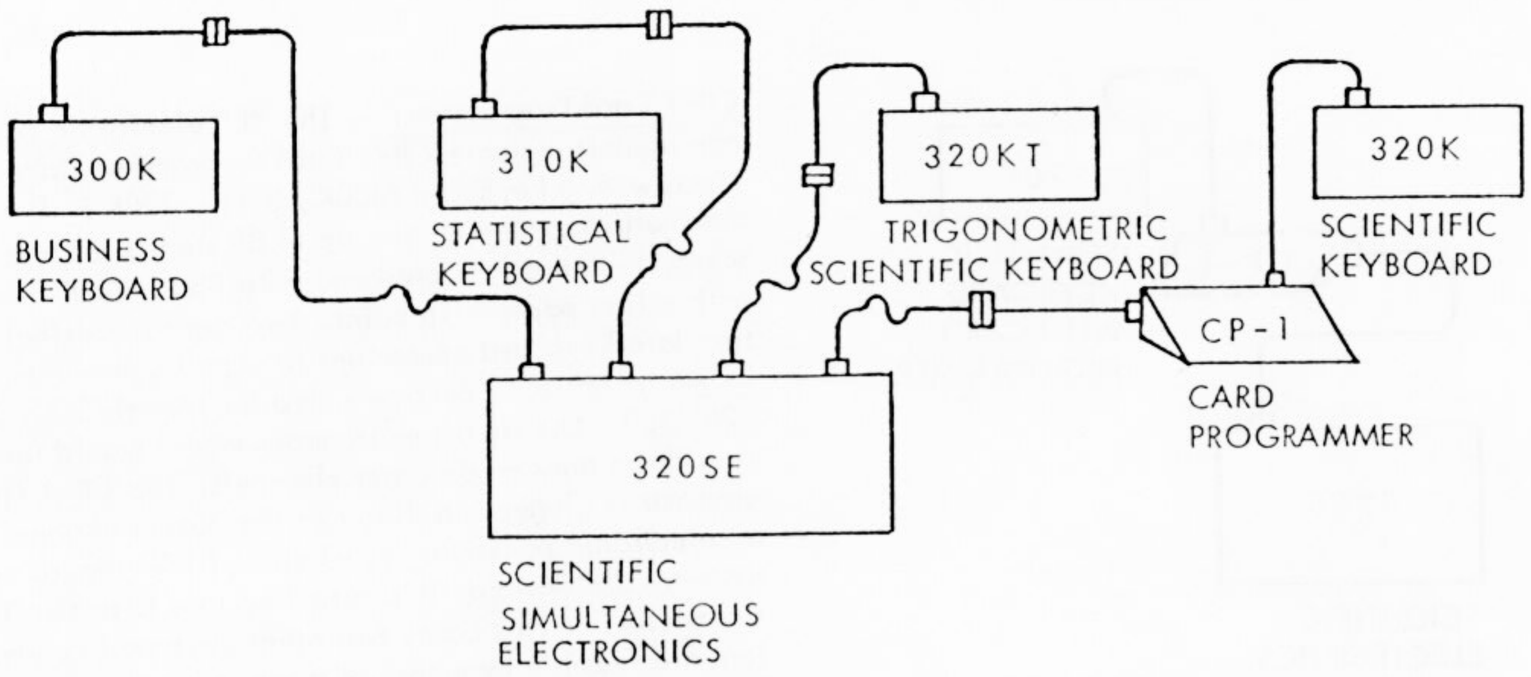


G. Extra Storage Model: Model 360 provides four extra random-access storage registers in addition to the two independent adder-accumulators on each keyboard. These registers increase data-handling efficiency materially in the more complicated types of calculations. The 360E electronic package, like the 320E package, can support up to four keyboards interlinked by means of "T" connectors and operating one at a time. Use of the 300K, 310K, or 320K Keyboard with the 360 Model would render its extra storage registers inoperative.

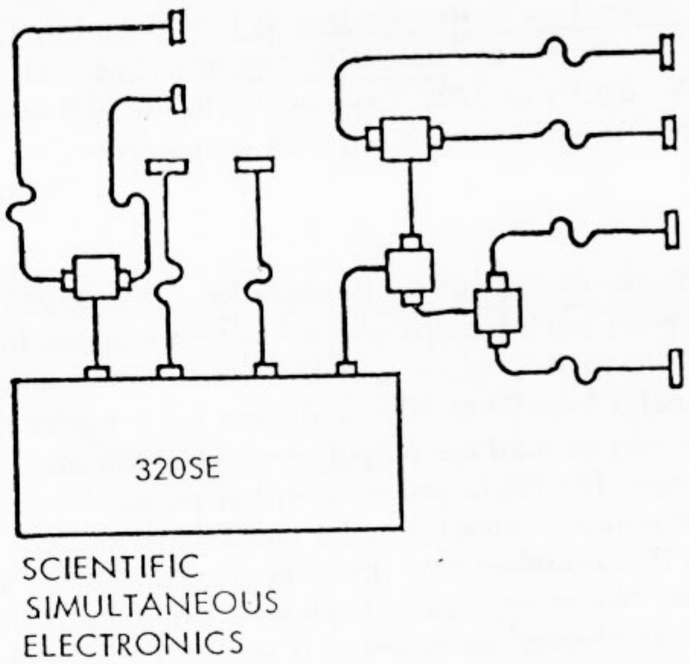


H. Trigonometric/Scientific Keyboards: The 320KT and the 360KT each incorporates a built-in program to generate $\sin\theta$, $\cos\theta$, arcsin X and arctan X functions for angles from 0^{o} to 90^{o}. Only one KT trigonometric keyboard can be used per output channel of the electronic package. The KT Keyboard is either plugged in direct to the output channel, or, for multi-keyboard connections, it is attached to a first-tier T- Connector. In such a case, two other regular keyboards may be attached to the same channel by means of a second T-Connector, forming a 3-to-1 linkage. This relationship also applies to each output channel of the simultaneous electronic package. Extension cable to the KT keyboard is limited to 50 feet maximum.

CALCULATOR CONFIGURATION (cont.)



1: Simultaneous Electronic Calculator: The 300S, 310S, 320S Models centralize on the 300SE, 310SE, and 320SE packages respectively. Each of the four output channels of an SE package can support a keyboard. Four channels may work simultaneously on four different calculations. Keyboard mixing applies, depending on the highest numbered electronic package selected. Use of a single KT trigonometric keyboard or a single CP-1 Programmer per channel is acceptable. Either of these devices would tend to slow down answers of calculations on the other channels. The SE package is primed each time when power is turned on by pressing a red button on the chassis. Occasional re-priming is necessary when power is momentarily interrupted.



J. Multiple Remote Outlets with SE package: From eight to sixteen remote outlets are possible in utilizing a simultaneous SE package. Caution must be taken so as not to overload a channel with more than one KT Trigonometric keyboard or more than one CP-1 Programmer per channel. For maximum safety in control of outlets the T-connectors should be located close to the electronic package.

III. KEYBOARD OPERATIONS

Working the Wang Electronic Calculator is a simple and fatigue-free process of man-machine interplay. The user keys in numerical inputs, followed by pressing the functional keys as appropriate to the calculation. Answers appear in the display with the proper algebraic sign and decimal point location. Intermediately stored totals are undisturbed until cleared. Totals in extra storage registers are unchanged until substituted with a new number. Following are descriptions of specific functional keys.

A. Clear All

When pressed after a keyboard is first turned on, this key primes the calculator for operation. The display and the dual adders have zeros. The product register has +1. This key is normally pressed prior to starting a calculation.

B. The Dual Adders

The two adder registers are independent of each other. Each is operated by the black set of keys on each side of the keyboard. Functions are $\underline{+}$, $\underline{-}$, Clear Adder, and Recall Adder. Abbreviations for these are $+A_R$, $-A_R$, CLA_R, REA_R for the right-hand adder; $+A_L$, $-A_L$, CLA_L, and REA_L for the left-hand adder.

C. The Work Register

A group of white keys gives a standard 10-key calculator layout of 0 to 9 and the decimal point. Clear Display is a key to remove a number indexed and shown in the display. It does not affect any other registers.

The Change Sign Key alters the algebraic sign of a number in the display, whether this number is newly indexed or one which has been recalled from storage, or one that results from a previous operation.

D. Instant X^2, $\sqrt{x}$, $\text{Log}_e X$ and e^x

Each of these blue colored operational keys produce instantaneous results as follows:

(a) $\underline{9}$ $\underline{X^2}$ gives +81.00000000.
(b) $\underline{9}$ $\underline{\sqrt{x}}$ gives +3.000000000.
(c) $\underline{9}$ $\underline{\text{Log}_e X}$ shows +02.19722457.
(d) $\underline{9}$ $\underline{e^x}$ produces +8103.083927.

E. Instant Reciprocals

The ÷= key produces reciprocals after an input is indexed.

(a) $\underline{7}$ $\underline{\div =}$ is +.1428571429.
(b) $\underline{99.67}$ $\underline{\div =}$ is +.0100331093.
(c) $\underline{8.24}$ $\underline{X^2}$ $\underline{\div =}$ is +.0147280611 for $\frac{1}{(8.24)^2}$
(d) $\underline{2.7}$ $\underline{X^2}$ $\underline{+A_L}$ $\underline{8.3}$ $\underline{X^2}$ $\underline{+A_L}$ $\underline{\div =}$ is +.0131268049 for $\frac{1}{(2.7)^2 + (8.3)^2}$

F. Enter Key

This key has many uses. It places a number in the Product Register for operations with x, ÷, $\sqrt{x}$, X^2, Log_eX, and e^x. Thus,

(a) 2 Enter 5 X= results in + 10.00000000.
(b) 2 Enter 5 ÷= results in + .4000000000.
(c) 2 Enter 5 $\sqrt{x}$ results in + 4.472135955.
(d) 2 Enter 5 X^2 results in + 50.00000000.
(e) 2 Enter 5 e^x results in + 296.8263182.

The above follows the general function of c.f(x). In the case of the Log_eX operation, the Enter key performs in the manner of f(c.X) as illustrated below.

(f) 2 Enter 5 Log_eX resulting in + 02.30258509 which is Log_e10.

To multiply Log_e5 by 2, we must "Enter" Log_e5:

(g) 5 Log_eX Enter 2 X= which results in + 3.218875825.

And to find 5 times Log_e2, we follow the following steps:

(h) 2 Log_eX Enter 5 X= for + 3.465735903.

G. Chain Multiplication with Enter Key

The Enter key further provides step savings in chain "multiplication." For instance:

(a) 2 Enter 4 Enter 6 X= gives + 48.00000000.
(b) 2 Enter 4 Enter 6 Change Sign X= provides - 48.00000000.
(c) 2 Enter 4 Enter 6 ÷= provides + 1.333333333.
(d) 2 Enter 4 Enter 6 X^2 results in + 288.0000000.
(e) 2 Enter 4 Enter 6 $\sqrt{x}$ results in + 19.59591794.
(f) 2 Enter 4 Enter 6 e^x results in + 3227.430347.

In each example the X= step for 2 x 4 is saved.

