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"SURVEYING"

FOR THE HP-41

SC-5

SURVEYING

PROGRAM	TITLE	PAGE
01702	Topographic Surveying	1
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1702C PROGRAM DESCRIPTION I

Program Title: TOPOGRAPHIC SURVEYING

Contributor's Name: RAYMOND VAN DYKE

Address: P.O. BOX 2567

City: FRESNO State/Country: CALIFORNIA Zip Code: 93745

Program Description, Equations, Variables: This program calculates horizontial distances and elevations from the three stadia wire readings ; using any vertical angle mode (direct or inverted). It incoroperates a slope distance check by comparing half stadia to full stadia. Calculates tape topo. X-sections, in degrees or percent and vertical angle profiles.

Equations: H. D. = interval x 100 x $\cos^2$ vert. $\angle$

Elevation = H. I. elevation - (H.D. x tan vert $\angle$) + rod.

$\angle$ = ATAN

Necessary Accessories: NONE

Operating Limits and Warnings: Vertical angles are calculated assuming horizontal is zero .

C. and K. stadia factors can be changed when necessary.

Reference(s): NONE

01702C PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Ground elevation 8166.8
HI rod 5.85

#		ROD READINGS	VERTICAL ANGLE	TAPED DISTANCE
	T	9.38		
1.	C	9.00	95.38	
	B	8.62		
2.	C	0.00	88.12	55.1

Note: Angles are input DMS
Rod readings are read and input to hundreths of a foot

SOLUTION:

Input	Function	Display	Comments
	USER		set user mode
	FIX 1		fix decimal place
	XEQ SIZE 005		
	XEQ TOPO	TOPO PT. EL?	
8166.8	R/S	HI: ?	
5.85	R/S	8172.7	El. height of instrument
	R/S	VERT∠, %?	
95.38	R/S	STD, TAPE ?	type of shot stadia or tape
	(A)	T? C? B: ?	
9.38	ENTER		top hair reading
9.00	ENTER		center hair reading
8.62	R/S	S.D. CK = 0.00	bottom hair reading, evaluate slope distance check
	R/S	HD = 75.3	horizontal distance
	R/S	EL = 8156.2	elevation of shot
	R/S	VERT∠ % ?	next shot
88.12	R/S	STD, TAPE ?	
	(B)	SD: ?	slope distance
55.1	R/S	HD= 55.1	horizontal distance
	R/S	ROD ?	center hair reading
0.00	R/S	EL= 8174.4	elevation of shot

702C PROGRAM DESCRIPTION II

ample Problem (Sketch if Desired)

			LT	&	RT
#3					
STATION	ELEV.	Rod	5.0	5.0	3.0
1+00	8166.8	Percent	10%	0%	-60%
		Slope D.	75	0.0	125

LUTION:

Input	Function	Display	Comments
	XEQ TOPO	TOPO PT. &L ?	Ground El. at center point
8166.8	R/S	HI = ?	
5.0	R/S	8171.8	Height of insturment
	R/S	VERT∠, % ?	
.10	(G)	STD , TAPE ?	
	(B)	SD = ?	
75	R/S	74.6	Horizontal distance
	R/S	ROD = ?	
5.0	R/S	8174.3	Ground shot
	R/S	VERT∠, % ?	Next shot same HI
.60	CHS (G)	STD , TAPE ?	
	(B)	SD = ?	
125	R/S	107.2	
	R/S	ROD = ?	
3.0	R/S	8104.5	

