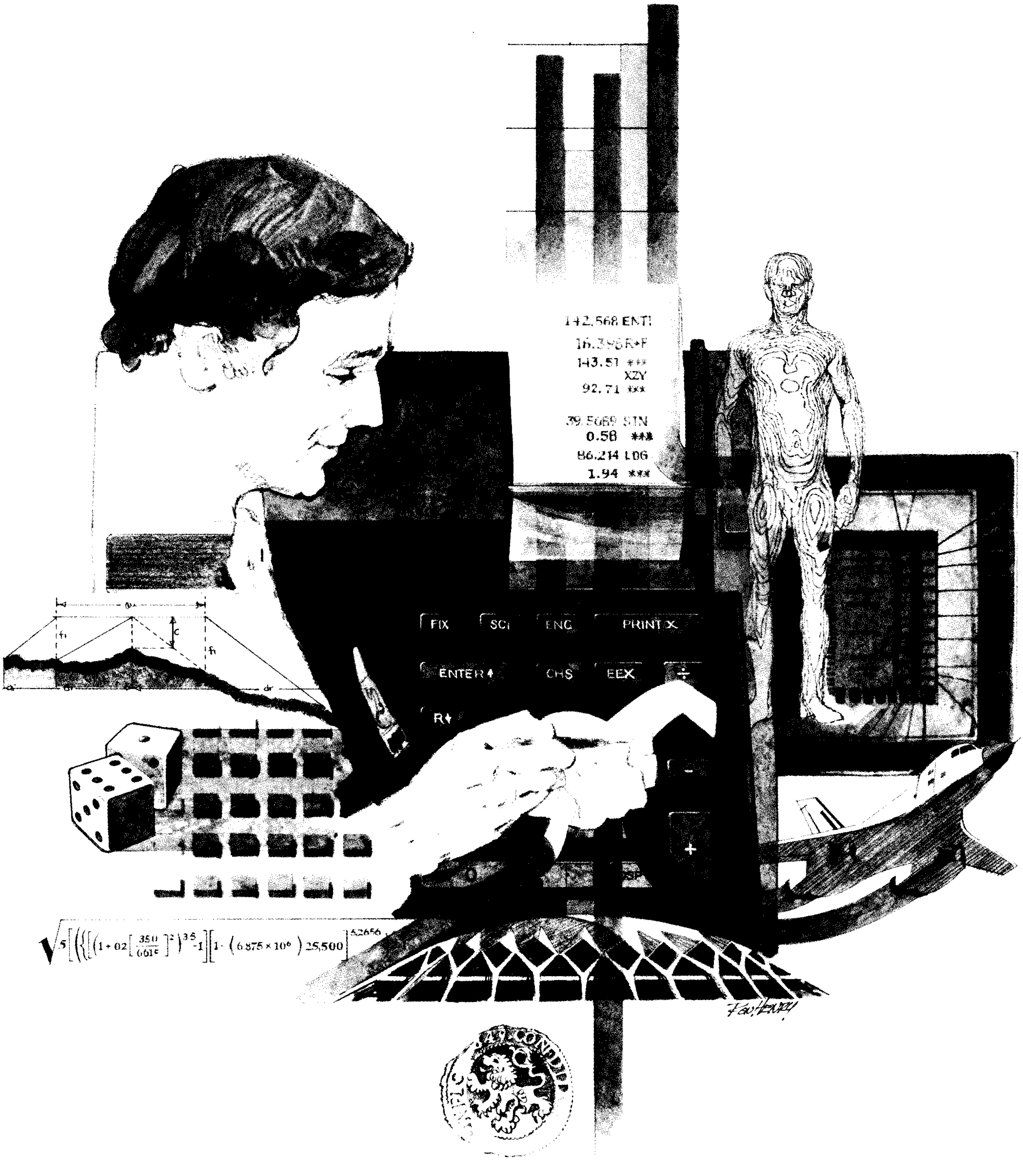
HEWLETT-PACKARD

HP-67/HP-97

Users' Library Solutions

EE (Lab)



INTRODUCTION

In an effort to provide continued value to it's customers, Hewlett-Packard is introducing a unique service for the HP fully programmable calculator user. This service is designed to save you time and programming effort. As users are aware, Programmable Calculators are capable of delivering tremendous problem solving potential in terms of power and flexibility, but the real genie in the bottle is program solutions. HP's introduction of the first handheld programmable calculator in 1974 immediately led to a request for program **solutions** — hence the beginning of the HP-65 Users' Library. In order to save HP calculator customers time, users wrote their own programs and sent them to the Library for the benefit of other program users. In a short period of time over 5,000 programs were accepted and made available. This overwhelming response indicated the value of the program library and a Users' Library was then established for the HP-67/97 users.

To extend the value of the Users' Library, Hewlett-Packard is introducing a unique service—a service designed to save you time and money. The Users' Library has collected the best programs in the most popular categories from the HP-67/97 and HP-65 Libraries. These programs have been packaged into a series of low-cost books, resulting in substantial savings for our valued HP-67/97 users.

We feel this new software service will extend the capabilities of our programmable calculators and provide a great benefit to our HP-67/97 users.

A WORD ABOUT PROGRAM USAGE

Each program contained herein is reproduced on the standard forms used by the Users' Library. Magnetic cards are not included. The Program Description I page gives a basic description of the program. The Program Description II page provides a sample problem and the keystrokes used to solve it. The User Instructions page contains a description of the keystrokes used to solve problems in general and the options which are available to the user. The Program Listing I and Program Listing II pages list the program steps necessary to operate the calculator. The comments, listed next to the steps, describe the reason for a step or group of steps. Other pertinent information about data register contents, uses of labels and flags and the initial calculator status mode is also found on these pages. Following the directions in your HP-67 or HP-97 **Owners' Handbook and Programming Guide,** "Loading a Program" (page 134, HP-67; page 119, HP-97), key in the program from the Program Listing I and Program Listing II pages. A number at the top of the Program Listing indicates on which calculator the program was written (HP-67 or HP-97). If the calculator indicated differs from the calculator you will be using, consult Appendix E of your **Owner's Handbook** for the corresponding keycodes and keystrokes converting HP-67 to HP-97 keycodes and vice versa. No program conversion is necessary. The HP-67 and HP-97 are totally compatible, but some differences do occur in the keycodes used to represent some of the functions.

A program loaded into the HP-67 or HP-97 is not permanent—once the calculator is turned off, the program will not be retained. You can, however, permanently save any program by recording it on a blank magnetic card, several of which were provided in the Standard Pac that was shipped with your calculator. Consult your **Owner's Handbook** for full instructions. A few points to remember:

> The Set Status section indicates the status of flags, angular mode, and display setting. After keying in your program, review the status section and set the conditions as indicated before using or permanently recording the program.
>
> REMEMBER! To save the program permanently, **clip** the corners of the magnetic card once you have recorded the program. This simple step will protect the magnetic card and keep the program from being inadvertently erased.

As a part of HP's continuing effort to provide value to our customers, we hope you will enjoy our newest concept.

TABLE OF CONTENTS

Program Description I

Program Title WIRE TABLE

Contributor's Name W. J. HOPKINS
Address 13668 Sunburst Street
City Arleta State CA Zip Code 91331

Program Description, Equations, Variables Calculates the wire diameter, circular area and linear resistance given any wire (AWG) gage from 0 up. Area and diameter are in circular mils (.001 inch) Will also find smallest usable AWG given either 1) wire length and max allowable resistance, or 2) required cross-sectional area and allowable current. By keying in one variable, the effect of changing the other may be seen. The following approximate equation is used:

$A \doteq 105530 \times 0.79306^{AWG}$ $R = rl/A$

A=Area in c.m. r=resistivity for copper=10575 ohm-c.m./1000ft
l=length of wire in ft. R=total resistance in ohms AWG=wire gage
To use this program for other than copper wire, insert the appropriate value for r in program steps 7-11 and 52-57. Value used in steps 52-57 is resistivity per foot, steps 7-11 use resistivity per 1000 feet.

Operating Limits and Warnings No safety design margins are built in. Accuracy of area equation is within .02% for large wire and ± 2 mils for small wire. Side two may be left unprotected to enable recording of data.

Registers 0-9, S1- S9 and I are available for user storage

Program Description II

Sketch(es)

Sample Problem(s) (A) determine the cross-sectional area, diameter and resistance per 1000 feet for 22 AWG wire.

(B) determine the smallest usable wire size for a 5000 foot run when the max allowable resistance is 14.0 ohms.

(C) determine the smallest usable wire gage if the cross-sectional area/amp must be 850 c.m. and carry 7.6 amps.

Solution(s)

```
(A): 22 (A)   22
        (C)   642.8 c.m.
        (D)   25.4   m.
        (B)   16.4502 ohms/Kft

(B): 5000 (E)   5000.0 ft
       14 (b)   14.0000 ohms
          (a)   14 AWG

(C): 850 (c)   850.00 c.m./Amp
     7.6 (d)   7.60 Amps
         (a)   12 AWG
```

Reference(s) The Radio Amateurs Handbook, 1974 (ARRL)
Standard Electrical Engineering Handbooks

User Instructions

1	→AWG	R_{max}	A_{xsect}/amp	I_{max}	START	2
	AWG	Ω/kft	A_{xsect}	DIA_{cm}	L_{ft}	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load Side 1				
2	Optional: clear all storage registers		f	E	0
	To calculate ohms/1000ft, cross-sectional area, or diameter:				
3	Enter wire gage (AWG)	AWG	A		AWG
4	Compute and display ohms/1000 ft		B		ohms/kft
	or				
4	Compute and display cross-sectional A		C		A_{xsect}
	or				
4	Compute and display diameter		D		Diameter
	To calculate smallest usable AWG given the cross-sectional area/amp and max allowable current:				
5	Enter cross-sectional area/amp	A_{xsect}/amp	f	C	area/amp
6	Enter maximum current in amps	I_{max}	f	D	I_{amps}
7	Compute smallest usable AWG		f	A	AWG
	To calculate smallest usable AWG given wire length and max allowable resistance:				
8	Enter wire length in feet	ft	E		feet
9	Enter max allowable resistance	R_{max}	f	B	Rmax
10	Compute smallest usable AWG		f	A	AWG

LABELS

A AWG	B ohms/kft	C Axsect	D DIAcm	E Lft
a → AWG	b Rmax	c Axset/amp	d Iamps	e START
0	1	2	3	4
5	6	7	8	9

FLAGS

Flag	
0	
1	
2	used
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL A	31 25 11	
	DSP 0	23 00	
	STO A	33 11	
	h RTN	35 22	
	f LBL B	31 25 12	
	DSP 4	23 04	
	1	01	
	0	00	
	5	05	
010	7	07	
	5	05	
	f GSB 1	31 22 01	
	÷	81	
	h RTN	35 22	
	f LBL C	31 25 13	
	DSP 1	23 01	
	f GSB 1	31 22 01	
	h RTN	35 22	
	f LBL D	31 25 14	
020	DSP 1	23 01	
	f GSB 1	31 22 01	
	f $\sqrt{x}$	31 54	
	h RTN	35 22	
	f LBL 1	31 25 01	
	.	83	
	7	07	
	9	09	
	3	03	
	0	00	
030	6	06	
	RCL A	34 11	
	h y^x	35 63	
	1	01	
	0	00	
	5	05	
	5	05	
	3	03	
	0	00	
	x	71	
040	h RTN	35 22	
	g LBL b	32 25 12	
	DSP 4	23 04	
	STO B	33 12	
	h RTN	35 22	
	f LBL E	31 25 15	
	DSP 1	23 01	
	STO E	33 15	
	h RTN	35 22	
	g LBL a	32 25 11	
050	h F? 2	35 71 02	
	GTO 3	22 03	
	1	01	
	0	00	
	.	83	
	5	05	
	7	07	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	5	05	
	RCL E	34 15	
	X	71	
060	RCL B	34 12	
	÷	81	
	f LBL 2	31 25 02	
	f LOG	31 53	
	1	01	
	0	00	
	5	05	
	5	05	
	3	03	
	0	00	
070	f LOG	31 53	
	−	51	
	.	83	
	7	07	
	9	09	
	3	03	
	0	00	
	6	06	
	f LOG	31 53	
	÷	81	
080	f INT	31 83	
	DSP 0	23 00	
	h RTN	35 22	
	g LBL c	32 25 13	
	DSP 2	23 02	
	STO C	33 13	
	h SF 2	35 51 02	
	h RTN	35 22	
	g LBL d	32 25 14	
	DSP 2	23 02	
090	STO D	33 14	
	h SF 2	35 51 02	
	h RTN	35 22	
	f LBL 3	31 25 03	
	RCL C	34 13	
	RCL D	34 14	
	X	71	
	GTO 2	22 02	
	g LBL e	32 25 15	
	f CL REG	31 43	
100	f P⇄S	31 42	
	f CL REG	31 43	
	0	00	
	h RTN	35 22	
	R/S	84	
110			

REGISTERS

0	1	2	3	4	5	6	7	8	9

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
AWG	Rmax	circ-mils/A	Iamps	Lft	

Program Description I

Program Title *OHMS LAW*

Contributor's Name *Jack B. Buster*

Address *P. O. Box 8062*

City *Anchorage,* **State** *Alaska* **Zip Code** *99508*

Program Description, Equations, Variables *Given two variables (Either watts, ohms, volts or amps) the program will calculate the other two according to one of the following formulas:*

$$I = \frac{E}{R} \qquad P = I^2 R$$

$$P = IE \qquad R = \frac{E^2}{P}$$

Operating Limits and Warnings

NONE

Program Description II

Sketch(es)

Sample Problem(s)

(1) Given 12 amps at 78 volts, find watts and resistance.

(2) Calculate power consumption at 12 volts for 1/4 to 1 ohm at 1/4 ohm intervals.