H. Ten-place Round-Off

The X, ÷, $\sqrt{x}$, and X^2 operations have tenth digit round-off. This would provide expected results when reversing the operation (e.g. $\sqrt{x}$ followed by X^2). It also meets the accuracy requirements of most calculations.

I. 14-Digit Log_eX with 12 Digit Accuracy

The electronics provides 12-digit accuracy to Log_eX. Thus Log_eX of 99999 is + 11.51291546. If we store the result in an adder and subtract the first two digits, we get + .5129154649 in the display, picking up two more trailing digits.

J. 14-Digit e^x Results with 11-Digit Accuracy

The electronics provides 11 digit accuracy to e^x operations. When we find e^x of 12, we get + 162754.7914. If we store the result in an adder and subtract the first four digits (162700 -AL), we then read + 54.79141970, picking up four more trailing digits. Accuracy is to the 11th digit. For e^{-20}, the operation would be 20 CHS e^x Enter 1000 X=. Read + .0000020611. Write answer as 2.061×10^{-9}.

K. Product Accumulation

The Product Accumulation switch in the "up" or "on" position causes the products, quotients, squares, and square roots to be automatically accumulated in the Left Adder. At the end of a series of $\times, \div, \sqrt{x}$ or X^2 operations, or any combinations thereof, the Recall Adder key on the left would call back the automatically accumulated algebraic sum.

Thus, turn on Product Accumulation Key, Clear All.

2	Enter	4	X=	for + 8.000000000.
3	Enter	2	÷=	for + 1.500000000.
6	Enter	9	$\sqrt{x}$	for + 18.00000000.
7	Enter	8	X^2	for + 448.0000000.

REAL for + 475.5000000.

L. Multiplier Accumulation

The Mult. Accum. key in the "up" or "on" position would accumulate the multipliers or second terms of $\times$, $\div$, $\sqrt{x}$, X^2 operations in the Right Adder. The Recall Adder key on the right would call back the accumulated algebraic sum.

Thus, turn on only the Mult. Accum. switch. Clear All. Perform the sample calculation as above. REAR for + 23.00000000.

M. Entry Accumulation

Similarly, the Entry Accum. switch causes all numbers following on Enter key depressions to be accumulated in the Right Adder. The total may be recalled by depressing the REAR key.

Thus, turn on only the Entry Accum. switch, Clear All. Perform the above calculation again. REAR for + 18.00000000.

N. Entry and Multiplier Accumulation

As expected, the two switches at the "on" position simultaneously would accumulate both the Entries and the Multipliers into the Right Adder. REAR would produce 41 in the above example.

O. Display Over-Cycling

The largest integer that can be stored and displayed is 999999999. Beyond this, the over-cycling light flashes on in the keyboard display. However, the answer given is valid under certain conditions.

In multiplication, if the answer is between 10^{10} and 10^{17}, we can take down the over-cycled readout and move the decimal point 10 places to the right.

99999999 Enter 88888888 X=. Read + 888888.8711*
The answer is 8,888,888,711,000,000.

The square of a seven-digit number gives an over-cycled readout of 9 accurate digits. The last digit is rounded off. The answer is valid.

9876543 X^2. Read + 9754.610163*
The answer is 97,546,101,600,000.

In exponential operations, display over-cycling may occur more than once beyond 10^{10} with valid answers, as the following examples illustrate.

e^{21}	is displayed as + .1318815734*	The answer is $.1318815734 \times 10^{10}$.
e^{44}	is displayed as + .1285160011*	The answer is $.1285160011 \times 10^{20}$.
e^{99}	is displayed as + 988.9030319*	The answer is $988.9030319 \times 10^{40}$.

P. Extra Storage Registers

Model 360 utilizes electronics with four additional random-access storage registers. The keyboard console has eight additional keys as compared to the Model 300K, 310K, and 320K keyboards.

Any number that appears in the keyboard display may be stored by depressing the desired Store Reg key (Store Reg 0, Store Reg 1, Store Reg 2, Store Reg 3). A previously stored number is recallable at random by depressing the proper Recall Reg key. (Recall Reg 0, Recall Reg 1, Recall Reg 2, Recall Reg 3).

The Clear All key does not affect the Storage Registers. If a new or different number is to be stored, it can be done simply be depressing the proper Store Reg key once more.

The abbreviations are SR_0, SR_1, SR_2, SR_3 and RER_0, RER_1, RER_2, RER_3 for storing and recall respectively.

Sample application: Billing for 125 = $69.25

Quantity	Billing Rate
First 15	$ .75
Next 25	.65
Next 35	.55
76 and up	.45

Turn on Prod Accum and Entry Accum. Clear All

.75 SR_0 .65 SR_1 .55 SR_2 .45 SR_3
15 Enter RER_0 X=
25 Enter RER1 X=
35 Enter RER_2 X=
125 -AR ChangeSign Enter RER3 X=
REAL for + 69.25000000.

Q. Sin θ , Cos θ , Arcsin X, Arctan X

The Model 320KT and 360KT keyboard consoles provide four additional keys. Each is marked with the subject function and actuates a built-in hardwired program to generate value for sin θ , cos θ , arcsin X and arctan X. θ is in degrees and fractions of a degree. Inverse function can be integer or fractional.

To find sin 65.85, simply index 65.85 and depress the sin θ key. The correct answer is displayed in a few seconds. Accuracy is .00,000,01 or one in 100 million between 0° and 90°.

To find arctan X, index the value of X and depress the arctan key. The correct answer is displayed in a brief time interval. Accuracy is $.00001^{\circ}$ or 100 thousandth of a degree for angles between 0° and 90°.

The two Adder registers are engaged during a trigonometric calculation. Therefore, these cannot be used as storages when a trigonometric operation is in progress. Both Adders are clear and ready for subsequent use of a trigonometric-function calculation.

Before the start of a trigonometric calculation, the right Adder must first be cleared.

R. Errors of Entry

1. When a number is indexed in error, depression of the Clear Display key will remove it. The correct number can now be indexed without affecting any other numbers in either accumulator or the product registers.

2. If a number has been entered into the Product Register in error, depression of the X = key will "zero" it out.

   3.53 Enter X = Read + .0000000000.

3. When a wrong number has been added or subtracted from an Adder, a compensating operation to reverse the sum should eliminate the effect.

   7.353 $+A_L$; 7.353 $-A_L$

4. By the same token, a negative product would eliminate a product of the same magnitude in case the Prod. Accum. is on.

   5.5 Enter 3 X = Read + 16.50000000.
   5.5 Enter 3 Change Sign X = Read - 16.50000000.

5. If a wrong angle or radian has been indexed, but the trigonometric-function calculation has not been started, the error can be corrected by pressing the Clear Display key. However, if a trigonometric-function calculation has been started, it should be allowed to run to its end. Then a new and correct trigonometric-function calculation can be initiated.

   Caution: When a trigonomtric-function calculation is started on a Simultaneous calculator, (whether with a CP-1 Programmer or a KT Keyboard), do not use the Clear All key to stop the trigonometric-function calculation. This would cause the entire system to come to a hault, thus affecting operations on the other keyboards as well. It would be necessary to re-prime the SE package and restart each keyboard before the system is ready for use again.

IV. CP-1 CARD PROGRAMMER

The CP-1 Card Programmer reads 80-steps, two digit octal codes and automates calculator operations when used with Model 300K, 310K, 320K, or 360K keyboards. START and CONTINUE operation controls are at the two ends on top of the casting. The CP-1 can be used on either the simultaneous or the non-simultaneous electronic package. Only one CP-1 can be attached to each output channel, either directly or from a first-tier T-Connector. Extension cable to the CP-1 is limited to 50 feet. in length. The CP-1 cannot be used with a KT Trig-Function Keyboard due to voltage drops.

A. 80-Step Program Card

Pre-scored tab card has two banks of pre-scored contact ports for digital command codes. It is prepared with a Portapunch and a stylus (available from Wang Laboratories). Code listing is as follows:

01	Stop	44	$\sqrt{x}$	60	0
		45	X^2	61	1
10	Store Reg 0	46	X =	62	2
11	Store Reg 1	47	÷ =	63	3
12	Store Reg 2			64	4
13	Store Reg 3	50	Clear Adder Right	65	5
14	Recall Reg 0	51	Recall Adder Right	66	6
15	Recall Reg 1	52	+ Adder Right	67	7
16	Recall Reg 2	53	- Adder Right		
17	Recall Reg 3	54	Clear Adder Left	70	8
		55	Recall Adder Left	71	9
40	Reserved	56	+ Adder Left	75	.
41	Enter	57	- Adder Left	76	Clear Display
42	Log_eX			77	Change Sign
43	e^x				

B. Programming

Arrange mathematical expression in calculator-operable sequence of steps in such a manner as to allow indexing of the variable, and storing, if necessary for multiple use. List logical steps on work sheet. Code each step and prepare program card in a Portapunch with stylus. Use "stop" code whenever an input number is to be indexed on the keyboard by hand.

C. Operation

Attach CP-1 Programmer connector to output channel of electronic package or to a first-tier T-Connector. Attach Keyboard connector to CP-1 Output receptacle. Turn CP-1 Switch to Auto mode. Turn on keyboard switch. Turn on power to electronic package. Prime keyboard with Clear All. Open CP-1 cover and slide program card into position between and under two guides. Close cover slowly but securely, making sure not to touch contact points. HANDLING OF CP-1 CONTACT POINTS CAN RESULT IN FAULTY OPERATIONS.

Index input variable, press START, index next input number, if applicable, and press CONTINUE etc. Readouts are shown automatically in keyboard display.

V. IC-1 ITEM COUNTER

A. Description

The IC-1 Item Counter is an optional accessory to the Series 300 Wang Electronic Calculators. Its function is to give the calculator user a ready reference to the number of like or related items taking place in a calculation. It weighs two pounds and measures 5 inches by 5-1/4 inches by 3-5/8 inches.

The IC-1 can be factory-installed to any calculator Keyboard in the 300 Series (i.e., 300K, 310K, 320K, 360K, 320KT, 360KT). In order to accommodate the IC-1, the Keyboard has to be fitted with an IC-1 output connector. The Counter itself has an input connector as well as an 18-inch cable. Thus, the IC-1 is a Keyboard attachable accessory.

In operation, the IC-1 can count up the number of items in any of the +, -, x, ÷, $\sqrt{X}$, and X^2 operations. It can also count up any combinations of these operations (e.g., all + and - operations on the left adder, or all + and - operations on both the left and right adders, etc.). The capacity of the counter is 10,000 less 1.

B. Operation

Operation of the IC-1 Item Counter is controlled by a series of selector switches. When a desired function is to be counted, set the appropriate switch by pushing it to the upper position. Then set the Counter readout to zero by pressing the black knob immediately below the readout window. The Counter is now ready to function.

Example 1: Count the Number of Items in an X^2 Operation:

Set the Counter X^2 selector switch in the upper position. Set all other selector switches in the lower position. Set the Counter readout to zero. Operate the keyboard for all values of X to be squared. The IC-1 will indicate the number of calculations of the X^2 function.