USER INSTRUCTIONS

SIZE: (HP-41C) .005

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Load program			
2	Fix number of decimal places desired.			
3	Initilize program.		XEQ TOPO	TOPO PT.EL ?
4	Elevation of insturment point.	El	R/S	HI ?
5	Height of insturment .	HI	R/S	HI ?Elevation
6			R/S	VERT∢ , % ?
7	Zenith or transit type.	VERT.∢	R/S	STD. TAPE ?
	If transit type and - (CHS)	or %	(C)	
	If percent and - (CHS)			
8	If stadia.		(A)	T? C? B =?
9	Enter top hair reading.	T	ENTER	
	Enter center hair reading.	C	ENTER	
	Bottom hair reading.	B	R/S	S.D. CK=
10	Evaluate slope distance check.		R/S	HD= ( )
			R/S	EL= ( )
6	New shot.		R/S	VERT∢, % ?
7		VERT.∢	R/S	STD, TAPE ?
8	If taped same HI EL		(B)	S.D. =?
		Slope dist.	R/S	HD= ( )
9			R/S	ROD= ?
10		ROD	R/S	EL= ( )
	If new insturment station re-initialise			
	NOTES: Angles are input DMS			
	Rod readings are read and input to humdredths of a foot			

702C PROGRAM LISTING

67 □ 97 ⊠ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
01	LBL "TOPO"		
	DEG		
	TOPO PT, EL?		
	PROMPT		
	ENTER↑		
	HI= ?		
	PROMPT		
	+		
	STO 00		
10	HI=		
	ARCL X		
	AVIEW		
	STOP		
	LBL 01		
	180		
	ENTER↑		
	VERT∠, %?		
	PROMPT		
	X≷Y?		
20	CHS		
	HR		
	1		
	P-R		
	X∠=Y?		Changes vertical angles
	X∠>Y		
	R-P		
	RDN		
	LBL 02		
	STO 04		
30	STD, TAPE?		
	PROMPT		
	LBL A		
	T↑ C↑ B= ?		Stadia hair readings
	PROMPT		
	STO 01		
	RDN		
	STO 02		
	RDN		
	STO 03		
40	RCL 01		
	-		
	100		
	*		
	STO 01		
	RCL 03		
	RCL 02		Checks slope distance
	-		
	100		
	*		
50	2		

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
51	*		
	-		
	S.D. CK=		
	ARCL X		
	AVIEW		
	PROMPT		
	RCL 04		
	COS		
	X↑2		Calculates horizontal distance
60	RCL 01		
	*		
	HD=		
	ARCL X		
	AVIEW		Caleulates vertical diff and elevation
	STOP		
	RCL 04		
	TAN		
	*		
	RCL 00		
70	+		
	RCL 02		
	*		
	EL=		
	ARCL X		
	AVIEW		
	STOP		
	GTO 01		
	LBL B		If taped
	RCL 04		
80	ENTER↑		
	TAN		
	X∠>Y		
	COS		Calculstes horizontal distance
	SD= ?		
	PROMPT		
	*		
	HD=		
	ARCL X		
	AVIEW		
90	PROMPT		
	*		
	RCL 00		
	+		
	ROD= ?		
	PROMPT		
	-		Calculstes vert diff and elevation
	EL=		
	ARCL X		
	AVIEW		
00	STOP		

01702C PROGRAM LISTING

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
01	GTO 01		Changes % to degrees
	LBL G		
	aTAN		
	GTO 02		
	END		
10			
20			
30			
40			
50			
51			
60			
70			
80			
90			
00			

Note: Refer to the 41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E o

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

0 HI of instrument
1 Bottom Hair & Slope Dist
2 Center Line Hair
3 Top Hair
4 Verticle

STATUS

SIZE 005 TOT. REG.