Solution(s) *Keystrokes:*

(1) [A] [1] [2] [C] [7] [8] [D] [B] =936 watts [E]= 6.5 ohms

(2) [A] [1] [2] [D] [.] [2] [5] [E] = 576 watts [.] [5] [E][B] =288 watts

[.] [7] [5] [E][B] = 192 watts [1][E] [B] = 144 watts

Reference(s)

User Instructions

1					2
		P	I	E	R
	START	WATTS	AMPS	VOLTS	OHMS

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load side 1 of card				0.00
2	Initialize		A		0.00
3	Enter first variable	P, I E or R			
4	Enter second variable	P,I,E or R			
5	Calculate third quantity				
6	Calculate fourth quantity				
7	Return to (4) for new case using same first variable				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLB	21 12	
002	STOB	35 12	
003	F3?	16 23 03	
004	RTN	24	
005	RCLC	36 13	
006	X=0?	16-43	
007	GTO0	22 00	
008	RCLD	36 14	
009	X=0?	16-43	Solve P=IE
010	GTO1	22 01	
011	x	-35	
012	STOB	35 12	
013	RTN	24	
014	*LBLC	21 13	
015	STOC	35 13	
016	F3?	16 23 03	
017	RTN	24	
018	RCLB	36 12	
019	X=0?	16-43	
020	GTO2	22 02	
021	RCLD	36 14	
022	X=0?	16-43	Solve I=P/E
023	GTO3	22 03	
024	÷	-24	
025	STOC	35 13	
026	RTN	24	
027	*LBLD	21 14	
028	STOD	35 14	
029	F3?	16 23 03	
030	RTN	24	
031	RCLB	36 12	
032	X=0?	16-43	
033	GTO4	22 04	
034	RCLC	36 13	Solve E = P/I
035	X=0?	16-43	
036	GTO5	22 05	
037	÷	-24	
038	STOD	35 14	
039	RTN	24	
040	*LBLE	21 15	
041	STOE	35 15	
042	F3?	16 23 03	
043	RTN	24	
044	RCLB	36 12	
045	X=0?	16-43	
046	GTO6	22 06	
047	RCLC	36 13	Solve $R=P/I^2$
048	X=0?	16-43	
049	GTO7	22 07	
050	X^2	53	
051	÷	-24	
052	RTN	24	
053	*LBL0	21 00	
054	RCLD	36 14	
055	X^2	53	Solve $P=E^2/R$
056	RCLE	36 15	
057	÷	-24	
058	STOB	35 12	
059	RTN	24	
060	*LBL1	21 01	
061	RCLC	36 13	
062	X^2	53	Solve $P=I^2R$
063	RCLE	36 15	
064	x	-35	
065	STOB	35 12	
066	RTN	24	
067	*LBL2	21 02	
068	RCLD	36 14	
069	RCLE	36 15	Solve I=E/R
070	÷	-24	
071	STOC	35 13	
072	RTN	24	
073	*LBL3	21 03	
074	RCLB	36 12	
075	RCLE	36 15	Solve $I=\sqrt{P/R}$
076	÷	-24	
077	$\sqrt{X}$	54	
078	STOC	35 13	
079	RTN	24	
080	*LBL4	21 04	
081	RCLC	36 13	
082	RCLE	36 15	Solve E=IR
083	x	-35	
084	STOD	35 14	
085	RTN	24	
086	*LBL5	21 05	
087	RCLB	36 12	
088	RCLE	36 15	$E=\sqrt{RP}$
089	x	-35	
090	$\sqrt{X}$	54	
091	STOD	35 14	
092	RTN	24	
093	*LBL6	21 06	
094	RCLD	36 14	
095	RCLC	36 13	
096	÷	-24	Solve R=E/I
097	STOE	35 15	
098	RTN	24	
099	*LBL7	21 07	
100	RCLD	36 14	
101	X^2	53	Solve $R=E^2/P$
102	RCLB	36 12	
103	÷	-24	
104	STOE	35 15	
105	RTN	24	
106	*LBLA	21 11	Initialize
107	CLRG	16-53	
108	CLX	-51	
109	RTN	24	
110	R/S	51	

REGISTERS

0	1	2	3	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
	WATTS	AMPS	VOLTS	OHMS	

Program Description I

Program Title REACTANCE CHART (NINE EQUATIONS)

Contributor's Name H. Peter Meisinger

Address c/o Versitron, Inc. 6310 Chillum Pl, N.W.

City Washington, D.C. State Zip Code 20011

Program Description, Equations, Variables

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$f = \frac{1}{2\pi C X_C}$$

$$f = \frac{X_L}{2\pi L}$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_L = 2\pi f L$$

$$L = \frac{X_L}{2\pi f}$$

$$L = \frac{1}{4\pi^2 f^2 C}$$

$$C = \frac{1}{2\pi f X_C}$$

$$C = \frac{1}{4\pi^2 f^2 L}$$

Operating Limits and Warnings

Program Description II

Sketch(es)

Sample Problem(s)

(1) What is the resonant frequency of a tank circuit consisting of a 250 pf capacitor and a 5 microhenry inductor?

(2) At what frequency does a 100 pf capacitor have a reactance of 100 ohms?

(3) At what frequency does a .02 henry inductor have a reactance of 16 ohms?

(4) What is the reactance of a 250 pf capacitor at 3.2 Mhz?

(5) What is the reactance of a 10 henry inductor at 60 hz?

(6) What is the value of an inductor whose reactance is 4 ohms at 300 hz?

(7) What is the value of an inductor that resonates with 250 pf at 3.2 Mhz?

(8) What is the value of a capacitor whose reactance is 4 ohms at 300 hz?

(9) What is the value of a capacitor that resonates with 12 h at 120 hz?

Solution(s)

(1) 250 pf & 5 μh = 4 501 581.58Hz or 4 501.582KHz

(2) 100 ohms & 100 pf = 15 915 494.31hz = 15 915.494KHz

(3) 16 ohms & .02 hy = 127.32hz

(4) 3.2Mhz & 250 pf = 198.94 ohms

(5) 60 hz & 10 h = 3 769.91

(6) 4 ohms & 300 hz = 2.1221 mH

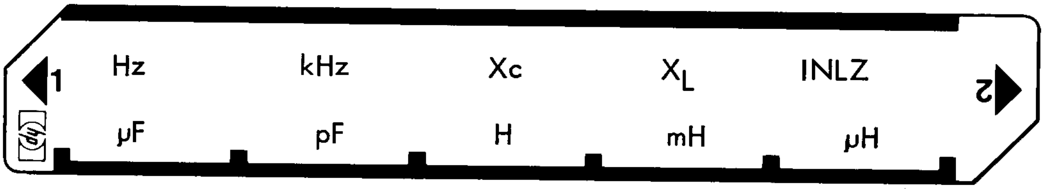
(7) 3.2Mhz & 250 pf = 9.894 6 μh

(8) 4 ohms & 300 hz = 132.629 12μfarads

(9) 120 hz & 12 h = 0.146 59μfarads

Reference(s)

User Instructions



STEP	INSTRUCTIONS		INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load side 1 and 2 of Program Card					
2	Initialize			E		
3	Input any two knowns					
	Frequency:	Hertz	Hz	A		
		Kilohertz	kHz	B		
		Megahertz	MHz	CHS	A or B	
	Capacitance:	Microfarads	μF	f	a	
		Picofarads	pF	f	b	
	Inductance:	Henries	H	f	c	
		Millihenries	mH	f	d	
		Microhenries	μH	f	e	
	Capacitive Reactance		Xc (ohms)	C		
	Inductive Reactance		X_L (ohms)	D		
4	Compute Unknowns					
	Frequency:	Hertz		A		Hz
		Kilohertz		B		kHz
		Megahertz		CHS	A or B	MHz
	Capacitance:	Microfarads		f	a	μF
		Picofarads		f	b	pF
	Inductance:	Henries		f	c	H
		Millihenries		f	d	mH
		Microhenries		f	e	μH
	Capacitive Reactance			C		Xc (ohms)
	Inductive Reactance			D		X_L (ohms)
5	Recall Inputs:	Frequency		RCL1		f Hz
		Capacitance		RCL2		C Farads
		Inductance		RCL3		L Henries
		Capacitive Reactance		RCL4		Xc Ohms
		Inductive Reactance		RCL5		X_L Ohms
	Computed data is automatically stored so that subse-					
	quent computations can be made without reentry.					
	NOTE: for new computation go to Step 2.					

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLE	21 15	
002	CLRG	16-53	
003	R/S	51	
004	*LBLA	21 11	
005	X<0?	16-45	
006	GTO2	22 02	
007	1	01	
008	STOI	35 46	
009	X⇄Y	-41	
010	F3?	16 23 03	
011	GTO0	22 00	
012	DSP2	-63 02	
013	RCL2	36 02	C
014	RCL3	36 03	L
015	×	-35	LC
016	√X	54	$\sqrt{LC}$
017	Pi	16-24	
018	×	-35	
019	2	02	
020	×	-35	$2\pi\sqrt{LC}$
021	X≠0?	16-42	$\frac{1}{2\pi\sqrt{LC}}$
022	1/X	52	
023	X≠0?	16-42	
024	STO1	35 01	
025	X≠0?	16-42	
026	RTN	24	
027	2	02	2
028	Pi	16-24	π
029	×	-35	2π
030	RCL2	36 02	C
031	×	-35	$2\pi C$
032	RCL4	36 04	Xc
033	×	-35	$2\pi CXc$
034	X≠0?	16-42	$\frac{1}{2\pi CXc}$
035	1/X	52	
036	X≠0?	16-42	
037	STO1	35 01	
038	X≠0?	16-42	
039	RTN	24	
040	RCL5	36 05	X_L
041	2	02	
042	Pi	16-24	π
043	×	-35	2π
044	RCL3	36 03	L
045	×	-35	$2\pi L$
046	÷	-24	$\frac{XL}{2\pi L}$
047	STO1	35 01	
048	RTN	24	
049	*LBLB	21 12	
050	X<0?	16-45	
051	GTO2	22 02	
052	EEX	-23	
053	3	03	
054	×	-35	
055	GSBA	23 11	
056	EEX	-23	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	3	03	
058	÷	-24	
059	DSP3	-63 03	
060	RTN	24	
061	*LBL0	21 00	Store-Compute decision
062	STOi	35 45	
063	RTN	24	
064	*LBL2	21 02	MHz LBL A or B
065	CHS	-22	
066	EEX	-23	
067	6	06	
068	×	-35	
069	GSBA	23 11	
070	EEX	-23	
071	6	06	
072	÷	-24	
073	DSP3	-63 03	
074	RTN	24	
075	*LBLc	21 16 13	H
076	3	03	
077	STOI	35 46	
078	X⇄Y	-41	
079	F3?	16 23 03	
080	GTO0	22 00	
081	DSP4	-63 04	
082	RCL5	36 05	X_L
083	RCL1	36 01	f
084	2	02	
085	Pi	16-24	
086	×	-35	2π
087	×	-35	
088	÷	-24	$\frac{X_L}{2\pi f}$
089	STO3	35 03	
090	X≠0?	16-42	
091	RTN	24	
092	4	04	4
093	Pi	16-24	π
094	X²	53	$4\pi^2$
095	×	-35	
096	RCL1	36 01	f
097	X²	53	f^2
098	×	-35	$4\pi^2 f^2$
099	RCL2	36 02	C
100	×	-35	$4\pi^2 f^2 C$
101	1/X	52	$\frac{1}{4\pi^2 f^2 C}$
102	STO3	35 03	
103	RTN	24	
104	*LBLd	21 16 14	
105	EEX	-23	
106	3	03	
107	÷	-24	
108	GSBc	23 16 13	
109	EEX	-23	
110	3	03	
111	×	-35	
112	RTN	24	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	f	C	L	Xc	X_L				

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	*LBLe	21 16 15	μH
114	EEX	-23	
115	6	06	
116	÷	-24	
117	GSBc	23 16 13	
118	EEX	-23	
119	6	06	
120	×	-35	
121	RTN	24	
122	*LBLD	21 14	X_L
123	5	05	
124	STOI	35 46	
125	X⇄Y	-41	
126	F3?	16 23 03	
127	GTO0	22 00	
128	DSP2	-63 02	
129	2	02	
130	Pi	16-24	π
131	×	-35	2π
132	RCL1	36 01	f
133	×	-35	$2\pi f$
134	RCL3	36 03	L
135	×	-35	$2\pi fL$
136	STO5	35 05	X_L
137	RTN	24	
138	*LBLC	21 13	
139	4	04	
140	STOI	35 46	
141	X⇄Y	-41	
142	F3?	16 23 03	
143	GTO0	22 00	
144	DSP2	-63 02	
145	2	02	2
146	Pi	16-24	π
147	×	-35	2π
148	RCL1	36 01	f
149	×	-35	$2\pi f$
150	RCL2	36 02	C
151	×	-35	$2\pi fC$
152	1/X	52	$\frac{1}{2\pi fC}$
153	STO4	35 04	
154	RTN	24	
155	*LBL1	21 01	Farads
156	2	02	
157	STOI	35 46	
158	X⇄Y	-41	
159	F3?	16 23 03	
160	GTO0	22 00	
161	DSP5	-63 05	
162	2	02	2
163	Pi	16-24	π
164	×	-35	2π
165	RCL1	36 01	f
166	×	-35	$2\pi f$
167	RCL4	36 04	X_c
168	×	-35	$2\pi fX_c$
169	X≠0?	16-42	$\frac{1}{2\pi fX_c}$
170	1/X	52	
171	X≠0?	16-42	
172	STO2	35 02	
173	X≠0?	16-42	
174	RTN	24	
175	4	04	4
176	Pi	16-24	π
177	X²	53	π^2
178	×	-35	$4\pi^2$
179	RCL1	36 01	f
180	X²	53	f^2
181	×	-35	$4\pi^2 f^2$
182	RCL3	36 03	L
183	×	-35	$4\pi^2 f^2 L$
184	1/X	52	
185	STO2	35 02	
186	RTN	24	
187	RTN	24	μF
188	*LBLa	21 16 11	
189	EEX	-23	
190	6	06	
191	÷	-24	
192	GSB1	23 01	
193	EEX	-23	
194	6	06	
195	×	-35	
196	RTN	24	pF
197	*LBLb	21 16 12	
198	EEX	-23	
199	1	01	
200	2	02	
201	÷	-24	
202	GSB1	23 01	
203	EEX	-23	
204	1	01	
205	2	02	
206	×	-35	
207	RTN	24	
210			
220			

LABELS

A Hz	B kHz	C Xc	D X_L	E Initialize
a μF	b pF	c H	d mH	e H
0 Sto-Comp	1 Farads	2 MHz	3	4
5	6	7	8	9

FLAGS

0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☐	DEG	☐	FIX	☐
1	☐	☐	GRAD	☐	SCI	☐
2	☒	☐	RAD	☐	ENG	☐
3	☒	☐			n	varies

Program Description I

Program Title COIL CALCULATIONS

Contributor's Name RICHARD L. KENNEDY

Address 5633 HEMMINGWAY

City EL PASO **State** TEXAS **Zip Code** 79924

Program Description, Equations, Variables PROGRAM CALCULATES SELF-INDUCTANCE OF FOUR TYPES OF INDUCTORS, OR REQUIRED NUMBER OF TURNS FOR THREE TYPES WHEN THE REMAINING PARAMETERS ARE GIVEN.

EQUATIONS USED ARE:

FOR SINGLE-LAYER COIL:

$$L = \frac{r^2 N^2}{9r + 10\ell}$$

$$N = \frac{\sqrt{L(9r+10\ell)}}{r}$$

FOR MULTI-LAYER COIL:

$$L = \frac{0.8\, r^2 N^2}{6r + 9\ell + 10b}$$

$$N = 1.118 \frac{\sqrt{L(6r+9\ell+10b)}}{r}$$

FOR SINGLE-LAYER SPIRAL COIL:

$$L = \frac{r^2 N^2}{8r + 11b}$$

$$N = \frac{\sqrt{L(8r+11b)}}{r}$$

ALL DIMENSIONS ARE IN INCHES. L IS IN MICROHENRIES. f IS IN HERTZ. ρ IS IN OHM-CM $\times 10^{-6}$. N IS THE NUMBER OF TURNS. δ WAS DEFINED IN REFERENCE 2 BY A GRAPH. TWO EQUATIONS WERE FOUND TO FIT FOR $x \leq 4.5$ AND $x \geq 4.5$.