Example 2: Count the Number of Multiplications:

Set the x= switch of the IC-1 in the upper position. Place all other switches in the lower position and set the Counter readout to zero. Perform multiplications on the keyboard as usual. The IC-1 will indicate the number of multiplication operations performed.

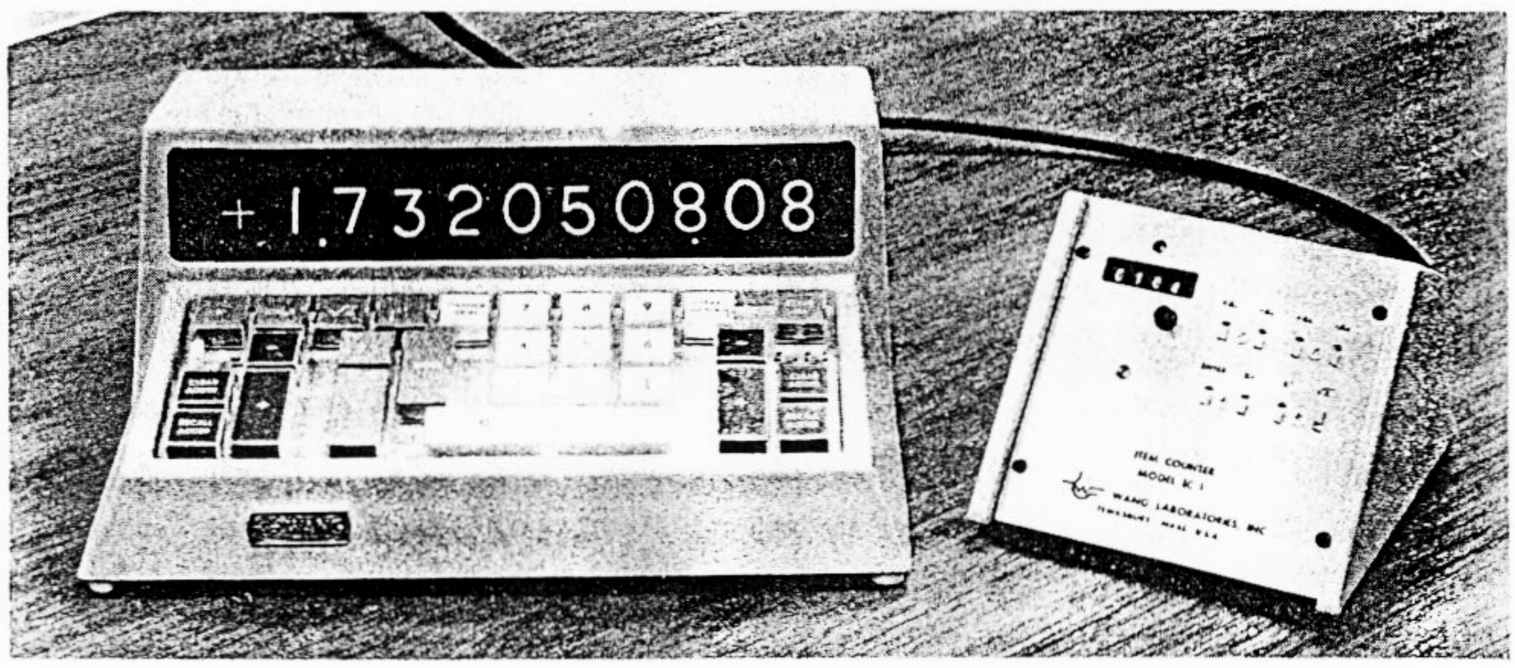
Example 3: Count the Number of Divisions:

Set the Enter switch of the IC-1 in the upper position. Place all other switches in the lower position, and set the Counter readout to zero. Perform divisions on the keyboard; the IC-1 will indicate the number of division operations performed.

VI. ILLUSTRATIVE CALCULATIONS

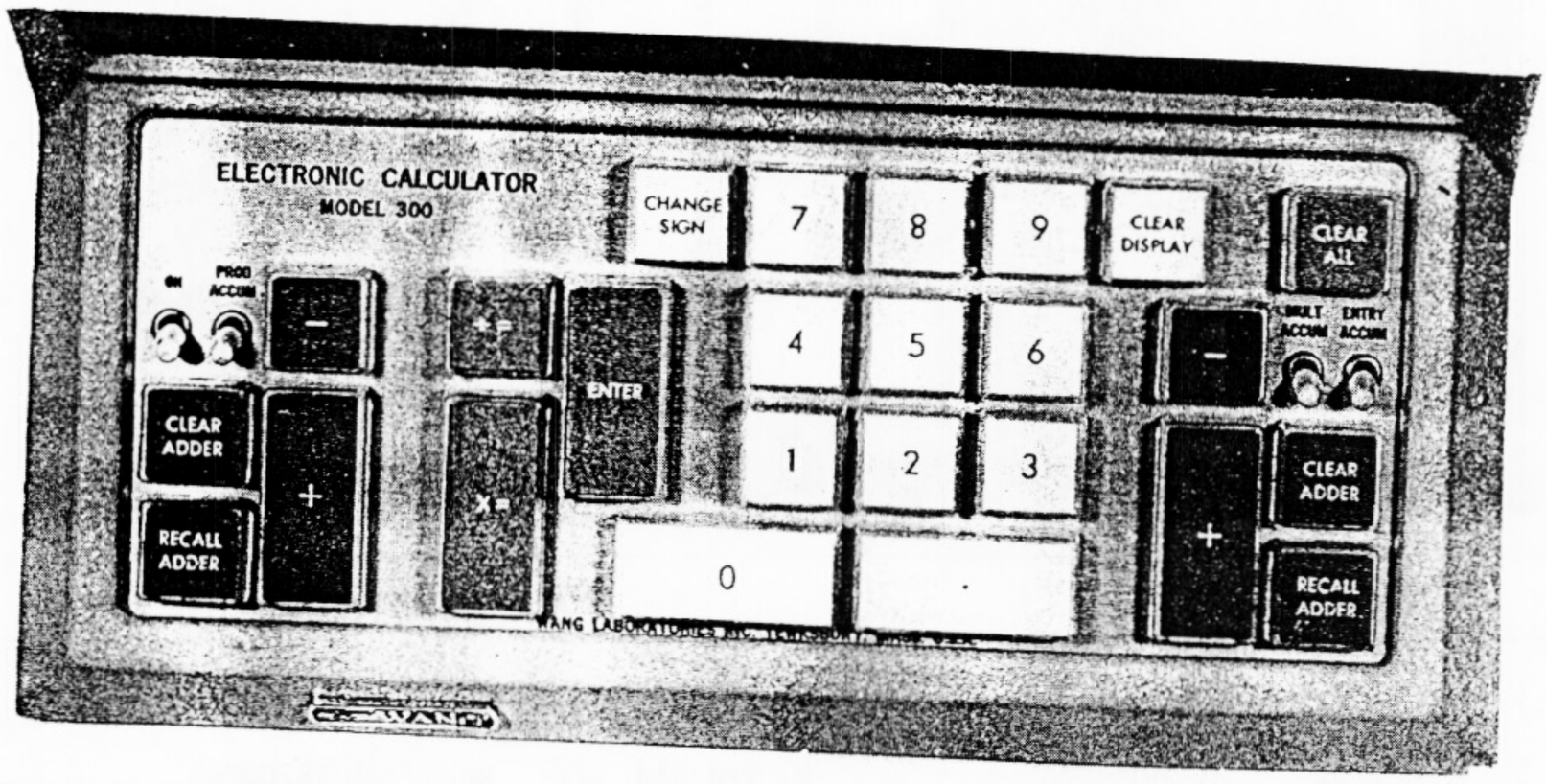
In the following several pages, illustrative calculations are shown for each of the keyboard models and for the CP-1 Programmer. Keyboard operations are denoted by symbols such as 7, +AL, ÷ =, Enter, etc. Abbreviations used are:

+AL	+ Adder Left	SR_o	Store Reg o
-AL	- Adder Left	SR_1	Store Reg 1
CLAL	Clear Adder Left	SR_2	Store Reg 2
REAL	Recall Adder Left	SR_3	Store Reg 3
+AR	+ Adder Right	RER_o	Recall Reg o
-AR	- Adder Right	RER_1	Recall Reg 1
CLAR	Clear Adder Right	RER_2	Recall Reg 2
REAR	Recall Adder Right	RER_3	Recall Reg 3
CHS	Change Sign	Prod Accum	Product Accumulation
CLD	Clear Display	Mult Accum	Multiplier Accumulation
		Entry Accum	Entry Accumulation



CP-1 Item Counter shown with the 320K Keyboard

A. Model 300K Keyboard for Business Applications

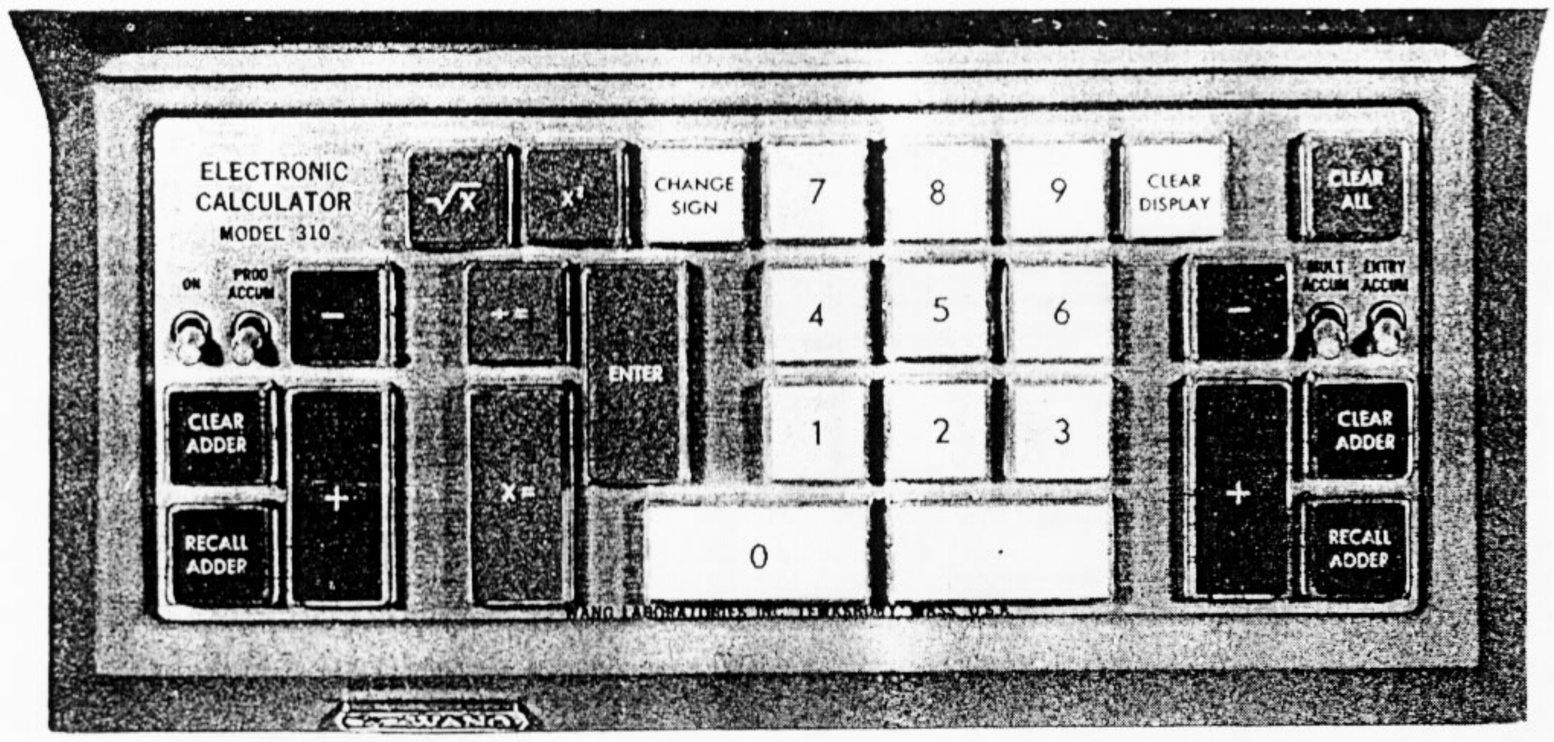


APPLICATION	KEYBOARD OPERATION
1. 12.34 + 103 - 27.18 = 88.16	1. Clear All 12.34 $+A_L$ 103 $+A_L$ 27.18 $-A_L$ Read +88.16000000
2. 16.39 x 15 = 245.85	2. 16.39 Enter 15 X= Read +245.8500000
3. $\frac{7 \times 9 \times 18}{6} = 189$	3. 7 Enter 9 Enter 18 Enter 6 ÷ = Read + 189.0000000
4. $\frac{1}{7} + \frac{1}{9.7} - \frac{1}{11.9} = .1619163130$	4. Prod Accum on Clear All 7 ÷ = 9.7 ÷ = 11.9 CHS ÷ = REAL Read + .1619163130
5. Last Year $21,644.39 This Year 32,659.32 Percent Change +51%	5. Entry Accum on Clear All 21644.39 Enter 32659.32 $-A_R$ CHS ÷ = ÷ = Read +.508904614 8
6. Invoicing with Chain Discount	6. Clear All Prod Accum on

Qty.	Price	Discounts	Total
25	$1.30	10/5/2	$27.23
28	16.20/100	25/10	3.06
34 3/4"	1.85/yd.	--	1.79
	Sub-total		$32.08
	3% Tax		.96
	Total		$33.04

25 Enter 1.3 Enter .9 Enter .95 Enter .98 X= Read +27.23175000
28 Enter .162 Enter .75 Enter .9 X= Read +03.06180000
34.75 Enter 1.85 Enter 36 ÷ = Read +01.78576388
REAL Read +32.07931388
Enter .03 X= Read +00.96237941
REAL Read + 33.04169330

B. Model 310K Keyboard for Statistical Applications



APPLICATION	KEYBOARD OPERATION
1. $12.763^2 = 162.894169$	1. 12.763 X^2 Read +162.8941690
2. $\sqrt{978.564} = 31.28200761$	2. 978.564 $\sqrt{x}$ Read +31.28200761
3. $7.5 \times 98.3 \times 2.56^2 = 4831.6416$	3. 7.5 Enter 98.3 Enter 2.56 X^2 Read +4831.641600
4. $\frac{7.5 \times 98.3 \times 2.56^2}{\sqrt{46.1}} = 711.6136159$	4. 46.1 $\sqrt{x}$ ÷ = Enter 7.5 Enter 98.3 Enter 2.56 X^2 Read +711.6136159
5. $\sqrt{\frac{13^2 + 21^2 + 35^2 + 67^2 + 42^2}{5}}$ $= 40.2193983$	5. Prod Accum on Clear All 13 X^2 21 X^2 35 X^2 67 X^2 42 X^2 Prod Accum off REAL Enter 5 ÷ = $\sqrt{x}$ Read +40.21939830
6.	6. Prod Accum/Mult Accum on Clear All

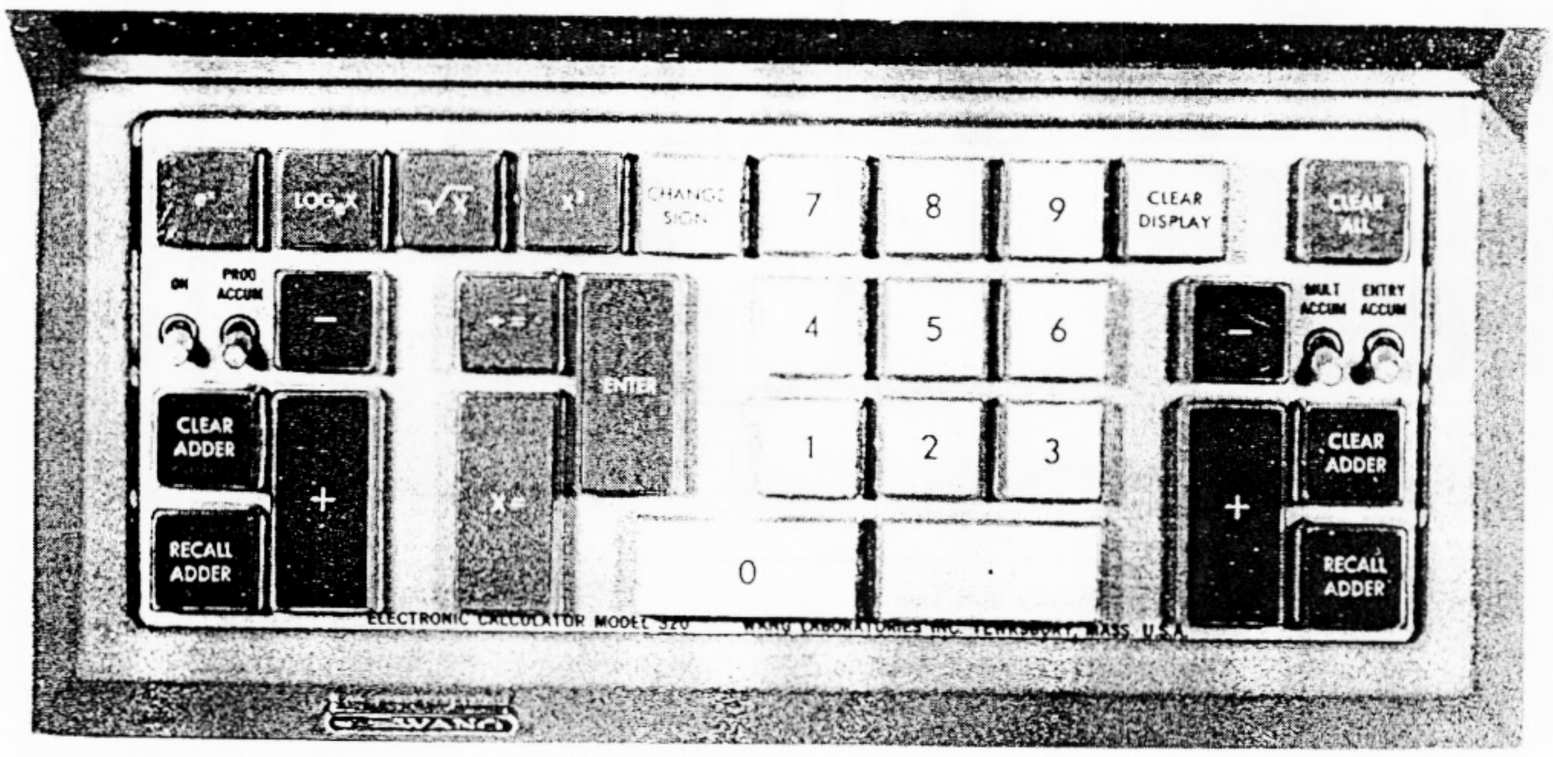
Bond Price (X)	X^2
$71	$5041
65	4225
41	1681
80	6400
69	6761
73	5329
$399	$27437

71 X^2 Read +5041.000000
65 X^2 Read +4225.000000
41 X^2 Read +1681.000000
80 X^2 Read +06400.00000
69 X^2 Read +04761.00000
73 X^2 Read +05329.00000
Prod Accum/Mult Accum off
REAR Read +399.0000000
REAL Read +27437.00000

7. $\sigma = \sqrt{\frac{\Sigma X^2}{n} - (\frac{\Sigma X}{n})^2}$
$= \sqrt{\frac{27437}{6} - (\frac{399}{6})^2}$
$= 12.27124008$

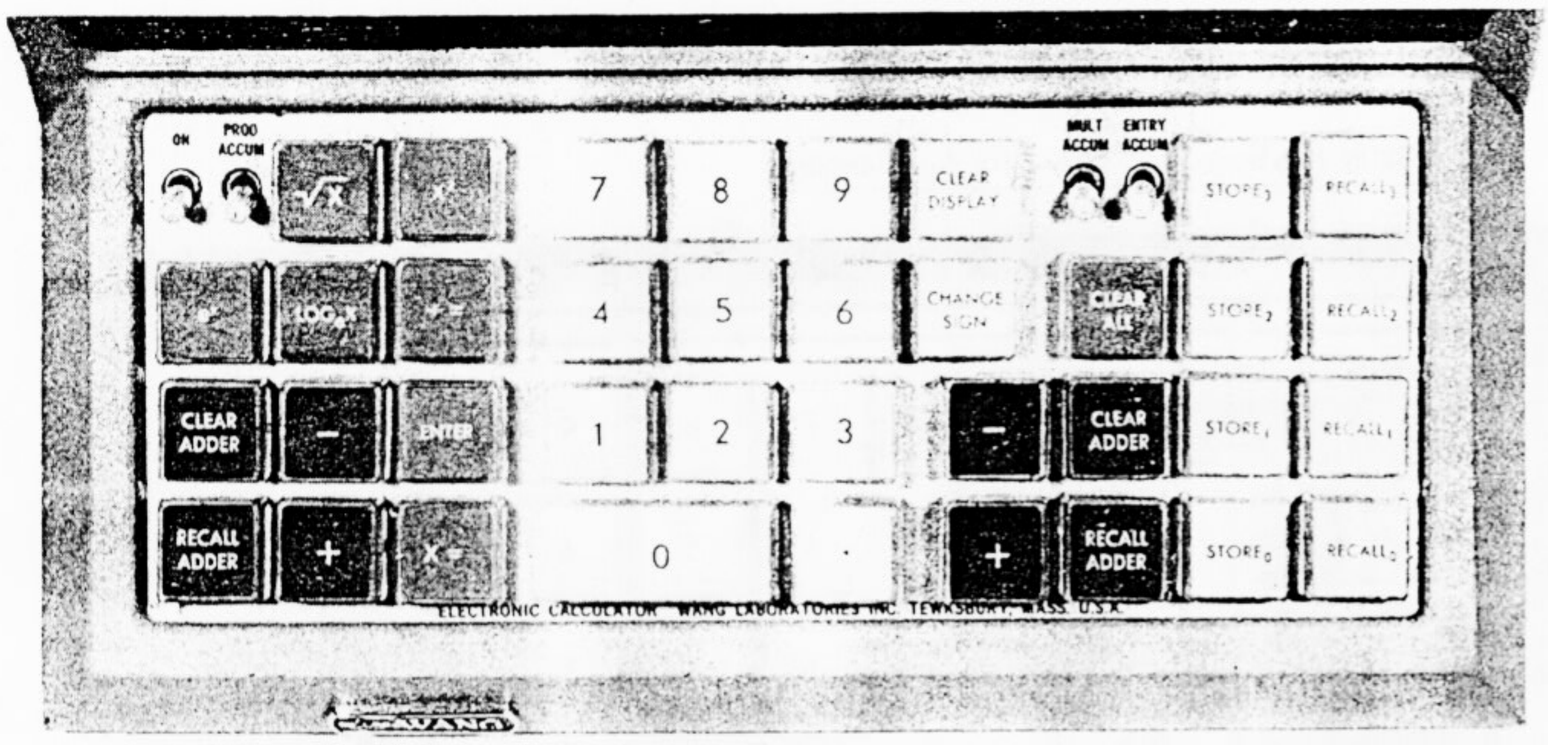
7. As continuation of (6)
Enter 6 ÷ = CLAL +AL
REAR Enter 6 ÷ = X^2 -AL
$\sqrt{x}$ Read +12.27124008