FOR STRAIGHT WIRE:

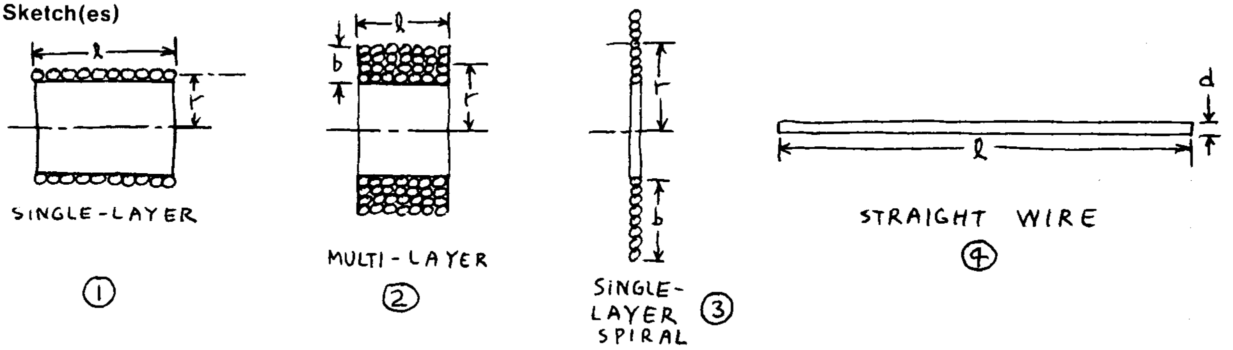
$$L = 0.00508\,\ell \left(\ln \frac{4\ell}{d} - 1 + \mu\delta + \frac{d}{2\ell}\right)$$

WHERE $\mu = 1$ FOR COPPER, $\delta = 0.25 - x^2/202.5$ FOR $x \leq 4.5$, $\delta = 10^{-(\log_{10} x + 0.155)}$ FOR $x \geq 4.5$, AND $x = 0.3569\, d \sqrt{\mu f/\rho} = 0.272\, d\sqrt{f}$ FOR COPPER WIRE

Operating Limits and Warnings EQUATIONS USED ARE APPROXIMATIONS ACCURATE TO ABOUT 1% FOR MOST SMALL AIR-CORE COILS. ACCURACY OF FIRST TWO SETS DETERIORATES FOR WINDING LENGTH MUCH DIFFERENT FROM THE DIAMETER ($2R \ll \ell$ OR $\ell \ll 2R$). EQUATIONS ARE VALID ONLY FOR NON-FERROUS MATERIALS, EXCEPT THAT THE EQUATION FOR INDUCTANCE OF A STRAIGHT WIRE IS FURTHER LIMITED TO COPPER WIRE, UNLESS A DIFFERENT VALUE OF RESISTIVITY (ρ) IS USED TO DEFINE x.

Program Description II

Sketch(es)



Sample Problem(s)

1. GIVEN r, ℓ, N, CALCULATE L FOR SINGLE - LAYER COIL.
2. GIVEN r, ℓ, L, CALCULATE N FOR SINGLE - LAYER COIL.
3. GIVEN r, ℓ, b, N, CALCULATE L FOR MULTI-LAYER COIL.
4. GIVEN r, ℓ, b, L, CALCULATE N FOR MULTI-LAYER COIL.
5. GIVEN r, b, N, CALCULATE L FOR SPIRAL COIL.
6. GIVEN r, b, L, CALCULATE N FOR SPIRAL COIL.
7. GIVEN ℓ, d, f, CALCULATE L FOR STRAIGHT WIRE.

DATA: r = 0.5 INCHES FOR ALL PROBLEMS USING THIS QUANTITY.
ℓ = 2.0 INCHES FOR ALL PROBLEMS USING THIS QUANTITY.
b = 0.8 INCHES FOR ALL PROBLEMS USING THIS QUANTITY.
N = 50 TURNS FOR ALL PROBLEMS USING THIS QUANTITY.
L = 100 μH (MICROHENRIES) FOR ALL PROBLEMS USING THIS QUANTITY.
d = 0.02010 INCHES FOR PROBLEM 7 (#24 AWG WIRE)

Solution(s)

1.	.5 [ENT↑] 2 [ENT↑] 50 [A]	→	25.5102	(L, μH)
2.	.5 [ENT↑] 2 [ENT↑] 100 [f] [A]	→	98.9949	(N, TURNS)
3.	.5 [ENT↑] 2 [ENT↑] .8 [ENT↑] 50 [B]	→	17.2414	(L, μH)
4.	.5 [ENT↑] 2 [ENT↑] .8 [ENT↑] 100 [f] [B]	→	120.4123	(N, TURNS)
5.	.5 [ENT↑] .8 [ENT↑] 50 [C]	→	48.8281	(L, μH)
6.	.5 [ENT↑] .8 [ENT↑] 100 [f] [C]	→	71.5542	(N, TURNS)
7.	2 [ENT↑] .0201 [ENT↑] 0 [D]	→	0.0533	(L, μH AT 0 Hz)
	2 [ENT↑] .0201 [ENT↑] 100 [EEX] 6 [D]	→	0.0508	(L, μH AT 100 MHz)
	2 [ENT↑] .0201 [ENT↑] [EEX] 9 [D]	→	0.0508	(L, μH AT 1 GHz)

Reference(s)

1. EUGENE CARRINGTON, ALLIED ELECTRONICS DATA HANDBOOK, THIRD EDITION, FIRST PRINTING, PAGE 30, ALLIED RADIO CORPORATION, FEB. 1962.

2. ENGINEERING STAFF, AEROVOX CORPORATION, ELECTRONICS REFERENCE DATA, VOL. 3, PAGE 114, HOWARD W. SAMS PUBLISHING CO., NEW YORK, N.Y., APRIL 1963.

User Instructions

COIL CALCULATIONS

1: r, ℓ, L → N | r, ℓ, b, L → N | r, b, L → N | 2

r, ℓ, N → L | r, ℓ, b, N → L | r, b, N → L | ℓ, d, f → L

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1.	LOAD SIDE 1 AND SIDE 2.			
2.	INPUT REQUIRED PARAMETERS, DEPENDING ON TYPE OF INDUCTOR:			
	A. FOR SINGLE-LAYER INDUCTANCE:	r	ENTER↑	
		ℓ	ENTER↑	
		N	A	L
	B. FOR MULTI-LAYER INDUCTANCE:	r	ENTER↑	
		ℓ	ENTER↑	
		b	ENTER↑	
		N	B	L
	C. FOR SPIRAL WINDING INDUCTANCE:	r	ENTER↑	
		b	ENTER↑	
		N	C	L
	D. FOR STRAIGHT WIRE INDUCTANCE:	ℓ	ENTER↑	
		d	ENTER↑	
		f	D	L
	E. FOR SINGLE-LAYER TURNS:	r	ENTER↑	
		ℓ	ENTER↑	
		L	f A	N
	F. FOR MULTI-LAYER TURNS:	r	ENTER↑	
		ℓ	ENTER↑	
		b	ENTER↑	
		L	f B	N
	G. FOR SPIRAL WINDING TURNS:	r	ENTER↑	
		b	ENTER↑	
		L	f C	N
3.	FOR A NEW CASE GO TO STEP 2 A THROUGH G, AS APPROPRIATE.			

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	LBL A	21 11	
	STO C	35 13	STORE N
	R↓	-31	
	STO B	35 12	STORE ℓ
	R↓	-31	
	STO A	35 11	STORE R
	x^2	53	
	RCL C	36 13	
	x^2	53	
010	×	-35	
	RCL A	36 11	
	9	09	
	×	-35	
	RCL B	36 12	
	1	01	
	0	00	
	×	-35	
	+	-55	
	÷	-24	
020	PRT x	-14	PRINTS L VALUE
	RTN	24	
	LBL f a	21 16 11	
	STO C	35 13	STORE L
	R↓	-31	
	STO B	35 12	STORE ℓ
	R↓	-31	
	STO A	35 11	STORE r
	9	09	
	×	-35	
030	RCL B	36 12	
	1	01	
	0	00	
	×	-35	
	+	-55	
	RCL C	36 13	
	×	-35	
	$\sqrt{x}$	54	
	RCL A	36 11	
	÷	-24	
040	PRT x	-14	PRINTS N VALUE
	RTN	24	
	LBL B	21 12	
	STO D	35 14	STORE N
	R↓	-31	
	STO C	35 13	STORE b
	R↓	-31	
	STO B	35 12	STORE ℓ
	R↓	-31	
	STO A	35 11	STORE r
050	x^2	53	
	RCL D	36 14	
	x^2	53	
	×	-35	
	•	-62	
	8	08	
	×	-35	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	RCL A	36 11	
	6	06	
	×	-35	
060	RCL B	36 12	
	9	09	
	×	-35	
	+	-55	
	RCL C	36 13	
	1	01	
	0	00	
	×	-35	
	+	-55	
	÷	-24	
070	PRT x	-14	PRINTS L VALUE
	RTN	24	
	LBL f b	21 16 12	
	STO D	35 14	STORE L
	R↓	-31	
	STO C	35 13	STORE b
	R↓	-31	
	STO B	35 12	STORE ℓ
	R↓	-31	
	STO A	35 11	STORE r
080	6	06	
	×	-35	
	RCL B	36 12	
	9	09	
	×	-35	
	+	-55	
	RCL C	36 13	
	1	01	
	0	00	
	×	-35	
090	+	-55	
	RCL D	36 14	
	×	-35	
	$\sqrt{x}$	54	
	1	01	
	•	-62	
	1	01	
	1	01	
	8	08	
	×	-35	
100	RCL A	36 11	
	÷	-24	
	PRT x	-14	PRINTS N VALUE
	RTN	24	
	LBL C	21 13	
	STO C	35 13	STORE N
	R↓	-31	
	STO B	35 12	STORE b
	R↓	-31	
	STO A	35 11	STORE r
110	x^2	53	
	RCL C	36 13	
	x^2	53	

REGISTERS

0	1	2	3	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
USED	USED	USED	USED		

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	x	-35	
	RCL A	36 11	
	8	08	
	x	-35	
	RCL B	36 12	
	1	01	
	1	01	
120	x	-35	
	+	-55	
	÷	-24	
	PRT x	-14	PRINTS L VALUE
	RTN	24	
	LBL f c	21 16 13	
	STO C	35 13	STORE L
	R↓	-31	
	STO B	35 12	STORE b
	R↓	-31	
130	STO A	35 11	STORE r
	8	08	
	x	-35	
	RCL B	36 12	
	1	01	
	1	01	
	x	-35	
	+	-55	
	RCL C	36 13	
	x	-35	
140	$\sqrt{x}$	54	
	RCL A	36 11	
	÷	-24	
	PRT x	-14	PRINTS N VALUE
	RTN	24	
	LBL D	21 14	
	STO C	35 13	STORE FREQUENCY
	R↓	-31	
	STO B	35 12	STORE d
	R↓	-31	
150	STO A	35 11	STORE ℓ
	4	04	
	x	-35	
	RCL B	36 12	
	÷	-24	$4\ell/d$
	ln x	32	
	1	01	
	−	-45	
	RCL B	36 12	
	RCL A	36 11	
160	2	02	
	x	-35	
	÷	-24	
	+	-55	
	STO D	35 14	STORE $\left(\ln\frac{4\ell}{d} - 1 + \frac{d}{2\ell}\right)$ PART
	RCL C	36 13	
	$\sqrt{x}$	54	
	RCL B	36 12	
	x	-35	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	•	-62	
170	2	02	
	7	07	
	2	02	
	x	-35	QUANTITY "x"
	4	04	
	•	-62	
	5	05	
	f x>y?	16-34	IS "x" < OR > 4.5?
	GTO 1	22 01	
	x⇄y	-41	
180	f LOG	16 32	EVALUATE δ ↓
	•	-62	
	1	01	
	5	05	
	5	05	
	+	-55	
	CHS	-22	
	f 10^x	16 33	
	GTO 2	22 02	
	LBL 1	21 01	
190	x⇄y	-41	
	x^2	53	
	2	02	
	0	00	
	2	02	
	•	-62	
	5	05	
	÷	-24	
	CHS	-22	
	•	-62	
200	2	02	
	5	05	
	+	-55	
	LBL 2	21 02	
	RCL D	36 14	
	+	-55	
	RCL A	36 11	
	x	-35	
	•	-62	
	0	00	
210	0	00	
	5	05	
	0	00	
	8	08	
	x	-35	
	PRT x	-14	PRINTS L VALUE
	RTN	24	
	R/S	51	END OF PROGRAM
220			

LABELS

A L (1)	B L (2)	C L (3)	D L (4)	E
a N (1)	b N (2)	c N (3)	d	e
0	1 δ	2 USED	3	4
5	6	7	8	9

FLAGS

0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n 4	

Program Description I

Program Title Complex Impedance Calculator - AC Circuit Calculator

Contributor's Name Ian A. Webb
Address 20621 Canyon View Dr.
City Saratoga, **State** CA **Zip Code** 95070

West Valley College
Saratoga, CA 95070

Program Description, Equations, Variables An AC circuit/complex number or impedance calculator that behaves the same as the HP-67/97 for real numbers. Fully automatic stack lift and exact stack movement simulating the bare HP-67/97 is provided. Functions implemented are: X and Y register exchange, 1/X, multiplication, division, addition, subtraction, enter, roll-down, STO (0-6) and RCL (0-6).
5 secondary (protected) storage locations and 2 primary (non-protected) locations are provided. Register review is possible viewing first the imaginary and then the real portion of each complex number in the simulated four-level stack.

COMPLEX SIMULATED STACK	T		Z		Y		X	
REGISTER USED	0	1	2	3	4	5	6	7
QUANTITY STORED	Imag.	Real	Imag.	Real	Imag.	Real	Imag.	Real

COMPLEX SIMULATED STACK	X		Y	
HP-67/97 STACK	x	y	z	t
QUANTITY	Real	Imag.	Real	Imag.

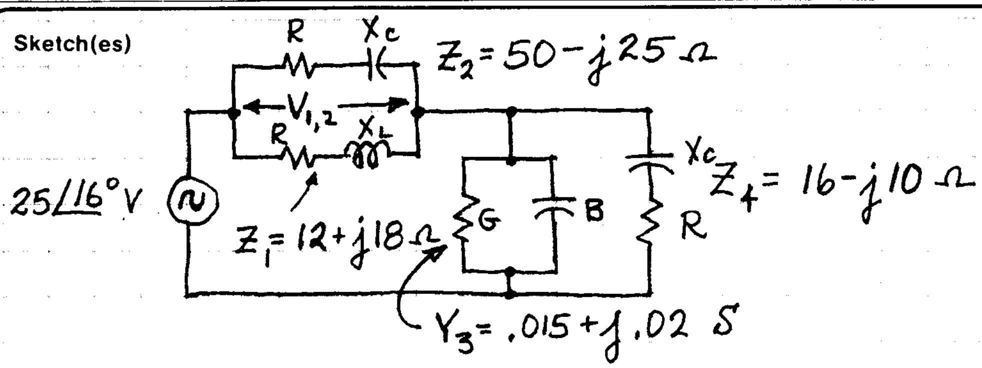
Registers 8 and 9 contain either the last number pair worked with or the results of the last arithmetic operation. (8 = imaginary part, 9 = real part)

Operating Limits and Warnings During STO and RCL operations, a number 0 through 6 must be entered during the pause operation after pressing the STO or RCL user-defined keys. A 0. is displayed as a reminder during this pause. This number indicates the storage location used.