C. Model 320K Keyboard for Scientific Applications



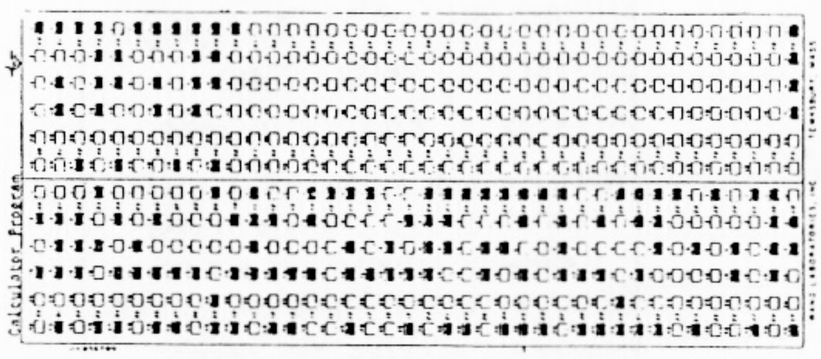
APPLICATION	KEYBOARD OPERATION
1. $\text{Log}_e\ 22.5 = 3.1135153$	1. 22.5 $\text{Log}_e X$ Read +03.11351530
2. $\text{Log}_{10}\ 1876 = \frac{\text{Log}_e\ 1876}{\text{Log}_e\ 10} = 3.273232834$	2. 10 $\text{Log}_e X$ $+A_R$ 1876 $\text{Log}_e X$ Enter REA_R $\div$ = Read +3.273232834
3. $e^{1.346} = 3.842026646$	3. 1.346 e^x Read +3.842026646
4. $e^{21} = 1,318,815,734$	4. 21 e^x Read + .1318815734 * with flashing over-cycling light
5. $\sqrt[7]{19487171} = 11$	5. 19487171 $\text{Log}_e X$ Enter 7 $\div$ = e^x Read + 11.00000000
6. $V = E_b(1 - e^{-\frac{t}{RC}}) = 128\ (1 - e^{-.35}) = 37.79992452$	6. 1 $+A_R$ .35 CHS e^x $-A_R$ Enter 128 X = Read + 37.79992452
7. Monthly Payment of Mortgage Loan $\frac{P \cdot i}{1 - (1+i)^{-n}}$ $\frac{16000 \times .005}{1 - (1.005)^{-180}}$ = \$135.02	7. Find the reciprocal of denominator and chain multiply: 1 $+A_R$ 1.005 $\text{Log}_e X$ Enter 180 CHS X = e^x $-A_R$ $\div$ = Enter 16000 Enter .005 X = Read +135.0170924

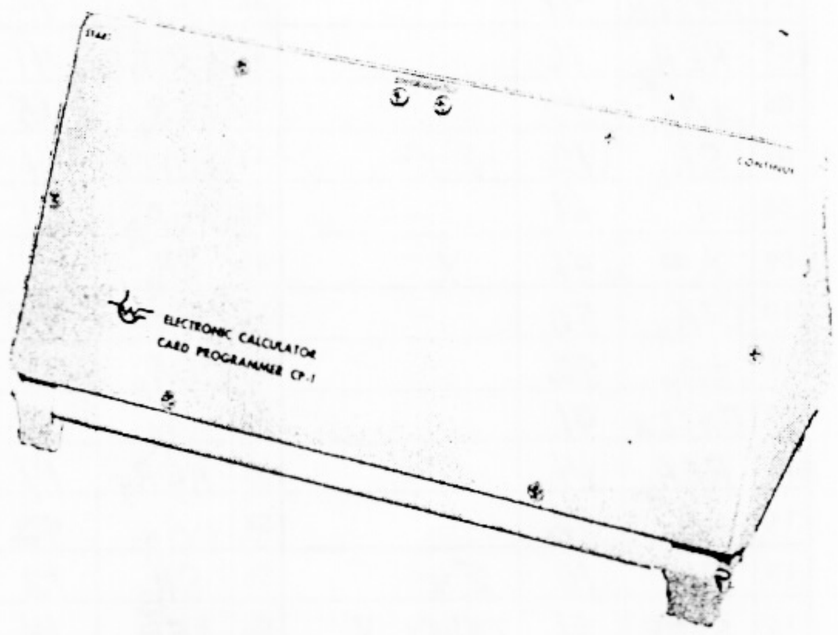
D. Model 360K Keyboard for Full-Range Applications



APPLICATION	KEYBOARD OPERATION
1. $e^{(-3 + 1.1X + .22X^2 + .014X^3)}$ = +.4458601237 when X = 1.5	1. Prod Accum on Clear All 3 SR_0 1.1 SR1 .22 SR2 .014 SR3. RER_0 $-A_L$. RER1 Enter 1.5 $+A_R$ X =. RER2 Enter REA_R X^2. RER3 Enter REA_R Enter REA_R X^2. REA_L e^x Read +.4458601237
2. $a_o + a_1X + a_2\frac{X^2}{2!} + a_3\frac{X^3}{3!} + a_4\frac{X^4}{4!}$ = +1470.779222 where $a_o = 21$ $a_1 = 32$ $a_2 = 43$ $a_3 = 54$ $a_4 = 65$ X = 3.765	2. Clear All (All Accum off) 32 SR_0 43 SR1 54 SR2 65 SR3 3.765 $+A_R$ 21 $+A_L$. RER_0 Enter REA_R X = $+A_L$. RER1 Enter 2 ÷ = Enter REA_R X^2 $+A_L$. 2 Enter 3 X = ÷ = Enter RER2 Enter REA_R X^2 Enter REA_R X = $+A_L$. 2 Enter 3 Enter 4 X = ÷ = Enter RER3 Enter REA_R X^2 Enter REA_R X^2 $+A_L$. Read +1470.779222
3. Billing for 2485 at rates below Quantity / Rate / Billing First 100 / .75 / $ 75.00 Next 500 / .65 / 325.00 Next 1000 / .55 / 550.00 1601 and up / .40 / 354.00 Total / $1,304.00	3. Prod Accum & Entry Accum on Clear All .75 SR3 .65 SR2 .55 SR1 .4 SR_0 100 Enter RER_3 X = Read +75.00000000 500 Enter RER_2 X = Read +325.0000000 1000 Enter RER1 X = Read +550.0000000 2485 $-A_R$ CHS Enter RER_0 X = Read +354.0000000 REA_L Read +1304.000000

E. CP-1 Card Programmer





APPLICATION	KEYBOARD OPERATION
1. $AX^2 + BX + C = 0$ A, B, C are given. 6.8 seconds	1. B Start A Continue C Continue Read X_1 Continue Read X^2
2. $\sin\theta$, $\cos\theta$, $\tan\theta$ 7.6 seconds θ in degrees and fractions	2. Prod Accum on Clear All θ (in degrees and fractions) Start Read $\sin\theta$. Continue Read $\cos\theta$. Continue Read $\tan\theta$.
3. Variance, Standard Deviation, Mean $\sigma^2 = \frac{1}{n-1}\left[\sum X_i^2 - \frac{1}{n}(\sum X_i)^2\right]$ $\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$ 17.8 seconds	3. Clear All X_1 Start X_2 Start X_3 Start X_4 Start X_5 Start X_6 Start X_7 Continue Read σ^2. Continue Read σ. Continue Read $\overline{X}$. (Model 360)
4. Mortgage Payment $d = p \cdot r \frac{(1+r)^n}{(1+r)^n - 1}$ 9 seconds p, r, n given	4. Clear All r Start n Continue p Continue Read d.

CALCULATOR PROGRAM No. CAL360-STAT-3 Date: MAY 27, 1967

No.	Cmd	Code	Comment	No.	Cmd	Code	Comment
00	CLA_R	50		40	CLA_R	50	
01	X^2	45		41	$+A_R$	52	
02	$+A_R$	52		42	$\div =$	47	
03	$\sqrt{X}$	44		43	$-A_L$	57	$\Sigma xy - \frac{1}{N}(\Sigma x)(\Sigma y)$
04	ENTER	41		44	RER_1	15	
05	RER_2	16		45	ENTER	41	
06	$+A_R$	52		46	RER_1	15	
07	SR_2	12	Σx^2	47	ENTER	41	
08	1	61		48	REA_R	51	
09	$X =$	46	X	49	SR_1	11	N
10	CLA_R	50		50	$\div =$	47	
11	$+A_R$	52		51	CLA_R	50	
12	ENTER	41		52	$-A_R$	53	
13	RER_0	14		53	RER_3	17	
14	$+A_R$	52		54	$+A_R$	52	
15	SR_0	10	Σx	55	SR_3	13	$\Sigma y^2 - \frac{1}{N}(\Sigma y)^2$
16	STOP	01	INDEX Y	56	RER_0	14	
17	CLA_R	50		57	ENTER	41	
18	$+A_R$	52		58	RER_0	14	
19	$X =$	46		59	ENTER	41	
20	$+A_L$	56	Σxy	60	RER_1	15	
21	REA_R	51		61	$\div =$	47	
22	ENTER	41		62	CLA_R	50	
23	RER_1	15		63	$-A_R$	53	
24	$+A_R$	52		64	RER_2	16	
25	SR_1	11	Σy	65	$+A_R$	52	$\Sigma x^2 - \frac{1}{N}(\Sigma x)^2$
26	1	61		66	ENTER	41	
27	$X =$	46		67	RER_3	17	
28	X^2	45	y^2	68	$X =$	46	
29	CLA_R	50		69	$\sqrt{X}$	44	
30	$+A_R$	52		70	$\div =$	47	
31	RER_3	17		71	ENTER	41	
32	$+A_R$	52		72	REA_L	55	
33	SR_3	13	Σy^2	73	$X =$	46	
34	STOP	01		74	STOP	01	READ R
35	RER_0	14		75			
36	ENTER	41		76			
37	RER_1	15		77			
38	ENTER	41		78			
39	STOP	01	INDEX N	79			

LINEAR CORRELATION

$$R = \frac{\Sigma xy - \frac{1}{N}\Sigma x \Sigma y}{\left(\left[\Sigma x^2 - \frac{1}{N}(\Sigma x)^2\right]\left[\Sigma y^2 - \frac{1}{N}(\Sigma y)^2\right]\right)^{1/2}}$$

where N = no. of X's and y's

OPERATING INSTRUCTIONS

(1) CLEAR ALL (AND SR_0, SR_1, SR_2, SR_3)
(2) INDEX X, PRESS START
(3) INDEX Y, PRESS CONTINUE
NOTE: A loop has been established from step 34 back to step 00 in order to accomodate unlimited sets of x & y.
(4) REPEAT STEPS (2) & (3) FOR ALL X & Y.
(5) AFTER INDEXING THE LAST Y AND PRESSING CONTINUE, READ Σy^2.
(6) PRESS CONTINUE, INDEX N, AND PRESS CONTINUE (AGAIN).
(7) READ R, correlation coefficient.