All entries must be converted to (or entered in) rectangular Real + j Imaginary format before any operations are used.

Program Description II

Sketch(es)



Sample Problem(s) Find: I_T , Z_T, and $V_{1,2}$ in circuit above

$Z_T = Z_{1,2} + Z_{3,4}$ $\quad 1/Z_{1,2} = 1/Z_1 + 1/Z_2$ $\quad 1/Z_{3,4} = Y_3 + 1/Z_4$

$I_T = V_T/Z_T$

$V_{1,2} = I_T \times Z_{1,2}$

ANSWERS FROM STEPS BELOW

Z_T = 25.79 + j3.30 Ω [g][→P] 26 /7.29° Ω

I_T = .95 + j.15 A [g][→P] .96 /8.71° A

$V_{1,2}$ = 13.20 + j13.15 V [g][→P] 18.63 /44.89° V

Solution(s) $1/Z_1$: 18 [E↑] 12 [f] [D] (.03 - j.04) (remember h x⇄y to view other part)
$1/Z_2$: 25 [CHS] [E↑] 50 [f] [D] (.02 + j.01), $1/Z_{1,2}$: (+) [B] (.04 - j.03)
$Z_{1,2}$: (1/Z) [f] [D] (15.64 + j11.44), Y_3: .02 [E↑] .015 (E↑) [A] (.02 + j.02)
$1/Z_4$: 10 [CHS] [E↑] 16 (1/Z) [f] [D] (.04 + j.03), $1/Z_{3,4}$; (+) [B] (.06 + j.05),
$Z_{3,4}$: (1/Z) [f] [D] (10.15- j8.14) Exchange $Z_{3,4}$ & $Z_{1,2}$ & save $Z_{1,2}$ [f] [E] ,
[f] [B] 1 ; Z_T : (+) [B] (25.79 + j3.30) ; V_T : 16 [E↑] 25 [f] [R←] (24.03 + j6.89),
Exchange Z_T and V_T: [f] [E] , I_T : (÷) [E] (.95 + j.15) , RCL $Z_{1,2}$: [f] [C] 1 ,
$V_{1,2}$: (X) [D] (13.20 + j13.15)

Reference(s)

User Instructions

R↓	STO (0-6)	RCL (0-6)	$1/Z_X$	$Z_x \rightleftarrows Z_y$
E↑	+	−	X	÷

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Enter program from card or keyboard.				
2.	Clear as desired: Stack Clear and memories		f	CLREG	
	5 and 6		CLX	E	
	Clear memories 0-4		f	P⇄S	
			f	CLREG	
			f	P⇄S	
3.	Solve complex number problem using RPN				
	ALL INPUTS IN RECTANGULAR FORMAT				
	ENTER (E↑) --- X [E↑] R (imag., enter, real)	X [E↑] R	A		Real part
	R↓	↓	f	A	↓
	+			B	
	-			C	
	X			D	
	÷			E	
	$1/Z_X$		f	D	
	$Z_x \rightleftarrows Z_y$ (X⇄Y)		f	E	
	STO (0-6)		f	B	0.
	input # of storage location 0 through 6	# location		#	Real part
	RCL (0-6)		f	C	0.
	input # of storage location 0 through 6	# location		#	Real part
	To raise to a power, use continued enters and multiplies.				
	0 1 2 3 4 5 6 7				
	STACK REVIEW (X_T, R_T; X_Z, R_Z; X_Y, R_Y; X_X, R_X)		h	REG	
4.	To view imaginary part at any time:	Real part	h	x⇄y	Imag. part
	CAUTION: Exchange before continuing	Imag. part	h	x⇄y	Real part
5.	To enter and use a polar notation number				
	enter as an angle and magnitude ∠θ [E↑] Z	magnitude	f	R←	Real part
6.	To convert an answer from resistance and react-				
	ance (real and imaginary) to impedance and	Real part	g	→P	magnitude
	angle (magnitude and angle)				
	CAUTION: Convert back to rectangular before	magnitude	f	R←	Real part
	continuing calculations.				
7.	To correct an incorrect entry use CLX to remove old entry and key over.				
	CAUTION: Since the arithmetic operations use				
	the x,y,z,t stack for numbers, the previous				
	X is moved to z and t. The stack order must be				
	maintained when correcting an incorrect entry.				
	Stack can be restored by a RCL 6, RCL 7.				

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL 8	31 25 08	ENDING LOCATION
	h SF 0	35 51 00	update x,y,z,t
	RCL 4	34 04	stack locations
	RCL 5	34 05	
	RCL 6	34 06	indicate no enter
	RCL 7	34 07	F0 set
	h RTN	35 22	
	f LBL 0	31 25 00	
	STO 9	33 09	DECISION TREE
010	h x⇄y	35 52	
	STO 8	33 08	returns 2,3 or 5
	2	02	depending upon:
	h F? 0	35 71 00	keyboard entry,
	GTO 0	22 00	RCL operation or
	h STI	35 33	previous operation
	h F? 3	35 71 03	an enter
	h RTN	35 22	
	h F? 2	35 71 02	stores present
	5	05	number pair in
020	h STI	35 33	temporary location
	h RTN	35 22	8 and 9, enters
	f LBL 0	31 25 00	returned number
	h F? 3	35 71 03	in I register
	3	03	
	h STI	35 33	
	h CF 2	35 61 02	
	h RTN	35 22	
	f LBL 1	31 25 01	
	RCL 2	34 02	Complex Z to T
030	STO 0	33 00	
	RCL 3	34 03	
	STO 1	33 01	
	h F? 3	35 71 03	
	GTO 4	22 04	
	h RTN	35 22	
	f LBL 4	31 25 04	Complex Y to Z
	RCL 4	34 04	
	STO 2	33 02	
	RCL 5	34 05	
040	STO 3	33 03	
	h F? 2	35 71 02	
	GTO 5	22 05	
	h RTN	35 22	
	f LBL 5	31 25 05	Temporary t to Y
	RCL 8	34 08	
	STO 4	33 04	
	RCL 9	34 09	
	STO 5	33 05	
	h RTN	35 22	
050	f LBL 6	31 25 06	temporary t to X
	RCL 8	34 08	
	STO 6	33 06	
	RCL 9	34 09	
	STO 7	33 07	
	h RTN	35 22	
	f LBL 7	31 25 07	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	RCL 4	34 04	Complex Y to X
	STO 6	33 06	
	RCL 5	34 05	
060	STO 7	33 07	
	h RTN	35 22	
	f LBL 9	31 25 09	
	RCL 6	34 06	Complex X to Y
	STO 4	33 04	
	RCL 7	34 07	
	STO 5	33 05	
	h RTN	35 22	
	f LBL A	31 25 11	
	f GSB 0	31 22 00	Enter Routine
070	GTO (i)	22 24	
	f LBL 3	31 25 03	and stack manip.
	f GSB 4	31 22 04	
	f GSB 9	31 22 09	
	f GSB 6	31 22 06	
	f LBL 2	31 25 02	
	h SF 3	35 51 03	
	h SF 2	35 51 02	
	f GSB 1	31 22 01	
	f GSB 6	31 22 06	
080	h CF 0	35 61 00	
	f LBL 5	31 25 05	ending for RCL only
	h RTN	35 22	
	g LBL a	32 25 11	
	f GSB 0	31 22 00	Roll down Routine
	GTO (i)	22 24	and stack manip.
	f LBL 2	31 25 02	
	f GSB 7	31 22 07	
	g GSB a	32 22 11	
	f LBL 3	31 25 03	
090	RCL 8	34 08	
	STO 0	33 00	
	RCL 9	34 09	
	STO 1	33 01	
	GTO 8	22 08	
	g LBL d	32 25 14	
	g GSB d	32 22 14	1/Z Routine
	f GSB 0	31 22 00	
	GTO (i)	22 24	
	f LBL 3	31 25 03	
100	h SF 3	35 51 03	
	f GSB 1	31 22 01	
	f GSB 9	31 22 09	
	f LBL 2	31 25 02	
	f GSB 6	31 22 06	
	GTO 8	22 08	
	f LBL E	31 25 15	Divide Routine
	g GSB d	32 22 14	
	f LBL D	31 25 14	Multiply Routine
	g →P	32 72	
110	h x⇄y	35 52	
	h R↓	35 53	
	h R↓	35 53	

REGISTERS

0 COMPLEX	1 T REG.	2 COMPLEX	3 Z REG.	4 COMPLEX	5 Y REG.	6 COMPLEX	7 X REG	8 TEMPORARY	9 REG, t
S0 ALL SECONDARY REGISTERS USED FOR STORED QUANTITIES IN STO AND RCL OPERATIONS ----------	S1	S2	S3	S4	S5	S6	S7	S8	S9
A REGISTERS THROUGH [illegible] USED FOR STORED QUANTITIES IN STO /RCL	B	C	D	E USED	I USED				

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	g →P	32 72	
	h R↑	35 54	
	x	71	
	h R↓	35 53	
	+	61	
	h R↑	35 54	
	f R←	31 72	
120	f GSB 0	31 22 00	
	GTO (i)	22 24	
	g LBL d	32 25 14	Invert routine for divide routine and 1/Z routine
	g →P	32 72	
	h 1/x	35 62	
	h x ⇄ y	35 52	
	CHS	42	
	h x ⇄ y	35 52	
	f R←	31 72	
	h RTN	35 22	
130	f LBL C	31 25 13	Subtract Routine
	CHS	42	
	h x ⇄ y	35 52	
	CHS	42	
	h x ⇄ y	35 52	
	f LBL B	31 25 12	Add routine
	h x ⇄ y	35 52	
	h R↓	35 53	
	+	61	
	h R↓	35 53	
140	+	61	
	h R↑	35 54	
	f GSB 0	31 22 00	
	GTO (i)	22 24	
	f LBL 2	31 25 02	
	g GSB a	32 22 11	
	f GSB 6	31 22 06	
	GTO 8	22 08	
	g LBL a	32 25 11	Complex Z to Y, T to Z
	RCL 2	34 02	
150	STO 4	33 04	
	RCL 3	34 03	
	STO 5	33 05	
	RCL 0	34 00	
	STO 2	33 02	
	RCL 1	34 01	
	STO 3	33 03	
	h RTN	35 22	
	f LBL 3	31 25 03	part of Add routine
	f GSB 1	31 22 01	
160	f GSB 6	31 22 06	
	GTO 8	22 08	
	g LBL e	32 25 15	Complex X, Y Exchng
	f GSB 0	31 22 00	
	h SF 2	35 51 02	
	GTO (i)	22 24	
	f LBL 2	31 25 02	
	f GSB 7	31 22 07	
	f GSB 5	31 22 05	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	GTO 8	22 08	
170	f LBL 3	31 25 03	
	h SF 2	35 51 02	
	h SF 3	35 51 03	
	f GSB 1	31 22 01	
	GTO 8	22 08	
	g LBL c	32 25 13	RCL Routine
	h SF 2	35 51 02	
	f GSB A	31 22 11	
	g GSB c	32 22 13	
	RCL E	34 15	
180	h STI	35 33	
	RCL (i)	34 24	
	STO 7	33 07	
	f ISZ	31 34	
	RCL (i)	34 24	
	STO 6	33 06	
	GTO 8	22 08	
	g LBL b	32 25 12	STO Routine
	f GSB 0	31 22 00	
	g GSB c	32 22 13	
190	GTO (i)	22 24	
	f LBL 3	31 25 03	
	h SF 3	35 51 03	
	f GSB 1	31 22 01	
	f GSB 9	31 22 09	
	f LBL 2	31 25 02	
	RCL E	34 15	
	h STI	35 33	
	f GSB 6	31 22 06	
	STO (i)	33 24	
200	f ISZ	31 34	
	h x ⇄ y	35 52	
	STO (i)	33 24	
	GTO 8	22 08	
	g LBL c	32 25 13	STO/RCL location entry Routine
	3	03	
	CHS	42	
	h x ⇄ i	35 24	
	0	00	
	DSP 0	23 00	
210	h PAUSE	35 72	
	h F? 3	35 71 03	
	GTO f c	22 31 13	
	GTO (i)	22 24	
	g LBL c	32 25 13	
	DSP 2	23 02	
	5	05	
	+	61	
	2	02	
	x	71	
220	STO E	33 15	
	h R↓	35 53	
	h R↓	35 53	
	h x ⇄ i	35 24	
	h RTN	35 22	

LABELS

A USED	B USED	C USED	D USED	E USED
a USED	b USED	c USED	d USED	e USED
0 USED	1 USED	2 USED	3 USED	4 USED
5 USED	6 USED	7 USED	8 USED	9 USED

FLAGS

0	USED
1	
2	USED
3	USED

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Program Description I

Program Title WYE DELTA TRANSFORMATIONS
DELTA WYE TRANSFORMATIONS

Contributor's Name DOUGLAS R. RANZ

Address 68 MITCHELL ROAD

City WILMINGTON **State** OHIO **Zip Code** 45177

Program Description, Equations, Variables GIVEN A WYE OR DELTA LOAD THIS PROGRAM CALCULATES THE RESPECTIVE IMPEDANCES OF THE OTHER EQUIVALENT LOAD.