TEST:

X	1	3	5
Y	2	6	10

ANS. R = 1.0 (N = 3)

List of operations.

Code	Cmd	Explanation	Code	Cmd	Explanation
00		Stop	50	CLA_R	Clear Adder Right
01			51	REA_R	Recall Adder Right
02			52	$+A_R$	+ Adder Right
03			53	$-A_R$	- Adder Right
04			54	CLA_L	Clear Adder Left
05			55	REA_L	Recall Adder Left
06			56	$+A_L$	+ Adder Left
07			57	$-A_L$	- Adder Left
10	SR_0	Store Reg 0	60	0	
11	SR_1	Store Reg 1	61	1	
12	SR_2	Store Reg 2	62	2	
13	SR_3	Store Reg 3	63	3	
14	RER_0	Recall Reg 0	64	4	
15	RER_1	Recall Reg 1	65	5	
16	RER_2	Recall Reg 2	66	6	
17	RER_3	Recall Reg 3	67	7	
20			70	8	
21			71	9	
22			72		
23			73		
24			74		
25			75	.	
26			76	CLD	
27			77	CAS	
30					
31					
32					
33					
34					
35					
36					
37					

Blank indicates not assigned.

Wang Laboratories, Inc. 836 NORTH STREET TEWKSBURY, MASSACHUSETTS C-1-66

CALCULATOR PROGRAM

No. CAL 320 - FIN - 1 Date: MAR. 2, 1967

No.	Cmd	Code	Comment	No.	Cmd	Code	Comment
00	ENTER	41		40			
01	STOP	01	INDEX i	41			
02	$+A_R$	52		42			
03	X=	46		43			
04	$+A_L$	56		44			
05	1	61		45			
06	$+A_R$	52		46			
07	Log_e X	42		47			
08	ENTER	41		48			
09	STOP	01	INDEX n	49			
10	CHS	77		50			
11	X=	46		51			
12	e^x	43		52			
13	CLA_R	50		53			
14	$-A_R$	53		54			
15	1	61		55			
16	$+A_R$	52		56			
17	÷ =	47		57			
18	ENTER	41		58			
19	REA_L	55		59			
20	X=	46		60			
21	STOP	01	READ M	61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			

MONTHLY MORTGAGE PAYMENT

$$M = \frac{P \cdot i}{1-(1+i)^{-n}}$$

where

P = principal

i = rate of interest per month

n = no. of monthly periods

OPERATING INSTRUCTIONS

(1) CLEAR ALL (AND SR_0, SR_1, SR_2, SR_3)
(2) INDEX P, PRESS START
(3) INDEX i, PRESS CONTINUE
(4) INDEX n, PRESS CONTINUE
(5) READ M, monthly mortgage payment

TEST:

P = #16000
i = 6%/yr. = .005/mo.
n = 15 yrs. = 180 mos.

ANS. M = $135.0170925

List of operations.

Code	Cmd	Explanation
00		
01	Stop	
02		
03		
04		
05		
06		
07		
10	SR_0	Store Reg 0
11	SR_1	Store Reg 1
12	SR_2	Store Reg 2
13	SR_3	Store Reg 3
14	RCR_0	Recall Reg 0
15	RCR_1	Recall Reg 1
16	RCR_2	Recall Reg 2
17	RCR_3	Recall Reg 3
20		
21		
22		
23		
24		
25		
26		
27		
30		
31		
32		
33		
34		
35		
36		
37		
40		
41	Enter	
42	$Log_e X$	
43	e^x	
44	$\sqrt{x}$	
45	X^2	
46	X=	
47	÷ =	
50	CLA_R	Clear Adder Right
51	RCA_R	Recall Adder Right
52	$+A_R$	+ Adder Right
53	$-A_R$	- Adder Right
54	CLA_L	Clear Adder Left
55	RCA_L	Recall Adder Left
56	$+A_L$	+ Adder Left
57	$-A_L$	- Adder Left
60	0	
61	1	
62	2	
63	3	
64	4	
65	5	
66	6	
67	7	
70	8	
71	9	
72		
73		
74		
75	.	
76	CLD	
77	CHS	

Blank indicates not assigned

Wang Laboratories, Inc. 836 NORTH STREET TEWKSBURY, MASSACHUSETTS C-1-66

CALCULATOR PROGRAM No. CAL320-FIN-3 Date: MAR. 6, 1967

No.	Cmd	Code	Comment	No.	Cmd	Code	Comment
00	ENTER	41		40			
01	STOP	01	INDEX i	41			
02	$+A_R$	52		42			
03	÷ =	47		43			
04	$+A_L$	56		44			
05	/	61		45			
06	$+A_R$	52		46			
07	$Log_e X$	42		47			
08	ENTER	41		48			
09	STOP	01	INDEX n	49			
10	X =	46		50			
11	e^x	43		51			
12	CLA_R	50		52			
13	$+A_R$	52		53			
14	1	61		54			
15	$-A_R$	53		55			
16	ENTER	41		56			
17	REA_L	55		57			
18	X =	46		58			
19	STOP	01	READ A	59			
20				60			
21				61			
22				62			
23				63			
24				64			
25				65			
26				66			
27				67			
28				68			
29				69			
30				70			
31				71			
32				72			
33				73			
34				74			
35				75			
36				76			
37				77			
38				78			
39				79			

ANNUITY

$$A = R \times S_{\overline{n}|i} = R\left[\frac{(1+i)^n - 1}{i}\right]$$

We use the equation in the following form:

$$A = \frac{R}{i}\left[(1+i)^n - 1\right]$$

where

A = accumulated amount of annuity

R = amount of each payment

i = interest rate per period

n = length of time during which payments are made

OPERATING INSTRUCTIONS

(1) CLEAR ALL (AND SR_0, SR_1, SR_2, SR_3)
(2) INDEX R, PRESS START
(3) INDEX i, PRESS CONTINUE
(4) INDEX n, PRESS CONTINUE
(5) READ A, amount

TEST:

$R = \$1000$
$i = .045$
$n = 14$
ANS. $A = \$18,932.10937$

List of operations.

Code	Cmd	Explanation	Code	Cmd	Explanation
00			90		
01	Stop		91	Enter	
02			92	$Log_e X$	
03			93	e^x	
04			94	$\sqrt{x}$	
05			95	X^2	
06			96	X=	
07			97	+=	
10	SR_0	Store Reg. 0	50	CLA_R	Clear Adder Right
11	SR_1	Store Reg. 1	51	REA_R	Recall Adder Right
12	SR_2	Store Reg. 2	52	$+A_R$	+ Adder Right
13	SR_3	Store Reg. 3	53	$-A_R$	- Adder Right
14	RER_0	Recall Reg. 0	54	CLA_L	Clear Adder Left
15	RER_1	Recall Reg. 1	55	REA_L	Recall Adder Left
16	RER_2	Recall Reg. 2	56	$+A_L$	+ Adder Left
17	RER_3	Recall Reg. 3	57	$-A_L$	- Adder Left
20			60	0	
21			61	1	
22			62	2	
23			63	3	
24			64	4	
25			65	5	
26			66	6	
27			67	7	
30			70	8	
31			71	9	
32			72		
33			73		
34			74		
35			75	.	
36			76	CLD	
37			77	CAS	

Blank indicates not assigned

Wang Laboratories, Inc. 836 NORTH STREET TEWKSBURY, MASSACHUSETTS C-1-66

CALCULATOR PROGRAM No. CAL320-TRIG-2 Date: OCT. 2, 1966

No.	Cmd	Code	Comment	No.	Cmd	Code	Comment
00	CLA_R	50		40	REA_R	51	
01	$+A_R$	52		41	X^2	45	
02	X^2	45		42	CLA_L	54	
03	ENTER	41		43	$+A_L$	56	
04	2	62		44	5	65	
05	.	75		45	$+A_L$	56	
06	3	63		46	÷ =	47	
07	1	61		47	ENTER	41	
08	X =	46		48	4	64	
09	CLA_L	54		49	ENTER	41	
10	$+A_L$	56		50	REA_R	51	
11	1	61		51	X^2	45	
12	1	61		52	CLA_L	54	
13	$+A_L$	56		53	$+A_L$	56	
14	÷ =	47		54	3	63	
15	ENTER	41		55	$+A_L$	56	
16	2	62		56	÷ =	47	
17	5	65		57	ENTER	41	
18	ENTER	41		58	REA_R	51	
19	REA_R	51		59	X^2	45	
20	X^2	45		60	CLA_L	54	
21	CLA_L	54		61	$+A_L$	56	
22	$+A_L$	56		62	1	61	
23	9	71		63	$+A_L$	56	
24	$+A_L$	56		64	÷ =	47	
25	÷ =	47		65	ENTER	41	
26	ENTER	41		66	REA_R	51	
27	1	61		67	ENTER	41	
28	6	66		68	5	65	
29	ENTER	41		69	7	67	
30	REA_R	51		70	.	75	
31	X^2	45		71	2	62	
32	CLA_L	54		72	9	71	
33	$+A_L$	56		73	5	65	
34	7	67		74	7	67	
35	$+A_L$	56		75	7	67	
36	÷ =	47		76	9	71	
37	ENTER	41		77	5	65	
38	9	71		78	X =	46	
39	ENTER	41		79	STOP	01	READ ARCTAN

ARCTANGENT

$$\text{ARCTAN } X = \cfrac{X}{1+\cfrac{X^2}{3+\cfrac{(2X)^2}{5+\cfrac{(3X)^2}{7+\cfrac{(4X)^2}{9+\cfrac{(5X)^2}{11+\cfrac{(6X)^2}{14}}}}}}}$$

$-1 \le X \le 1 \Rightarrow -45° \le \theta \le 45°$

ERROR $\le 8 \times 10^{-7}$ rad.

5×10^{-5} deg.

0.2 sec.

OPERATING INSTRUCTIONS

(1) CLEAR ALL

(2) INDEX ARCTAN (RADS.)
PRESS START

(3) READ ARCTAN IN DEGS.

TEST : $X = 1.0$, $TAN^{-1}X = 45.00001245$

List of operations.

Blank indicates not assigned.