EQUATIONS USED ARE:

$$\bar{\bar{Z}}_A = \frac{\bar{\bar{Z}}_1\bar{\bar{Z}}_2 + \bar{\bar{Z}}_2\bar{\bar{Z}}_3 + \bar{\bar{Z}}_1\bar{\bar{Z}}_3}{\bar{\bar{Z}}_2} \qquad \bar{\bar{Z}}_1 = \frac{\bar{\bar{Z}}_A\bar{\bar{Z}}_B}{\bar{\bar{Z}}_A + \bar{\bar{Z}}_B + \bar{\bar{Z}}_C}$$

$$\bar{\bar{Z}}_B = \frac{\bar{\bar{Z}}_1\bar{\bar{Z}}_2 + \bar{\bar{Z}}_2\bar{\bar{Z}}_3 + \bar{\bar{Z}}_1\bar{\bar{Z}}_3}{\bar{\bar{Z}}_3} \qquad \bar{\bar{Z}}_2 = \frac{\bar{\bar{Z}}_B\bar{\bar{Z}}_C}{\bar{\bar{Z}}_A + \bar{\bar{Z}}_B + \bar{\bar{Z}}_C}$$

$$\bar{\bar{Z}}_C = \frac{\bar{\bar{Z}}_1\bar{\bar{Z}}_2 + \bar{\bar{Z}}_2\bar{\bar{Z}}_3 + \bar{\bar{Z}}_1\bar{\bar{Z}}_3}{\bar{\bar{Z}}_1} \qquad \bar{\bar{Z}}_3 = \frac{\bar{\bar{Z}}_A\bar{\bar{Z}}_C}{\bar{\bar{Z}}_A + \bar{\bar{Z}}_B + \bar{\bar{Z}}_C}$$

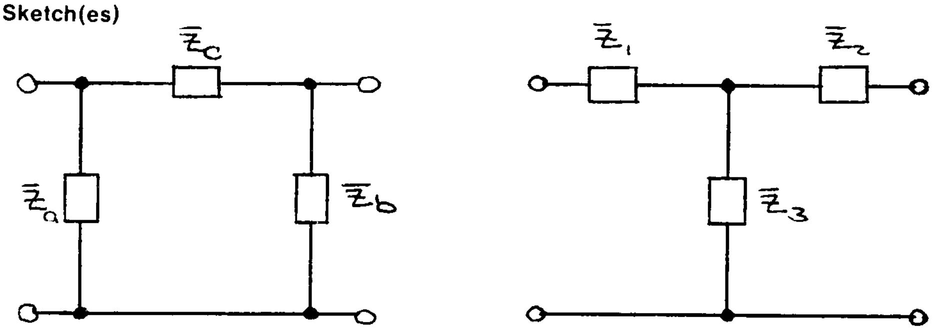
Operating Limits and Warnings

1. IT IS VERY IMPORTANT TO OBSERVE COMPONENT DESIGNATIONS.

2. BE SURE TO INPUT ZERO (DO NOT SIMPLY PRESS [CLx]) FOR X (OR R) WHEN Z IS PURELY RESISTIVE (OR REACTIVE).

Program Description II

Sketch(es)



Sample Problem(s)

GIVEN: $\bar{Z}_1 = 43.35 + j0$
$\bar{Z}_2 = 1.57 + j0$
$\bar{Z}_3 = 81.98 + j0$

FIND: $\bar{Z}_a = 2388.9 + j0$
$\bar{Z}_b = 45.75 + j0$
$\bar{Z}_c = 86.52 + j0$

Solution(s) KEYSTROKES

0 ↑ 43.35 [A]
0 ↑ 1.57 [B]
0 ↑ 81.98 [C]

[D] → SEE SOLUTIONS ABOVE (THE REAL PART OF EACH IMPEDANCE IS DISPLAYED FIRST.)

Reference(s) <u>ENGINEERING CIRCUIT ANALYSIS</u>, HAYT AND KEMMERLY, MCGRAW-HILL, 1962, 1971.

<u>CIRCUITS</u>, GENERAL MOTORS INSTITUTE, 1968, 1974

User Instructions

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	LOAD SIDE ONE AND SIDE TWO			
	INPUT:			
2	jX	RECT.	ENTER↑	
3	R	RECT.	A	
4	jX	RECT.	ENTER↑	
5	R	RECT.	B	
6	jX	RECT.	ENTER↑	
			C	
7	SELECT TRANSFORMATION			
	→ a▽c (b) (DELTA)		D	
	→ Y (1 2 3) (WYE)		E	
	OUTPUT:			
	R PAUSE jX			RECT.
	R PAUSE jX			RECT.
	R PAUSE jX			RECT.

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL A	31 25 11	
	STO 0	33 00	
	h x↔y	35 22	
	STO 1	33 01	
	h RTN	35 22	
	f LBL B	31 25 12	
	STO 2	33 02	
	h x↔y	35 52	
	STO 3	33 03	
010	h RTN	35 22	
	f LBL C	31 25 13	
	STO 4	33 04	
	h x↔y	35 52	
	STO 5	33 05	
	h RTN	35 22	
	f LBL D	31 25 14	
	f GSB 0	31 22 00	
	RCL 3	34 03	
	RCL 2	34 02	
020	f GSB 3	31 22 03	
	RCL 5	34 05	
	RCL 4	34 04	
	f GSB 3	31 22 03	
	RCL 1	34 01	
	RCL 0	34 00	
	f GSB 3	31 22 03	
	h RTN	35 22	
	f LBL E	31 25 15	
	RCL 1	34 01	
030	RCL 0	34 00	
	f GSB 1	31 22 01	
	RCL 3	34 03	
	RCL 2	34 02	
	f GSB 2	31 22 02	
	f GSB 4	31 22 04	
	RCL 3	34 03	
	RCL 2	34 02	
	f GSB 1	31 22 01	
	RCL 5	34 05	
040	RCL 4	34 04	
	f GSB 2	31 22 02	
	f GSB 4	31 22 04	
	RCL 1	34 01	
	RCL 0	34 00	
	f GSB 1	31 22 01	
	RCL 5	34 05	
	RCL 4	34 04	
	f GSB 2	31 22 02	
	f GSB 4	31 22 04	
050	h RTN	35 22	
	f LBL 0	31 25 00	
	f P↔S	31 42	
	0	00	
	STO 4	33 04	
	STO 6	33 06	
	f P↔S	31 42	
	RCL 1	34 01	
	RCL 0	34 00	
	f GSB 1	31 22 01	
060	RCL 3	34 03	
	RCL 2	34 02	
	f GSB 2	31 22 02	
	Σ+	21	
	RCL 3	34 03	
	RCL 2	34 02	
	f GSB 1	31 22 01	
	RCL 5	34 05	
	RCL 4	34 04	
	f GSB 2	31 22 02	
070	Σ+	21	
	RCL 1	34 01	
	RCL 0	34 00	
	f GSB 1	31 22 01	
	RCL 5	34 05	
	RCL 4	34 04	
	f GSB 2	31 22 02	
	Σ+	21	
	RCL Σ+	34 21	
	f GSB 1	31 22 01	
080	h RTN	35 22	
	f LBL 1	31 25 01	
	g→P	32 72	
	STO 6	33 06	
	h x↔y	35 52	
	STO 7	33 07	
	h RTN	35 22	
	f LBL 2	31 25 02	
	g→P	32 72	
	STO × 6	33 71 06	
090	h x↔y	35 52	
	STO + 7	33 61 07	
	RCL 7	34 07	
	RCL 6	34 06	
	f R←	31 72	
	h RTN	35 22	
	f LBL 3	31 25 03	
	g→P	32 72	
	STO 8	33 08	
	h x↔y	35 52	
100	STO 9	33 09	
	RCL 6	34 06	
	RCL 8	34 08	
	/	81	
	STO A	33 11	
	RCL 7	34 07	
	RCL 9	34 09	
	−	51	
	RCL A	34 11	
	f R←	31 72	
110	f -x-	31 84	
	h x↔y	35 52	
	f -x-	31 84	

REGISTERS

0	1	2	3	4	5	6	7	8	9
R	jX	R	jX	R	jX	USED	USED	USED	USED

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
				USED		USED			

A	B	C	D	E	I
USED				USED	

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	h RTN	35 22	
	f LBL 4	31 25 04	
	RCL 0	34 00	
	RCL 2	34 02	
	RCL 4	34 04	
	+	61	
	+	61	
120	STO E	33 15	
	RCL 1	34 01	
	RCL 3	34 03	
	RCL 5	34 05	
	+	61	
	+	61	
	RCL E	34 15	
	f GSB 3	31 22 03	
	h RTN	35 22	
130			
140			
150			
160			
170			
180			
190			
200			
210			
220			

LABELS

A	B	C	D	E
∫X ↑ R	∫X ↑ R	∫X ↑ R	→ a √c	→ Y
a	b	c	d	e
0 USED	1 USED	2 USED	3 USED	4 USED
5	6	7	8	9

FLAGS: 0, 1, 2, 3 (blank)

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n 2	

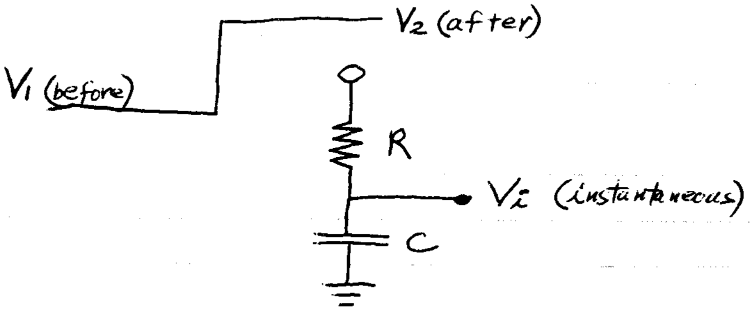
Program Description I

Program Title RC TIMING

Contributor's Name John Craig
Address RFD 1
City Malcolm **State** Nebr **Zip Code** 68402

Program Description, Equations, Variables

Given 5 of 6 variables, the sixth value will be solved for. They are; Resistance, capacitance, Voltage before step, Voltage after step, instantaneous voltage, and time.



A variety of design solutions can be expedited with this program. Timers, oscillators, etc., often use RC charging times.

~~**Operating Limits and Warnings**~~

Extra note: For voltages across the resistor remember that $V_R + V_C = V_{applied}$ at all times.

Program Description II

Sketch(es) All solutions are algebraically derived from this basic formula:

$$V_i = V_1 e^{\frac{-t}{RC}} + V_2\left(1 - e^{\frac{-t}{RC}}\right)$$

[redacted] Flag 3 indicates for each Key whether data entry or a solution is desired.

Sample Problem(s) Problem 1;

A 555 type integrated circuit timer uses an external RC configuration for time determination. When used as a one-shot its output pulse terminates when the capacitor charges to 2/3 of the supply voltage. Until the pulse starts, the capacitor is shorted across, so $V_1 = 0$. Given a supply voltage of 12V, a 47μF capacitor, and you need a 1 second pulse, what size resistor should you use?

Load program,
$V_1 = 0$ (no need to enter this), $V_2 = 12$ (Key A), $V_i = 8$ (Key B),
$C = 47 \times 10^{-6}$ (Key C), $T = 1$ (Key E), then R (Key D) = 19.4KΩ

~~Solution(s)~~ Problem 2;

Input voltage to an RC configuration suddenly drops from +12 VDC to −24 VDC. If R = 1 Meg (1×10^6), C = 47μF (47×10^{-6}), how long will it take for the voltage across the capacitor to reach −23VDC?

Solution Steps: 12 fA, 24CHS A, 23chs B, eex6 D, 47eex6chs C, E (→T) yields 168 seconds

~~Reference(s)~~ How about −22 VDC? 22chs B, E → 136 sec.
or −21 VDC? 21chs B, E → 117 sec.
etc.

User Instructions

RC TIMING

1 V_1

V_2 | V_i | C | R | T

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1			
2	Enter known data and use appropriate key to load. Example:	2000	D	(R entered)
3	Repeat step 2 for total of 5 knowns. (Note that V_1 is often zero and needs no loading.)			
4	Activate solution of the unknown value by using appropriately labeled key. Example:		E	"seconds" (solution)
	Note: For multiple solutions where maybe only one factor varies, just reload the changing variable each time. Data remains after each solution.			

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	lbl A	31 25 11	
	STO A	33 11	
	F?3	35 71 03	V_2
	RS	84	
	lbl 1	31 25 01	
	GSB fC	32 22 13	
	RCL 9	34 09	
	+	61	
	RCL B	34 12	
010	XY	35 52	
	÷	81	
	RCL 9	34 09	
	+	61	
	STO A	33 11	
	R/S	84	
	lbl B	31 25 12	
	STO B	33 12	
	F?3	35 71 03	
	R/S	84	
020	lbl 2	31 25 02	
	GSB fC	32 22 13	V_i
	RCL A	34 11	
	RCL 9	34 09	
	−	51	
	×	71	
	RCL 9	34 09	
	+	61	
	STO B	33 12	
	R/S	84	
030	lbl C	31 25 13	
	STO C	33 13	
	F?3	35 71 03	
	R/S	84	
	lbl 3	31 25 03	C
	GSB fB	32 22 12	
	RCL D	34 14	
	×	71	
	RCL E	34 15	
	XY	35 52	
040	÷	81	
	STO C	33 13	
	R/S	84	
	lbl D	31 25 14	
	STO D	33 14	
	F?3	35 71 03	
	R/S	84	
	lbl 4	31 25 04	R
	GSB fB	32 22 12	
	RCL C	34 13	
050	×	71	
	RCL E	34 15	
	XY	35 52	
	÷	81	
	STO D	33 14	
	R/S	84	
	lbl E	31 25 15	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	STO E	33 15	
	F?3	35 71 03	
	R/S	84	
060	lbl 5	31 25 05	T
	GSB fB	32 22 12	
	RCL C	34 13	
	RCL D	34 14	
	×	71	
	×	71	
	STO E	33 15	
	R/S	84	
	lbl fA	32 25 11	
	STO 9	33 09	
070	F?3	35 71 03	
	R/S	84	
	lbl 6	31 25 06	
	GSB fC	32 22 13	
	RCL A	34 11	V_1
	×	71	
	RCL B	34 12	
	XY	35 52	
	−	51	
	RCL E	34 15	
080	RCL D	34 14	
	RCL C	34 13	
	×	71	
	÷	81	
	CHS	42	
	e^x	32 52	
	÷	81	
	STO 9	33 09	
	R/S	84	
	lbl fB	32 25 12	subroutine
090	1	01	
	RCL B	34 12	$-\ln\left(1-\frac{V_i-V_1}{V_2-V_1}\right)$
	RCL 9	34 09	
	−	51	
	RCL A	34 11	
	RCL 9	34 09	
	−	51	
	÷	81	
	−	51	
	ln	31 52	
100	CHS	42	
	RTN	35 22	
	lbl fC	32 25 13	
	1	01	subroutine
	RCL E	34 15	
	RCL D	34 14	$1-e^{-\frac{t}{RC}}$
	RCL C	34 13	
	×	71	
	÷	81	
	CHS	42	
110	e^x	32 52	
	−	51	
	RTN	35 22	

REGISTERS

0	1	2	3	4	5	6	7	8	9
									V_1
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
V_2	V_i	C	R	T	

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS

User may wish to develop a similar program for this half of card for R L circuits if it would benefit you.

```
LBL A
STO A
F?3
R/S
LBL 1
 :
(Solution)
 :
STO A
R/S
```

Use this format, modified for each variable of course.

LABELS					FLAGS
A V_2	B V_i	C C	D R	E T	0
a V_1	b used	c used	d	e	1
0	1 used	2 used	3 used	4 used	2
5 used	6 used	7	8	9	3 data?

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☐
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☒
3	☐	☒			n	2

Program Description I

Program Title SERIES R-L-C CIRCUIT ANALYSIS PROGRAM

Contributor's Name HARLAN ASLIN

Address 4796 WINGATE DRIVE

City PLEASANTON State CALIFORNIA Zip Code 94566

Program Description, Equations, Variables Given the values of R, L, and C, the program determines the characteristics and performance of the series RLC circuit for the condition where the capacitor is initially charged. The first part of the program determines whether the circuit is underdamped, critically damped, or overdamped. This information is followed by an evaluation of the time to peak current, and the normalized value of peak current. For the underdamped case, these information are supplemented by the normalized value of capacitor voltage reversal.

The second part of the program determines circuit current as a function of time for a given capacitor initial charge voltage, V_c, and a given time step, Δt, specified by the user.