Wang Laboratories, Inc. 836 NORTH STREET TEWKSBURY, MASSACHUSETTS

CALCULATOR PROGRAM No. CAL320-TRIG-1 Date: MAY 25, 1967

No.	Cmd	Code	Comment	No.	Cmd	Code	Comment
00	ENTER	41		40	÷ =	47	
01	5	65		41	CLA_R	50	
02	7	67		42	$+A_R$	52	
03	.	75		43	1	61	
04	2	62		44	$+A_R$	52	
05	9	71		45	ENTER	41	
06	5	65		46	REA_L	55	
07	7	67		47	ENTER	41	
08	7	67		48	4	64	
09	9	71		49	2	62	
10	5	65		50	÷ =	47	
11	÷ =	47	X into rads.	51	CLA_R	50	
12	X^2	45		52	$+A_R$	52	
13	CLA_L	54		53	1	61	
14	$-A_L$	57		54	$+A_R$	52	
15	ENTER	41		55	ENTER	41	
16	1	61		56	REA_L	55	
17	5	65		57	ENTER	41	
18	6	66		58	2	62	
19	÷ =	47		59	0	60	
20	CLA_R	50		60	÷ =	47	
21	$+A_R$	52		61	CLA_R	50	
22	1	61		62	$+A_R$	52	
23	$+A_R$	52		63	1	61	
24	ENTER	41		64	$+A_R$	52	
25	REA_L	55		65	ENTER	41	
26	ENTER	41		66	REA_L	55	
27	1	61		67	ENTER	41	
28	1	61		68	6	66	
29	0	60		69	÷ =	47	
30	÷ =	47		70	CLA_R	50	
31	CLA_R	50		71	$+A_R$	52	
32	$+A_R$	52		72	1	61	
33	1	61		73	$+A_R$	52	
34	$+A_R$	52		74	ENTER	41	
35	ENTER	41		75	REA_L	55	
36	REA_L	55		76	CHS	77	
37	ENTER	41		77	$\sqrt{X}$	44	
38	7	67		78	X =	46	
39	2	62		79	STOP	01	READ SIN X

SIN X

$$\text{SIN } X = X\left(1-\frac{X^2}{2\cdot3}\left(1-\frac{X^2}{4\cdot5}\left(1-\frac{X^2}{6\cdot7}\left(1-\frac{X^2}{8\cdot9}\left(1-\frac{X^2}{10\cdot11}\left(1-\frac{X^2}{12\cdot13}\right)\right)\right)\right)\right)\right)$$

OPERATING INSTRUCTIONS

(1) CLEAR ALL
(2) INDEX X (deg's.), PRESS START
(3) READ SIN X

TEST: X = 45°
SIN X = .7071067813

NOTE: $-90° \le X \le 90°$
ERROR $\le 0.6 \times 10^{-9}$

List of operations.

Code	Cmd	Explanation
00		
01	Stop	
02		
03		
04		
05		
06		
07		
10	SR_0	Store Reg 0
11	SR_1	Store Reg 1
12	SR_2	Store Reg 2
13	SR_3	Store Reg 3
14	REA_0	Recall Reg 0
15	REA_1	Recall Reg 1
16	REA_2	Recall Reg 2
17	REA_3	Recall Reg 3
20		
21		
22		
23		
24		
25		
26		
27		
30		
31		
32		
33		
34		
35		
36		
37		
40		
41	Enter	
42	Lift X	
43	x^2	
44	$\sqrt{x}$	
45	$x \rightleftarrows y$	
46	+ =	
47	÷ =	
50	CLA_R	Clear Adder Right
51	REA_R	Recall Adder Right
52	$+A_R$	+ Adder Right
53	$-A_R$	- Adder Right
54	CLA_L	Clear Adder Left
55	REA_L	Recall Adder Left
56	$+A_L$	+ Adder Left
57	$-A_L$	- Adder Left
60	0	
61	1	
62	2	
63	3	
64	4	
65	5	
66	6	
67	7	
70	8	
71	9	
72		
73		
74		
75	.	
76	CLR	
77	CHS	

Blank indicates not assigned.

Wang Laboratories, Inc. 836 NORTH STREET TEWKSBURY, MASSACHUSETTS C-1-66

VII. SPECIFICATIONS

A. Circuitry:

All solid-state construction using replaceable digital plug-in circuit modules.

B. AC Input:

115 volts AC ± 10%, 60 ± 2Hz, single phase, 3-wire, grounded. 115/220 V/50 Hz operation available on request at no extra charge. Power consumption 35 to 45 watts.

C. Output:

250 volts DC at 15 milli-amps from electronic package to keyboard consoles to drive Nixies and -9V ± 3V at a few milli-amps for keyboard logic. 60 milli-amps for shared-time electronic packages.

D. Keyboard Console 300K:

Size 4 1/2" x 8" x 10 1/4", weight 6 lbs. Standard calculator arrangement of 0 to 9 and decimal keys. Independent dual adder-accumulators with random access recall. Duplex accumulation switches for sums of products, multipliers and/or entries. Independent product register with exclusive automatic single-keystroke reciprocal. Simplified chain multiplication. Glare-free display with 5/8" high numerals. Readout of 10-digit accuracy with automatic floating decimal point. Recycled valid answers for numbers greater than 10^{10}, 10^{20}, etc. Instant +, −, ×, ÷, operations with tenth digit round-off. 12' cable included.

E. Keyboard Console 310K:

All features above plus instant $\sqrt{x}$ and X^2 operation with 10th digit round-off. Automatic and simultaneous accumulation of ΣX and ΣX^2 for statistical computations.

F. Keyboard Console 320K:

All features above plus instant $\text{Log}_e X$ and e^x operations for exponential computations with 12-digit accuracy.

G. Electronic Packages 300E, 310E, 320E:

Size 5" x 9" x 17", weight 15 lbs. Provide calculations as described for 300K, 310K, and 320K keyboards respectively. Each can support a maximum of four interlinked keyboards, working one at a time.

H. Electronic Packages 300SE, 310SE, 320SE

Size 5" x 8" x 24", weight 25 lbs. Provide calculation for keyboards 300K, 310K, and 320K respectively. Four output channels each serving one keyboard operation at a time. Four keyboard consoles may operate simultaneously when all output channels are utilized.

I. Keyboard Console 360K

Same in size and weight as 320K. Four extra storage registers added, each having capacity of 10 digits plus floating decimal point and sign. Stored numbers recallable at random and not affected by Clear All key. Store numbers by keying Store Reg 0, Store Reg 1, Store Reg 2, and Store Reg 3.

J. Electronic Package 360E

Same in size and weight as 320E. Four extra random-access storage registers added. Provides calculation for keyboard 360K; can support four interlinked keyboards, working one at a time. Keyboards 300K, 310K and 320K when used on Model 360, would render the extra storage registers inoperative. Keyboard 320KT or 360KT, one only, also acceptable.

K. Trigonometric Keyboards 320KT and 360KT

Correspond to 320K and 360K respectively in capability. Built-in hardwire programs provide single keystroke calculation of sin θ, cos θ, arcsin X, and arctan X. Accuracy of .00000001 for sinθ and cosθ from 0° to 90° and accuracy of .00001 degree for arcsin X and arctan X. Operable with 320E / 320SE and 360E electronic packages respectively. Extension cable to KT keyboard limited to 50' length. Keyboard size is 5-1/4" x 9-3/4" x 12", and weight 9 lbs.

L. Card Programmer CP-1

Size 4" x 4" x 8 1/2". Weight 4 lbs. Reads 80-step, two digit octal codes and automates calculator operations when used with Model 300K, 310K, 320K, or 360K keyboard. Operable when attached in series from electronic package to CP-1 Programmer to keyboard. Limited to single Programmer per output channel of electronic package. "START" and "CONTINUE" controls on Programmer casting. Snap-on cover assures electric contact. Accessories and supplies include Portapunch and stylus, pads of program work-sheets, and pre-scored program cards.

M. Extension Cables and Mounting Plates

30-conductor No. 26 wire extension cable to keyboards, .300 O.D., 80°C PVC. Standard lengths at 25', 50', 75', 100', 125', 150', 175' and 200', assembled with the 57-30360 Input Connector and 57-60360 Output Connector. The former connector may be left unassembled for convenience of on-site installation when pulling cables through conduits. Connector assembly diagram No. 5315 for soldering instructions. Wall-mount cover plate in stainless steel available on special request.

N. T-Connector

Single input, twin output assembly with branching and lock-on circuit module housed in plastic enclosure. One foot cable included. Maximum convenience and control of extension outlet when attached immediately to output connector of electronic package. Limited to two-tier, 3-connector, and 4-outlet maximum with "k" series keyboards. Limited to two-connector, three-outlet maximum when KT Keyboard or CP-1 Programmer is connected to first-tier output. PT Connector with priority output on one side available.

O. IC-1 Item Counter

The IC-1 is 5" x 5-1/4" x 3-5/8" and weighs 2 lbs. For counting the number of +, -, x, ÷, $\sqrt{x}$, and X^2 operations or any combination thereof. Factory-installed or retrofitted to any 300 Series Keyboard (300K, 310K, 320K, 360K, 320KT, 360KT, etc.). Specify IC-1 output connector to be added to Keyboard for counter attachment.

VIII. WARRANTY AND SERVICE

The Wang Electronic Calculator is warranted against defects in workmanship and materials for 90 days from installation of the equipment. Parts only are warranted for a period of one year, exclusive of labor.

Our liability under this warranty is limited to the repair and adjustment of the instrument within 90 days of the date it was delivered to the original purchaser and to the replacement of any defective parts, except readout tubes, transistors and fuses. Tubes, transistors, and fuses are subject to the standard RETMA guarantee.

Equipment returned to us for servicing must be carefully packed and shipped with transportation prepaid. WANG LABORATORIES, INC. does not assume any liability for consequential damage, and, in any event, WANG LABORATORIES, INC. liability shall in no case exceed the original purchase price of the product.

If any difficulty should develop with the instrument, please notify us, giving details of the problem as well as the model and serial number of the instrument. If the period of the warranty has expired, we shall estimate the repair charges and request your approval before work is begun.

IX. SAFE OPERATING CONDITIONS

Circuitry characteristics as well as voltage requirements of the calculator system and its components give rise to a number of physical as well as operational boundries. The following summary of limitations, when observed, will help insure safe and effective operation of the 300 Series Wang Electronic Calculator.

A. The keyboard must be turned off before attempting any connection or disconnection at the electronic package, an extension outlet, or at the CP-1 Programmer.

B. The keyboard must be primed by depressing the Clear All key before starting off on a new calculation.

C. It is not necessary to turn off the electronic package (simultaneous or non-simultaneous) during a work day. Precaution A and B, however, must be observed. The simultaneous electronic package must be primed (with the red button on the chassis) each time when power to this package is turned on. Then, each keyboard must also be primed.

D. For multiple-outlet installations, the non-simultaneous electronic package, or each of the four output channels of the simultaneous package, is limited to a two-tier, three (3) T-Connector maximum set up branching out to four (4) outlets for regular keyboards (300K, 310K, 320K, 360K).