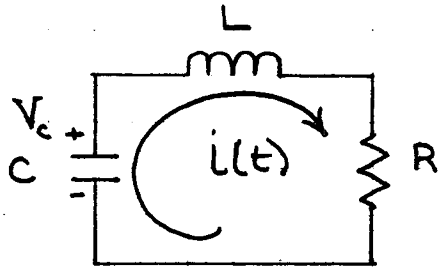
The relevant equations are:

	underdamped	critically damped	overdamped
$i(t)$	$= \frac{V_c}{L\beta'} e^{-\alpha t} \sin \beta' t$	$= \frac{V_c}{L} t e^{-\alpha t}$	$= \frac{V_c}{L\beta} e^{-\alpha t} \sinh \beta t$
t_p	$= \frac{1}{\beta'} \tan^{-1} \beta'/\alpha$	$= 1/\alpha$	$= \frac{1}{2\beta} \ln\left[\frac{1+\beta/\alpha}{1-\beta/\alpha}\right]$
rev.	$= e^{-\frac{\pi\alpha}{\beta'}}$		

$$\left[\alpha = \frac{R}{2L},\ \beta' = (\omega^2-\alpha^2)^{1/2},\ \beta = (\alpha^2-\omega^2)^{1/2},\ \omega = \frac{1}{(LC)^{1/2}}\right]$$

Program Description II

Sketch(es)



Sample Problem(s) Evaluate circuit performance, and determine the current as a function of time for the following parameters:

$R = 2\ \Omega$
$L = 4\ \mu H$
$C = 1\ \mu F$
$V_c = 1\ kV$

Let $\Delta t = 0.2\ \mu s$

Solution(s) Keystrokes

2 [↑] 4×10^{-6} [↑] 1×10^{-6} [A]	→	-187.50×10^{9}	(β^2)
[R/S]	→	2.4184×10^{-6}	(t_p)*
[R/S]	→	273.15×10^{-3}	(i_p)*
[R/S]	→	163.03×10^{-3}	(rev.)*
1×10^{3} [↑] 0.2×10^{-6} [B]	→	0.0000×10^{00}, 47.502×10^{00}, 90.032×10^{00}, ETC	($i(t)$)

Reference(s) Analysis of Electric Circuits, Brenner and Javid
McGraw Hill, 1959

User Instructions

SERIES R-L-C CIRCUIT ANALYSIS PROGRAM

1 ◀ ▶ 2

START | i(t)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 & 2			
2	Input value of R	R	ENTER	
3	Input value of L	L	ENTER	
4	Input value of C	C	A	β^2 *
	* the sign of β^2 determines the type of circuit,			
	$-\beta^2$ underdamped			
	0 critically damped			
	$+\beta^2$ overdamped			
5			R/S	t_{peak} **
	** time to peak current			
6			R/S	i_{peak} †
	† peak current normalized to V_c = 1 volt			
7	(underdamped case only)		R/S	reversal ††
	†† Capacitor voltage reversal normalized to V_c = 1 volt			
8	Input capacitor initial voltage	V_c	ENTER	
9	Input time step, Δt	Δt	B	$i(t)$
	or alternatively to compute $v_R(t)$ rather than $i(t)$			
8	Input capacitor initial voltage	V_c	RCL 0	
			×	$V_c \times R$
9	Input time step, Δt	Δt	B	$v_R(t)$

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL A	31 25 11	
	CF 0	35 61 00	
	CF 1	35 61 01	
	STO 2	33 02	C
	x⇄y	35 52	
	STO 1	33 01	L
	ENTER	41	
	R↓	35 53	
	x	71	
010	1/x	35 62	
	RND	31 24	
	R↓	35 53	
	STO 0	33 00	R
	÷	81	
	2	02	
	x	71	
	1/x	35 62	
	STO 3	33 03	α
	x^2	32 54	
020	RND	31 24	
	R↑	35 54	
	−	51	
	x=0?	31 51	
	GTO 0	22 00	
	x>0?	31 81	
	GTO 1	22 01	
	R/S	84	(−) underdamped
	STO E	33 15	
	SF 0	35 51 00	
030	ABS	35 64	
	$\sqrt{x}$	31 54	
	STO 4	33 04	β
	RCL 3	34 03	
	÷	81	
	TAN^{-1}	32 64	
	RCL 4	34 04	
	÷	81	
	STO 5	33 05	t_{peak}
	R/S	84	
040	RCL 5	34 05	
	ENTER	41	
	RCL 4	34 04	
	x	71	
	SIN	31 62	
	x⇄y	35 52	
	RCL 3	34 03	
	x	71	
	CHS	42	
	e^x	32 52	
050	x	71	
	RCL 4	34 04	
	RCL 1	34 01	
	x	71	
	1/x	35 62	
	x	71	
	STO 6	33 06	$\dot{i}_{peak}$

STEP	KEY ENTRY	KEY CODE	COMMENTS
	R/S	84	
	RCL 3	34 03	
	RCL 4	34 04	
060	÷	81	
	π	35 73	
	x	71	
	CHS	42	
	e^x	32 52	
	STO 7	33 07	cap. reversal
	R/S	84	
	RTN	35 22	
	f LBL 0	31 25 00	(0) critically
	R/S	84	damped
070	STO E	33 15	
	RCL 3	34 03	
	1/x	35 62	
	STO 4	33 04	t_{peak}
	R/S	84	
	1	01	
	CHS	42	
	e^x	32 52	
	2	02	
	x	71	
080	RCL 0	34 00	
	÷	81	
	STO 5	33 05	i_{peak}
	RTN	35 22	
	f LBL 1	31 25 01	(+) overdamped
	R/S	84	
	STO E	33 15	
	SF 1	35 51 01	
	$\sqrt{x}$	31 54	
	STO 4	33 04	β
090	1	01	
	ENTER	41	
	RCL 4	34 04	
	RCL 3	34 03	
	÷	81	
	+	61	
	1	01	
	LST X	35 82	
	−	51	
	÷	81	
100	ln	31 52	
	RCL 4	34 04	
	2	02	
	x	71	
	÷	81	
	STO 5	33 05	t_{peak}
	R/S	84	
	RCL 4	34 04	
	RCL 5	34 05	
	x	71	
110	GSB 2	31 22 02	
	RCL 3	34 03	
	RCL 5	34 05	

REGISTERS

0	1	2	3	4	5	6	7	8	9
R	L	C	α	used	used	used	used	0	Δt

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
used	$i(t)$ or $V_R(t)$	t		β^2	incr. Δt

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	x	71	
	CHS	42	
	e^x	32 52	
	x	71	
	RCL 1	34 01	
	RCL 4	34 04	
	x	71	
120	÷	81	
	STO 6	33 06	peak value
	RTN	35 22	
	f LBL B	31 25 12	initialize
	0	00	
	STO i	35 33	
	R↓	35 53	
	F0?	35 71 00	
	GTO C	22 13	
	F1?	35 71 01	
130	GTO E	22 15	
	GTO D	22 14	
	f LBL C	31 25 13	i(t) underdamped
	STO 9	33 09	
	x⇄y	35 52	
	RCL 1	34 01	
	RCL 4	34 04	
	x	71	
	1/x	35 62	
	x	71	
140	STO A	33 11	
	f LBL 3	31 25 03	i(t) loop
	GSB 4	31 22 04	
	ENTER	41	
	ENTER	41	
	RCL 4	34 04	
	x	71	
	SIN	31 62	
	x⇄y	35 52	
	RCL 3	34 03	
150	x	71	
	CHS	42	
	e^x	32 52	
	x	71	
	RCL A	34 11	
	x	71	
	STO B	33 12	
	-x-	31 84	
	ISZ	31 34	
	GTO 3	22 03	
160	f LBL D	31 25 14	i(t) critically damped
	STO 9	33 09	
	x⇄y	35 52	
	RCL 1	34 01	
	÷	81	
	STO A	33 11	
	f LBL 5	31 25 05	i(t) loop
	GSB 4	31 22 04	
	ENTER	41	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	ENTER	41	
170	RCL 3	34 03	
	x	71	
	CHS	42	
	e^x	32 52	
	x	71	
	RCL A	34 11	
	x	71	
	STO B	33 12	
	-x-	31 84	
	ISZ	31 34	
180	GTO 5	22 05	
	f LBL E	31 25 15	i(t) overdamped
	STO 9	33 09	
	x⇄y	35 52	
	RCL 1	34 01	
	RCL 4	34 04	
	x	71	
	1/x	35 62	
	x	71	
	STO A	33 11	
190	f LBL 6	31 25 06	i(t) loop
	GSB 4	31 22 04	
	ENTER	41	
	ENTER	41	
	RCL 4	34 04	
	x	71	
	GSB 2	31 22 02	
	x⇄y	35 52	
	RCL 3	34 03	
	x	71	
200	CHS	42	
	e^x	32 52	
	x	71	
	RCL A	34 11	
	x	71	
	STO B	33 12	
	-x-	31 84	
	ISZ	31 34	
	GTO 6	22 06	
	f LBL 2	31 25 02	sinh βt
210	e^x	32 52	
	ENTER	41	
	1/x	35 62	
	−	51	
	2	02	
	÷	81	
	RTN	35 22	
	f LBL 4	31 25 04	t + Δt
	RCL 9	34 09	
	RCL i	35 34	
220	x	71	
	STO C	33 13	
	RTN	35 22	

LABELS

A	B	C	D	E
RLC	i(t)	i(t) underdamped	i(t) crit. damped	i(t) overdamped
a	b	c	d	e
0 RLC crit. damped	1 RLC overdamped	2 sinh βt	3 i(t) loop	4 t + Δt
5 i(t) loop	6 i(t) loop	7	8	9

FLAGS

Flag	Use
0	underdamped
1	overdamped
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☐
GRAD	☐
RAD	☒

DISP	
FIX	☐
SCI	☐
ENG	☒
n	4

Program Description I

Program Title PASSIVE HIGH AND LOW PASS COMPOSITE FILTER DESIGN

Contributor's Name ROBERT L. SHERMAN

Address 808 SOUTH SARATOGA AVENUE, APT. D-206

City SAN JOSE **State** CA **Zip Code** 95129

Program Description, Equations, Variables Given the desired cut-off frequency and image impedance, the program computes the component values for a prototype "T" or "π" high or low pass filter. Given the desired frequency of infinite attenuation or the desired "m", the program will then compute the component values for an m-derived filter section based on the prototype previously computed.

<u>High-Pass Formulas</u>

$$L_k = \frac{R}{4\pi f_c} \qquad C_k = \frac{1}{4\pi R f_c}$$

$$L_b = \frac{L_k}{m} \qquad C_a = \frac{C_k}{m}$$

$$L_a = \frac{4m}{1-m^2} L_k \qquad C_b = \frac{4m}{1-m^2} C_k$$

$$m = \left[1 - (f_\infty / f_c)^2\right]^{1/2}$$

<u>Low Pass Formulas</u>

$$L_k = \frac{R}{\pi f_c} \qquad C_k = \frac{1}{\pi R f_c}$$

$$L_a = m L_k \qquad C_b = m C_k$$

$$L_b = \frac{1-m^2}{4m} L_k \qquad C_a = \frac{1-m^2}{4m} C_k$$

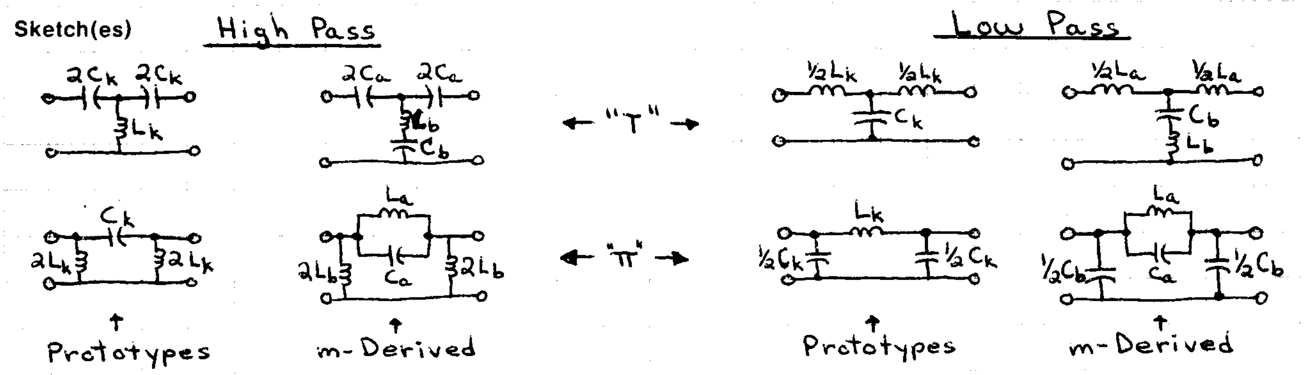
$$m = \left[1 - (f_c / f_\infty)^2\right]^{1/2}$$

Variables: f_c = Cut-off frequency; R = Image impedance; L = Inductance; C = Capacitance; f_∞ = Frequency of infinite attenuation.

Operating Limits and Warnings

Program Description II

Sketch(es)



Sample Problem(s) (1) Given $f_c = 10\text{ kHz}$ and $R_o = 100\ \Omega$, design "T" low pass prototype and m-derived filter sections. ($m = 0.5$)

(2) Given $f_c = 75\text{ Hz}$ and $R_o = 50\ \Omega$, design "π" high pass prototype and m-derived filter sections. ($f_\infty = 65\text{ Hz}$)

Solution(s)

Keystrokes		
[f] [A]	→ 0.00	
10 [EEX] 3 [↑] 100 [A]	→ 10.00×10^3	
[f] [B]	→ 318.3×10^{-9}	(C_k)
	1.592×10^{-3}	(½L_k)
0.5 [f] [C]	→ 1.194×10^{-3}	(L_b)
	159.2×10^{-9}	(C_b)
	795.8×10^{-6}	(½L_a)

Keystrokes		
75 [↑] 50 [A]	→ 75×10^0	
[D]	→ 106.1×10^{-3}	($2L_k$)
	21.22×10^{-6}	(C_k)
65 [E]	→ 212.7×10^{-3}	($2L_b$)
	42.54×10^{-6}	(C_a)
	140.9×10^{-3}	(L_a)

Reference(s)

Skilling, Hugh H.; Electrical Engineering Circuits; Sixth Printing; Pages 619-620; John Wiley & Sons; 1961.

User Instructions

Prototype and m-Derived Low & High Pass Filter Design

1					2
Set "m"	Proto T-LP	m-Der T-LP	Proto T-HP	m-Der T-HP	
↑f_c, R_o	Proto π-LP	m Der π-LP	Proto π-HP	m-Der π-HP	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load side 1 and side 2.		[ ]	[ ]	
2*	Optional: Set "m" mode.		f	A	
3	Input f_c	f_c, Hz	ENTER↑		f_c, Hz
4	Input R_o	R_o, Ω	A		f_c, Hz
5	Compute prototype "T" low pass		f	B	C_k, F
					½L_k, H
6	Compute prototype "π" low pass		B		½C_k, F
					L_k, H
7	Compute m-derived "T" low pass	$f_{\infty 1}$, Hz	f	C	L_b, H
		or "m"†			C_b, F
					½L_a, H
8	Compute m-derived "π" low pass	$f_{\infty 1}$, Hz	C		½C_b, F
		or "m"†			L_a, H
					C_a, F
9	Compute prototype "T" high pass		f	D	L_k, H
					2C_k, F
10	Compute prototype "π" high pass		D		2L_k, H
					C_k, F
11	Compute m-derived "T" high pass	$f_{\infty 1}$, Hz	f	E	C_b, F
		or "m"†			L_b, H
					2C_a, F
12	Compute m-derived "π" high pass	$f_{\infty 1}$, Hz	E		2L_b, H
		or "m"†			C_a, F
					L_a, H
	*Must be performed when "m" will be input in Steps 7,8,11 or 12. Otherwise, do <u>not</u> perform.				
	† - Ensure Step 2 has been performed.				