E. The branching maximum is limited to a two (2) T-Connector, three (3) outlet set up whenever a CP-1 Programmer, or a KT Trigonometric keyboard is to be attached. Further, either of these items must be connected to a first-tier or primary T-Connector. This rule also applies when a priority PT-Connector is attached.

F. Due to power requirements the extension cable from the electronic package to the CP-1 Programmer or to the KT Trigonometric keyboard is limited to a 50' maximum.

G. There is a limitation of 200' maximum for extension cables to regular keyboard outlets other than that cited in F above.

H. Keyboard extension cables cannot be placed in a conduit which is already occupied by an AC power line. Conduits should be used to protect extension cables which are subjected to indefinite exposure outdoors in extreme tropical conditions of saturation humidity and high ambient temperature.

I. The CP-1 Programmer and the KT Trigonometric keyboard cannot be used in series on a non-simultaneous electronic package, or on the same output channel of a simultaneous electronic package.

J. When using a CP-1 Programmer, care should be taken to avoid handling or otherwise bending the contact points. The program card must be seated properly between and under the two guides on the sides.

K. Prior to the start of a trigonometric calculation on the KT keyboard, the Adder on the right should be cleared.

L. The 360K Keyboard should not be attached to the same T-Connector with a 320K Keyboard. When this occurs the 360K Keyboard would lose the use of the extra storage registers. Two 360K Keyboards attached to a T-Connector would function normally.

M. The Clear All cannot be used to stop the programmed trigonometric calculation on a Simultaneous calculator system. If the Clear All key is depressed in the middle of a trigonometric operation, the entire SE simultaneous package would be affected and operations on all keyboards would be interrupted. When this occurs the SE Electronic Package must be re-primed and each keyboard must be cleared before the re-start of operations.

N. The entry accumulator, the multiple accumulator and the product accumulator should all be turned off while doing the trigonometric operations on the KT keyboard: Otherwise, the results will be wrong.

O. The simplest way to interrupt a programmed calculation with the CP-1 card programmer would be to open the programmer cover and then clear the operations by pressing the Clear All key.

APPENDIX - REFERENCE MATHEMATICAL EXPRESSIONS

A. Rules of Exponent

1. $X^m \cdot X^n = X^{m+n}$ — $3^4 \cdot 3^2 = 3^{4+2} = 3^6 = 729$
2. $X^m / X^n = X^{m-n}$ — $\frac{3^4}{3^2} = 3^{4-2} = 3^2 = 9$
3. $(X^m)^n = X^{mn}$ — $(3^4)^2 = 3^{4\times2} = 3^8 = 6561$
4. $\sqrt[n]{X^m} = X^{m/n}$ — $\sqrt[2]{3^4} = 3^{\frac{4}{2}} = 3^2 = 9$
5. $X^o = 1 \ (X \neq 0)$
6. $X^{-n} = 1/X^n$
7. $\sqrt[n]{X} = X^{1/n} \ (n \neq 0)$

B. Logarithm

1. If $X = 10^y$, $y = \text{Log}_{10}X$
2. If $X = a^y$, $y = \text{Log}_a X$
3. $\text{Log}_a X = \text{Log}_{10}X / \text{Log}_{10}a$
4. $e = \lim_{n \to \infty} (1 + \frac{1}{n})^n = 2.71828\ 18284\ 59045\ \ldots$ (By definition)
5. If $X = \text{Log}_{10}X = \text{Log}_e X / \text{Log}_e 10$
6. $\text{Log}\, X = \text{Log}_{10}X = \text{Log}_e X / \text{Log}_e 10$
7. $a^x = e^{x \text{Log}_e a}$

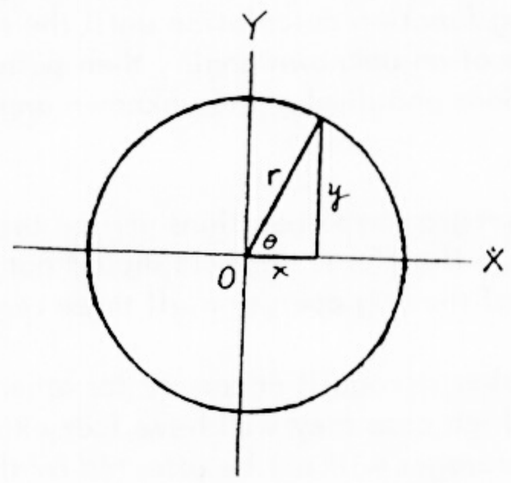
For example, $9^{3.15} = e^{3.15 \text{Log}_e 9}$ The keyboard operations are:

9 $\text{Log}_e X$ Enter 3.15 X= e^x. Read + 1013.593705

Log 2 = $\text{Log}_{10}2 = \text{Log}_e 2 / \text{Log}_e 10$ = .3010299957. Keyboard operations are:

10 $\text{Log}_e X$ +AL 2 $\text{Log}_e X$ Enter REAL += Read + .3010299957.

C. Basic Trigonometric Functions and Indentities



1. $\sin \theta = y/r$
2. $\cos \theta = x/r$
3. $\sin^2\theta + \cos^2 \theta = 1$
4. $\tan \theta = \sin \theta / \cos \theta$
5. $\text{ctn } \theta = \cos \theta / \sin \theta$
6. $\sec \theta = 1/\cos \theta$
7. $\csc \theta = 1/\sin \theta$
8. $1 + \tan^2 \theta = \sec^2 \theta$
9. $\text{ctn}^2 \theta + 1 = \csc^2 \theta$
10. If $a = \sin \theta$, $\theta = \text{arc sin } a$ or $\sin^{-1} a$
11. If $b = \tan \theta$, $\theta = \text{arc tan } b$ or $\tan^{-1} b$
12. If $\sin \theta = a$, $\theta = \text{arc tan} \left(\frac{a}{\sqrt{1 - a^2}} \right)$

D. Reference Numbers

1. Exponential Function

x	e^x	e^{-x}
0.100	1.10517 09180	0.90483 74180
0.250	1.28402 54166	0.77880 07830
0.500	1.64872 12707	0.60653 06597
0.750	2.11700 00166	0.47236 65507
1.000	2.71828 18284	0.36787 94411
10	22026. 46579	0.00004 53999
20	(8) 4.85165 19540	(-9) 2.06115 36224
40	(17) 2.35385 26683	
80	(34) 5.54062 23843	
99	(42) 9.88903 03193	

2. $\pi = 3.1415\ 92653\ 58979 \ldots$
3. $\text{Log}_e 10 = 2.30258\ 50929\ 94045 \ldots$
   For common logarithms, find the $\log_e x$ and divide the result by above constant.

BRIEF OPERATING INSTRUCTIONS OF 320 KT, 360 KT KEYBOARDS

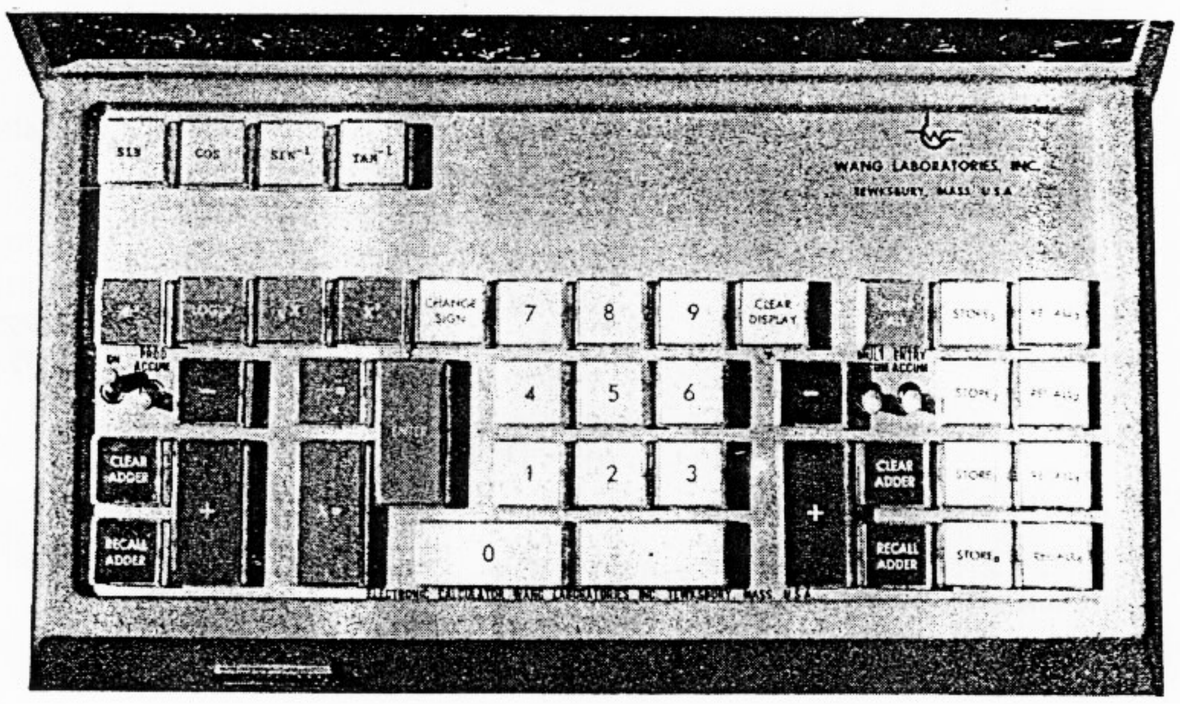
These 320KT and 360KT trig keyboards are designed to be used in conjunction with the 320E and 360E electronics packages respectively. They are essentially keyboards with built-in programmers to generate sine, cosine, arc sine, and arc tangent. To get sine or cosine of an angle, index the angle first in degrees and decimals and push either the sine or cosine key. The program will start the trig function calculation until the result is displayed. Similarly, after indexing the tangent or sine of an unknown angle, then pushing the $\sin^{-1}$ or $\tan^{-1}$ key, the program will generate these functions and display the unknown angle in degrees and fractions at the end of the programmed operations.

These four programmed operations utilize the right Adder register, the left Adder register, and the log register. Therefore, numbers should not be stored in these registers before the trig operation. At the end of the trig operation all three registers are cleared and they can be reused again.

If extra number storage is necessary for other operations, we recommend the use of a 360E and a 360KT in which case they will have four extra storages available to store the temporary result. These four storages will not be affected by the trig operations and will not be cleared by the CLEAR ALL key.

We do not recommend the use of these keyboards on the 320SE electronics package. A programmed calculation not only will tend to slow down the operations of the other channels, but may interrupt the other three keyboard users if the KT operator inadvertently pushes the CLEAR ALL key while the trig program is operating. The system would then have to be re-primed at the SE package.

The range of the angle in the sine, cosine function is 0°-90° and the accuracy of the answer is .00000001. The range of the arc sine and arc tangent is also 0°-90° for the answer and the accuracy is .00001. The entry accumulator, the multiply accumulator and product accumulator should be turned off while doing the trig operations; otherwise, the results will be wrong. If any figure had been stored in the right Adder, it must be cleared before starting any trig function operation.



360KT Trigonometric Keyboard

Revised 5-67 5K
700 0042