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	g LBL f a	32 25 11	Set F0 for "m-derived filters.
	h SF 0	35 51 00	
	h RTN	35 22	
	f LBL A	31 25 11	
	STO 2	33 02	Store R_o
	h R↓	35 53	
	STO 1	33 01	Store f_c
	h RTN	35 22	
	g LBL f b	32 25 12	T-Low Pass Prototype
010	f GSB 2	31 22 02	
	RCL 4	34 04	
	f -x-	31 84	Display C_k
	RCL 3	34 03	
	2	02	
	÷	81	
	h RTN	35 22	Display ½L_k
	f LBL B	31 25 12	π-Low Pass Prototype
	f GSB 2	31 22 02	
	RCL 4	34 04	
020	2	02	
	÷	81	
	f -x-	31 84	Display ½C_k
	RCL 3	34 03	
	h RTN	35 22	Display L_k
	g LBL f d	32 25 14	T-High Pass Prototype
	f GSB 3	31 22 03	
	RCL 5	34 05	
	f -x-	31 84	Display L_k
	2	02	
030	RCL 6	34 06	
	x	71	
	h RTN	35 22	Display 2C_k
	f LBL D	31 25 14	π-High Pass Prototype
	f GSB 3	31 22 03	
	2	02	
	RCL 5	34 05	
	x	71	
	f -x-	31 84	Display 2L_k
	RCL 6	34 06	
040	h RTN	35 22	Display C_k
	f LBL 1	31 25 01	Compute π f_c
	h π	35 73	
	RCL 1	34 01	
	x	71	
	h RTN	35 22	
	f LBL 2	31 25 02	Compute C_k and L_k for Low Pass Filter and store.
	RCL 2	34 02	
	f GSB 1	31 22 01	
	÷	81	
050	STO 3	33 03	(L_k)
	f GSB 1	31 22 01	
	RCL 2	34 02	
	x	71	
	h 1/x	35 62	
	STO 4	33 04	(C_k)
	h RTN	35 22	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	f LBL 3	31 25 03	Compute C_k and L_k for High Pass Filter and store.
	RCL 2	34 02	
	f GSB 1	31 22 01	
060	4	04	
	x	71	
	÷	81	
	STO 5	33 05	(L_k)
	f GSB 1	31 22 01	
	4	04	
	x	71	
	RCL 2	34 02	
	x	71	
	h 1/x	35 62	
070	STO 6	33 06	(C_k)
	h RTN	35 22	
	g LBL f c	32 25 13	m-Derived "T" Low Pass Filter
	STO 0	33 00	
	f GSB 5	31 22 05	
	RCL 0	34 00	
	h F? 0	35 71 00	
	f GSB 4	31 22 04	
	f GSB 7	31 22 07	
	RCL 3	34 03	
080	x	71	
	f -x-	31 84	Display L_b
	RCL 4	34 04	
	RCL 7	34 07	
	x	71	
	f -x-	31 84	Display C_b
	RCL 7	34 07	
	RCL 3	34 03	
	x	71	
	2	02	
090	÷	81	
	h RTN	35 22	Display ½L_a
	f LBL C	31 25 13	m-Derived "π" Low Pass Filter
	STO 0	33 00	
	f GSB 5	31 22 05	
	RCL 0	34 00	
	h F? 0	35 71 00	
	f GSB 4	31 22 04	
	RCL 4	34 04	
	RCL 7	34 07	
100	x	71	
	2	02	
	÷	81	
	f -x-	31 84	Display ½C_b
	RCL 3	34 03	
	RCL 7	34 07	
	x	71	
	f -x-	31 84	Display L_a
	f GSB 7	31 22 07	
	RCL 4	34 04	
110	x	71	
	h RTN	35 22	Display C_a
	f LBL 4	31 25 04	

REGISTERS

0	1	2	3	4	5	6	7	8	9
Used	f_c	R_o	L_k (Low Pass)	C_k (Low Pass)	L_k (High Pass)	C_k (High Pass)	m		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

67 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
	STO 7	33 07	Store "m"
	h CF 0	35 61 00	
	h RTN	35 22	
	f LBL 5	31 25 05	
	RCL 1	34 01	Compute and store "m", given f_∞ (Low Pass Filters)
	h x⇄y	35 52	
	÷	81	
120	g x^2	32 54	
	CHS	42	
	1	01	
	+	61	
	h ABS	35 64	
	f $\sqrt{x}$	31 54	
	STO 7	33 07	(m)
	h RTN	35 22	
	f LBL 7	31 25 07	
	RCL 7	34 07	Compute $\frac{1-m^2}{4m}$
130	g x^2	32 54	
	CHS	42	
	1	01	
	+	61	
	RCL 7	34 07	
	÷	81	
	4	04	
	÷	81	
	h RTN	35 22	
	g LBL f e	32 25 15	m-Derived "T" High Pass Filter
140	STO 0	33 00	
	f GSB 6	31 22 06	
	RCL 0	34 00	
	h F? 0	35 71 00	
	f GSB 4	31 22 04	
	RCL 6	34 06	
	f GSB 7	31 22 07	
	÷	81	
	f -x-	31 84	Display C_b
	RCL 5	34 05	
150	RCL 7	34 07	
	÷	81	
	f -x-	31 84	Display L_b
	RCL 6	34 06	
	RCL 7	34 07	
	÷	81	
	2	02	
	x	71	
	h RTN	35 22	Display $2C_a$
	f LBL E	31 25 15	m-Derived "π" High Pass Filter
160	STO 0	33 00	
	f GSB 6	31 22 06	
	RCL 0	34 00	
	h F? 0	35 71 00	
	f GSB 4	31 22 04	
	RCL 5	34 05	
	RCL 7	34 07	
	÷	81	
	2	02	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	x	71	
170	f -x-	31 84	Display $2L_b$
	RCL 6	34 06	
	RCL 7	34 07	
	÷	81	
	f -x-	31 84	Display C_a
	RCL 5	34 05	
	f GSB 7	31 22 07	
	÷	81	
	h RTN	35 22	Display L_a
	f LBL 6	31 25 06	
180	RCL 1	34 01	Compute and store "m", given f_∞. (High Pass Filters)
	÷	81	
	g x^2	32 54	
	CHS	42	
	1	01	
	+	61	
	h ABS	35 64	
	f $\sqrt{x}$	31 54	
	STO 7	33 07	
	h RTN	35 22	
190			
200			
210			
220			

LABELS				
A Store R_o & f_c	B π Low Pass Prototype	C m-Derived π Low Pass	D π High Pass Prototype	E m-Derived π High Pass
a Set F0 for "m-Der."	b T Low Pass Prototype	c m-Derived T Low Pass	d T High Pass Prototype	e m-Derived T High Pass
0	1 Compute πf_c	2 C_k & L_k Low Pass	3 C_k & L_k High Pass	4 Store m
5 Compute & store m (LP)	6 Compute & store m (HP)	7 Compute $(1-m^2)/4m$	8	9

FLAGS	
0	Used
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☐
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☒
3	☐	☒			n	3

Program Description I

Program Title "L" Attenuator (Generator Impedance Greater than Load Impedance)

Contributor's Name H. Peter Meisinger

Address c/o Versitron, Inc. 6310 Chillum Pl, NW

City Washington, DC **State** **Zip Code** 20011

Program Description, Equations, Variables

LCL C Computes and stores K and S.
Computes and displays the minimum loss.

$$R_s \text{ (series)} = \frac{Z\ gen}{S}\left(\frac{KS-1}{K}\right)$$

$$R_p \text{ (parallel)} = \frac{Z\ gen}{S}\left(\frac{1}{K-S}\right)$$

where

$$S = \sqrt{Z\ gen / Z\ load}$$

$$K = 10^{(db/20)} = \frac{E\ in}{E\ out}$$

$$\text{Min Power loss db} = 10 \log_{10}\left(\sqrt{\frac{Z\ gen}{Z\ load}} + \sqrt{\frac{Z\ gen}{Z\ load} - 1}\right)^2$$

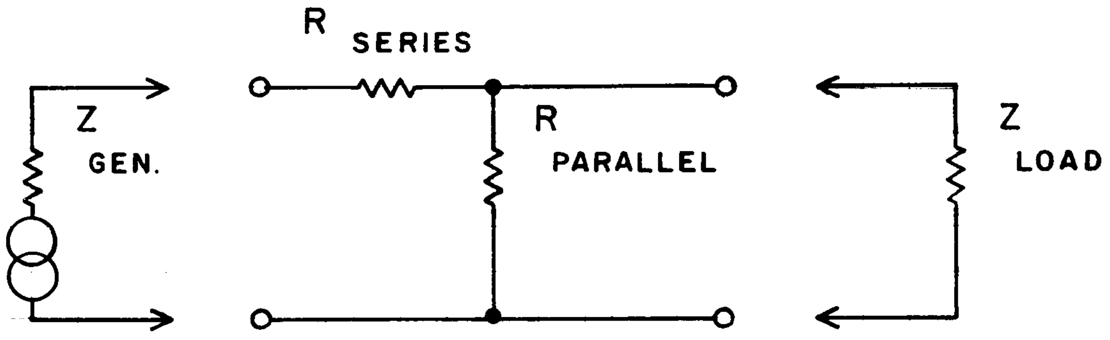
$$Z\ out = \frac{R\ ser \times R\ par}{R\ ser + R\ par} \quad \text{(when Z gen = Zero)}$$

$$Z\ out = \frac{1}{\dfrac{1}{Z\ gen + R\ ser} + \dfrac{1}{R\ par}} \quad \text{(when Z gen is matched)}$$

Operating Limits and Warnings Use the program only where the generator impedance is equal to or greater than the load impedance.

Program Description II

Sketch(es)



Sample Problem(s)

1.. Design a minimum loss attenuator to match an 8 ohm generator to a 4 ohm load and compute the minimum loss.

2. Design a 10 db attenuator to join a 600 ohm generator to a 500 ohm load.

3. Design a 6 db attenuator to work between a 150 ohm generator and a 150 ohm load.

In each of the above cases:

A. Compute the impedance of pad and matched impedance generator combination as viewed by the load.

B. Compute the impedance of pad and zero impedance generator combination as viewed by the load.

Solution(s)

	R_s (Series)	R_p (Parallel)	Loss	Z Matched Z gen + Pad	Z Zero Z gen + Pad
1.	5.6569 ohms	5.6569 ohms	7.6555 db (min)	4	2.8284
2.	426.7949	265.0058	10	210.6413	163.4909
3.	74.8219	150.7140	6	90.2279	49.9996

Reference(s)

User Instructions

1	Z gen	Z load	db	R ser	R par	2
	Match	Zero	Min db	"L" $Z_g \geq Z_L$		

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter Generator Impedance	Ohms	A		Ohms
2	Enter Load Impedance	Ohms	B		Ohms
3a	Enter Desired Loss	db	C		Min loss db
3b	Compute Minimum Loss Pad		f	c	Min loss db
4	Compute R series		D		Ohms
5	Compute R parallel		E		Ohms
6	Compute Impedance of Pad and Matched Z Generator combination as viewed by the load		f	a	Ohms
7	Compute Impedance of Pad and Zero Z Generator combination as viewed by the load.		f	b	Ohms
8	Recall Z gen		RCL	A	Ohms
9	Recall Z load		RCL	B	Ohms
10	Recall $K = \frac{E\ in}{E\ out} = 10^{(db/20)}$		RCL	C	K
11	Recall R series		RCL	D	Ohms
12	Recall R parallel		RCL	E	Ohms
13	Recall S = Z gen/Z load		RCL	3	S

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL A	31-25-11	
	STO A	33-11	Z gen
	h RTN	35-22	
	f LBL B	31-25-12	
	STO B	33-12	Z load
	h RTN	35-22	
	f LBL C	31-25-13	
	DSP 4	23-04	
	2	02	
010	0	00	
	÷	81	
	g 10^x	32-53	$10^{(db/20)}=K$
	STO C	33-13	K
	RCL A	34-11	Z_G
	RCL B	34-12	Z_L
	÷	81	Z_G/Z_L
	f $\sqrt{x}$	31-54	
	STO 3	33-03	$\sqrt{Z_G/Z_L}=S$
	↑	41	
020	g x^2	32-54	Z_G/Z_L
	1	01	
	−	51	$(Z_G/Z_L)-1$
	f $\sqrt{x}$	31-54	
	+	61	
	g x^2	32-54	
	f Log	31-53	
	1	01	
	0	00	
	×	71	
030	h RTN	35-22	
	g LBL c	32-25-13	
	f GSB C	31-22-13	
	GTO C	22-13	
	f LBL D	31-25-14	
	RCL A	34-11	Z_G
	RCL 3	34-03	S
	÷	81	Z_G/S
	RCL C	34-13	K
	RCL 3	34-03	S
040	×	71	KS
	1	01	
	−	51	(KS)-1
	RCL C	34-13	K
	÷	81	[(KS)-1] /K
	×	71	
	STO D	33-14	R series
	h RTN	35-22	
	f LBL E	31-25-15	
	RCL A	34-11	Z_G
050	RCL 3	34-03	S
	÷	81	Z_G/S
	RCL C	34-13	K
	RCL 3	34-03	S
	−	51	K-S
	h 1/x	35-62	1/(K-S)
	×	71	
	STO E	33-15	R par
	h RTN	35-22	
	g LBL a	32-25-11	
060	RCL A	34-11	Z gen
	RCL D	34-14	R ser
	+	61	Z_G+R_S
	h 1/x	35-62	
	RCL E	34-15	R par
	h 1/x	35-62	
	+	61	
	h 1/x	35-62	Z out for matched Z gen
	h RTN	35-22	
	g LBL b	32-25-12	
070	RCL D	34-14	R ser
	RCL E	34-15	R par
	×	71	$R_S R_P$
	RCL D	34-14	R ser
	RCL E	34-15	R par
	+	61	$R_S + R_P$
	÷	81	
	h RTN	35-22	
080			
090			
100			
110			

REGISTERS

0	1	2	3	4	5	6	7	8	9
			S						

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Z gen	Z load	K	R series	R par	

Program Description I

Program Title 1% RESISTANCE VALUE SUBROUTINE

Contributor's Name TERRY MICKELSON

Address PO BOX 608,

City DUNCAN, B.C., CANADA **State** **Zip Code** V9L 3X9

Program Description, Equations, Variables THE 28 STEPS OF THIS SUBROUTINE FIND THE NEAREST AVAILABLE 1% (2%) RESISTOR FROM WHATEVER VALUE IS ENTERED INTO THE PROGRAM. WHILE NO SAFEGUARDS ARE BUILT IN TO REJECT UNREAL VALUES, IT IS EXPECTED THAT THE USER WOULD RECOGNIZE THESE AND IGNORE THE OUTPUT. THE PROGRAM FINDS THE GRADE # OF THE INPUT VALUE THEN CALCULATES THE REAL VALUE FOR THAT GRADE. THIS IS DONE BY THE RND FUNCTION WHICH CORRECTS THE CALCULATED GRADE TO A REAL GRADE PRIOR TO FINDING THE RESISTANCE VALUE ASSOCIATED WITH THIS.

A FEW OPTIONS ARE OPEN TO THE USER IN THAT THE LABEL MAY BE CHANGED, THE GRADE # MAY BE DISPLAYED AND THE OUTPUT MAY BE LEFT IN THE FIX MODE. PRESENTLY,THE OUTPUT IS SET TO THE ENG. MODE ALTHOUGH THE PROGRAM INCLUDES THE FIX MODE FOR THE RND FUNCTIONS'OPERATION. STEP ØØ2: FIX,MAY BE DELETED IF THE CALLING PROGRAM PRESETS THE FIX MODE -OR- THE FIX MODE IS USED EXCLUSIVELY IN WHICH CASE STEP Ø27: ENG., MAY BE DELETED ALSO FOR A 26 STEP ROUTINE.

Operating Limits and Warnings AN ERROR INDICATION WILL OCCUR IF THE INPUT IS NEGATIVE AND THAT'S AS IT SHOULD BE. VALUES OVER 10 MEGS ARE NOT AVAILABLE, SO IGNORE THE O/P IF OVER 10 MEGS. ie SELECT A 5% VALUE.

Program Description II

Sketch(es)

Sample Problem(s) A FEW ENTRIES ARE GIVEN AS EXAMPLES:

INPUT	CAL. GRADE.	ACTUAL GRADE.	ACTUAL AVAILABLE	VALUE.	
3500	52.231	52	(3480)	3.480	03
6300	76.737	77	(6340)	6.340	03
106284	2.541	3	(107000)	107.0	03
312247	47.472	47	(309000)	309.0	03

IT MAY BE NECESSARY TO INCLUDE ANOTHER SUBROUTINE IN THE MAIN PROGRAM TO GIVE THE RESULTANT REAL TIMES, VOLTAGES ETC. BASED ON THESE NEW RESISTANCES. THIS CHANGE FROM CALCULATED TO ACTUAL AVAILABLE VALUES SHOULDN'T BE OVERLOOKED.

THE VALUES GENERATED BY THIS PROGRAM WERE COMPARED TO A CHART OF 1% RESISTORS AND WERE FOUND TO BE ACCURATE.

Solution(s)

Reference(s)

User Instructions

1% RESISTANCE VALUE SUBROUTINE.

28 STEPS-ONE LABEL __ . NO REGISTERS USED.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	CHECK MAIN PROGRAM FOR A SUITABLE MERGE			
	LOCATION.GTO THAT LOCATION.			
2	PRESS g-MERGE or f-MERGE, READ CARD, ONE SIDE.			
3	IN W/PRGM MODE, KEY IN CALLING ROUTINES. CHANGE			
	THE SUBROUTINE'S LABEL IF IT CONFLICTS WITH			
	THE MAIN PROGRAM.			
4	AFTER THE CALLING ROUTINES, KEY IN OUTPUT-			
	ROUTINE ROUTING OR NEW VALUE CHECK SUBROUTINE-			
	ADDRESS.ie PERFORMANCE WITH REAL COMPONENTS.			
5	CHECK PROPER OPERATION WITH KNOWN VALUES.			
6	--NOTE--			
	FILL IN THE LABEL AND ITS CODE IN THE PROGRAM			
	LISTING. THIS WAS LEFT BLANK ON PURPOSE.			

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	* LBL ___	3_ 25 ___	Calculated value of resistor.
	FIX	31 23	
	LOG	31 53	
	FRAC	32 83	FIX MODE IS USED ALLOWING RND FUNCTION TO OPERATE PROPERLY.
	LAST X	35 82	
	INT	31 83	
	2	02	
	−	51	
	10^x	32 53	
010	X ⇄ Y	35 52	
	9	09	
	6	06	
	1/X	35 62	
	÷	81	
	LAST X	35 82	
	10^x	32 53	
	X ⇄ Y	35 52	
	DSP Ø	23 00	
	RND	31 24	INS.PAUSE TO SEE-GRADE CLASSIFICATION.
020	Y^x	35 63	
	EEX	43	
	2	02	
	x	71	
	RND	31 24	
	x	71	
	DSP 3	23 03	)OPTIONAL RTN. RESET
	ENG	35 23	
	RTN	35 22	
030			
040			
050			

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	* LBL ___	3_ 25 ___	This is a shorter version of the program to the left. Both programs will carry the input in the stack if ENTER↑ follows the label.
	FIX	31 23	
	LOG	31 53	
	FRAC	32 83	
	LAST X	35 82	
	INT	31 83	
	10^x	32 53	
	X⇄Y	35 52	
	9	09	Step 002 [FIX] may be deleted if the calling program is in the FIX mode. (21 steps minimum)
010	6	06	
	1/X	35 62	
	÷	81	
	LAST X	35 82	
	10^x	32 53	
	X⇄Y	35 52	
	DSP Ø	23 00	
	RND	31 24	
	Y^x	35 63	
	DSP 2	23 02	
020	RND	31 24	
	x	71	
	RTN	35 22	
090			
100			LBLs & STATUS TO AGREE WITH CALLING PROGRAM, IF LOADED FIRST.
110			

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	■	DEG	■	FIX	■
1	☐	■	GRAD	☐	SCI	☐
2	☐	■	RAD	☐	ENG	☐
3	☐	■			n 2	

REGISTERS

0	1	2	3	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Wheatstone Bridge

Contributor's Name Harry E. Parshall Jr.

Address 3772 Menzie RD SE

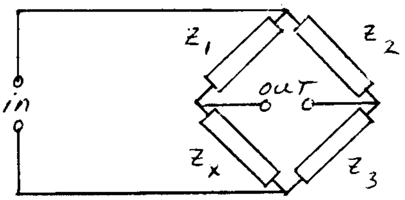
City Port Orchard **State** Wash **Zip Code** 98366

Program Description, Equations, Variables

Given three of the impedances in a basic Wheatstone Bridge, this program computes the fourth. Inputs are: real, polar, or rectangular numbers.

$$Z_x = \frac{Z_1 Z_3}{Z_2} \angle \theta_1 - \theta_2 + \theta_3$$

Rect. inputs are first converted to Polar.



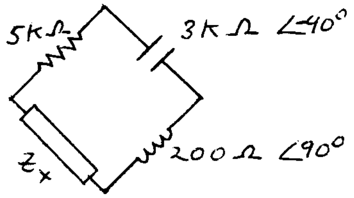
Operating Limits and Warnings None

Program Description II

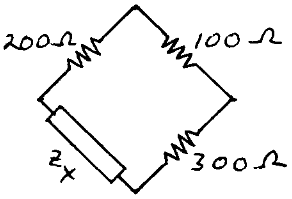
Sketch(es)

Sample Problem(s)

Problem 1



Problem 2



Solution(s)

Problem 1

Press	Display
C	1.00E00
0 Enter	
5 EEX 3 R/S	2.00E00
90 CHS Enter	
3 EEX 3 R/S	3.00E00
90 Enter	
200 R/S	333. E00 = z_x
R/S	180. E00 = θ_x

Problem 2

Press	Display
B	1.00E00
200 R/S	2.00E00
100 R/S	3.00E00
300 R/S	600. E00 = z_x

Reference(s) None

User Instructions

Wheatstone Bridge

1 | real | polar | rect | 2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Read card into calculator.			
2	Select input mode:			
	real		B	1.00E00
	polar		C	1.00E00
	rect		D	1.00E00
3	To input real go to step 9.			
4	Input impedances 1,2,&3.	θ or y	ENTER	
		r or x	R/S	count
5	Repeat step 4 for all 3 impedances.			
6	After all three impedances are input			
	calculator will display r or x depending			
	on mode selected.			r or x
7	To see θ or y press:		R/S	θ or y
8	For new case go to step 2.			
9	Input resistances 1,2,&3.	R	R/S	count
10	Repeat step 9 for all three impedances			
	calculator will display R_4.			R_4
11	For new case go to step 2.			

67 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	f LBL B	31 25 12	store and calculate real.
	1	01	
	R/S	84	
	f P⇄S	31 42	
	STO 0	33 00	
	f P⇄S	31 42	
	2	02	
	R/S	84	
	f P⇄S	31 42	
010	STO 1	33 01	
	f P⇄S	31 42	
	3	03	
	R/S	84	
	f P⇄S	31 42	
	STO 3	33 03	
	RCL 0	34 00	
	x	71	
	RCL 1	34 01	
	÷	81	
020	f P⇄S	31 42	
	GTO 1	22 01	
	f LBL D	31 25 14	rect.
	f GSB 0	31 22 00	
	RCL 3	34 03	
	RCL 2	34 02	
	g R→P	32 72	
	RCL 1	34 01	
	RCL 0	34 00	
	g R→P	32 72	
030	h x⇄y	35 52	
	h R↑	35 54	
	−	51	
	h R↓	35 53	
	h x⇄y	35 52	
	÷	81	
	h R↑	35 54	
	h x⇄y	35 52	
	RCL 5	34 05	
	RCL 4	34 04	
040	g R→P	32 72	
	h x⇄y	35 52	
	h R↓	35 53	
	x	71	
	h R↓	35 53	
	+	61	
	h R↑	35 54	
	f LBL 1	31 25 01	} x⇄y
	R/S	84	
	h x⇄y	35 52	
050	GTO 1	22 01	
	f LBL C	31 25 13	polar
	f GSB 0	31 22 00	
	RCL 0	34 00	
	RCL 4	34 04	
	x	71	
	RCL 2	34 02	
	÷	81	
	RCL 1	34 01	
	RCL 3	34 03	
060	−	51	
	RCL 5	34 05	
	+	61	
	h x⇄y	35 52	
	GTO 1	22 01	
	f LBL 0	31 25 00	} store z_1, z_2, + z_3
	1	01	
	R/S	84	
	f P⇄S	31 42	
	STO 0	33 00	
070	h R↓	35 53	
	STO 1	33 01	
	f P⇄S	31 42	
	2	02	
	R/S	84	
	f P⇄S	31 42	
	STO 2	33 02	
	h R↓	35 53	
	STO 3	33 03	
	f P⇄S	31 42	
080	3	03	
	R/S	84	
	f P⇄S	31 42	
	STO 4	33 04	
	h R↓	35 53	
	STO 5	33 05	
	h RTN	35 22	
090			
100			

FLAGS

0	
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☐
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☒
3	☐	☒			n 2	

LABELS

A	B real	C polar	D rect	E
a	b	c	d	e
0 store	1 used	2	3	4
5	6	7	8	9

REGISTERS

0	1	2	3	4	5	6	7	8	9
S0 used	S1 used	S2 used	S3 used	S4 used	S5 used	S6	S7	S8	S9

A	B	C	D	E	I

NOTES

NOTES

NOTES

Hewlett-Packard Software

In terms of power and flexibility, the problem-solving potential of the Hewlett-Packard line of fully programmable calculators is nearly limitless. And in order to see the practical side of this potential, we have several different types of software to help save you time and programming effort. Every one of our software solutions has been carefully selected to effectively increase your problem-solving potential. Chances are, we already have the solutions you're looking for.

Application Pacs

To increase the versatility of your fully programmable Hewlett-Packard calculator, HP has an extensive library of "Application Pacs". These programs transform your HP-67 and HP-97 into specialized calculators in seconds. Each program in a pac is fully documented with commented program listing, allowing the adoption of programming techniques useful to each application area. The pacs contain 20 or more programs in the form of prerecorded cards, a detailed manual, and a program card holder. Every Application Pac has been designed to extend the capabilities of our fully programmable models to increase your problem-solving potential.

You can choose from:

Statistics
Mathematics
Electrical Engineering
Business Decisions
Clinical Lab and Nuclear Medicine
Mechanical Engineering
Surveying
Civil Engineering
Navigation
Games

Users' Library

The main objective of our Users' Library is dedicated to making selected program solutions contributed by our HP-67 and HP-97 users available to you. By subscribing to our Users' Library, you'll have at your fingertips, literally hundreds of different programs. No longer will you have to: research the application; program the solution; debug the program; or complete the documentation. Simply key your program to obtain your solution. In addition, programs from the library may be used as a source of programming techniques in your application area.

A one-year subscription to the Library costs $9.00. You receive: a catalog of contributed programs; catalog updates; and coupons for three programs of your choice (a $9.00 value).

Users' Library Solutions Books

Hewlett-Packard recently added a unique problem-solving contribution to its existing software line. The new series of software solutions are a collection of programs provided by our programmable calculator users. Hewlett-Packard has currently accepted over 6,000 programs for our Users' Libraries. The best of these programs have been compiled into 40 Library Solutions Books covering 39 application areas (including two game books).

Each of the Books, containing up to 15 programs without cards, is priced at $10.00, a savings of up to $35.00 over single copy cost.

The Users' Library Solutions Books will compliment our other applications of software and provide you with a valuable new tool for program solutions.

Options/Technical Stock Analysis
Portfolio Management/Bonds & Notes
Real Estate Investment
Taxes
Home Construction Estimating
Marketing/Sales
Home Management
Small Business
Antennas
Butterworth and Chebyshev Filters
Thermal and Transport Sciences
EE (Lab)
Industrial Engineering
Aeronautical Engineering
Control Systems
Beams and Columns
High-Level Math
Test Statistics
Geometry
Reliability/QA
Medical Practitioner
Anesthesia
Cardiac
Pulmonary
Chemistry
Optics
Physics
Earth Sciences
Energy Conservation
Space Science
Biology
Games
Games of Chance
Aircraft Operation
Avigation
Calendars
Photo Dark Room
COGO-Surveying
Astrology
Forestry

EE LAB

Many of the charts commonly found in electrical engineering labs appear in this collection of programs.

- WIRE TABLE
- OHM'S LAW
- REACTANCE CHART (NINE EQUATIONS)
- COIL CALCULATIONS
- COMPLEX IMPEDANCE CALCULATOR - AC CIRCUIT CALCULATOR
- WYE-DELTA TRANSFORMATIONS
- RC TIMING
- SERIES R-L-C CIRCUIT ANALYSIS PROGRAM
- PASSIVE HIGH AND LOWPASS COMPOSITE FILTER DESIGN
- "L" ATTENUATOR (GENERATOR IMPEDANCE GREATER THAN LOAD IMPEDANCE)
- 1% RESISTOR VALUE SUBROUTINE
- WHEATSTONE BRIDGE

HEWLETT PACKARD

1000 N.E. Circle Blvd., Corvallis, OR 97330

Reorder No. 00097-14025 Printed in U.S.A. 00097-90200
Revision E 12-78