USER MODE ON X OFF

ENG	X	FIX	SCI	
DEG	X	RAD	GRAD	

FLAGS

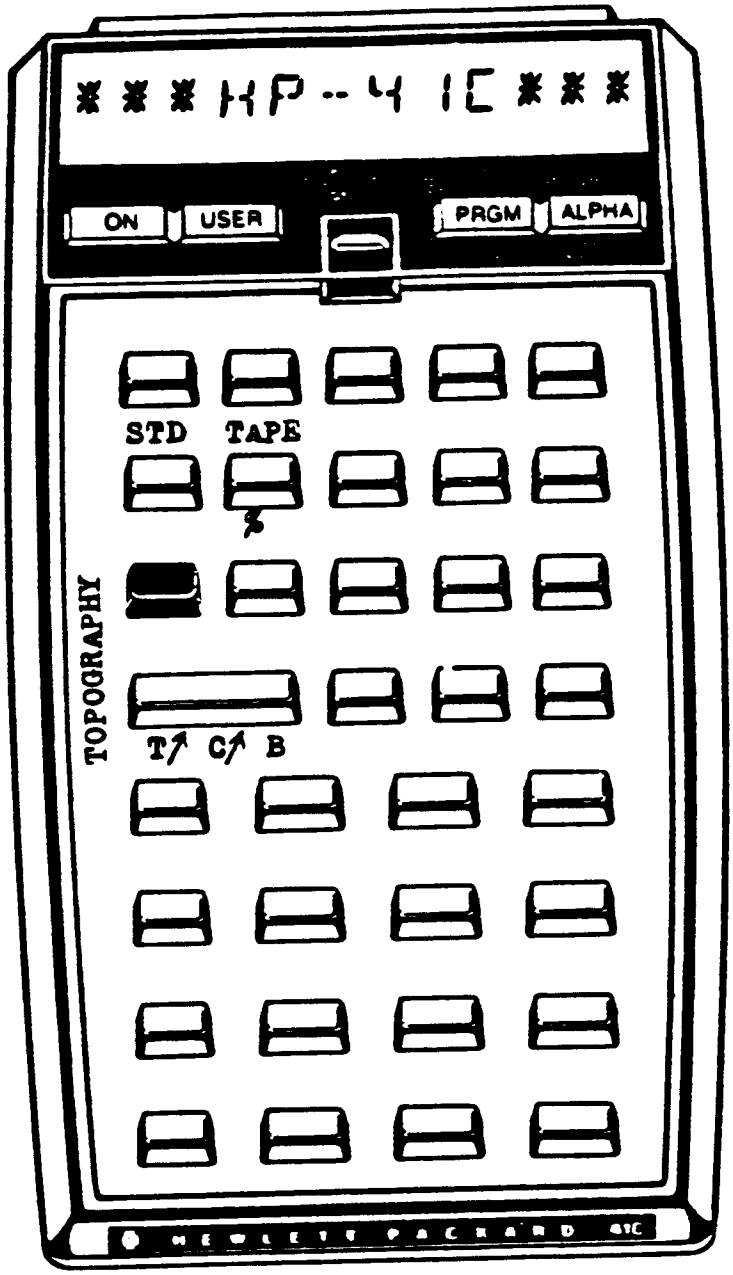
#	INIT S/C	SET INDICATES	CLEAR INDICATES

ASSIGNMENTS

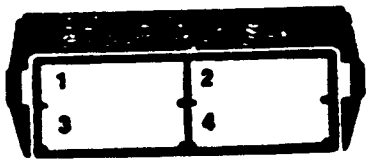
FUNCTION	KEY	FUNCTION	KEY

KEYBOARD CARD LABELING

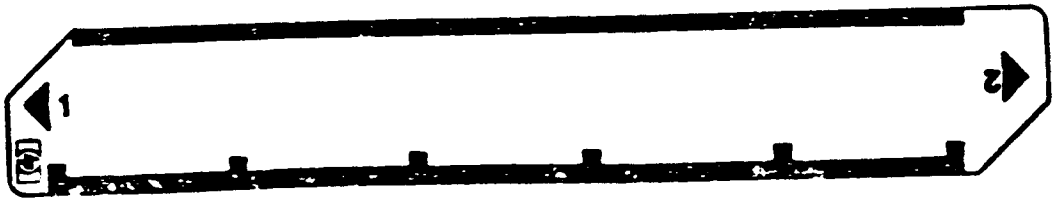
KEYBOARD



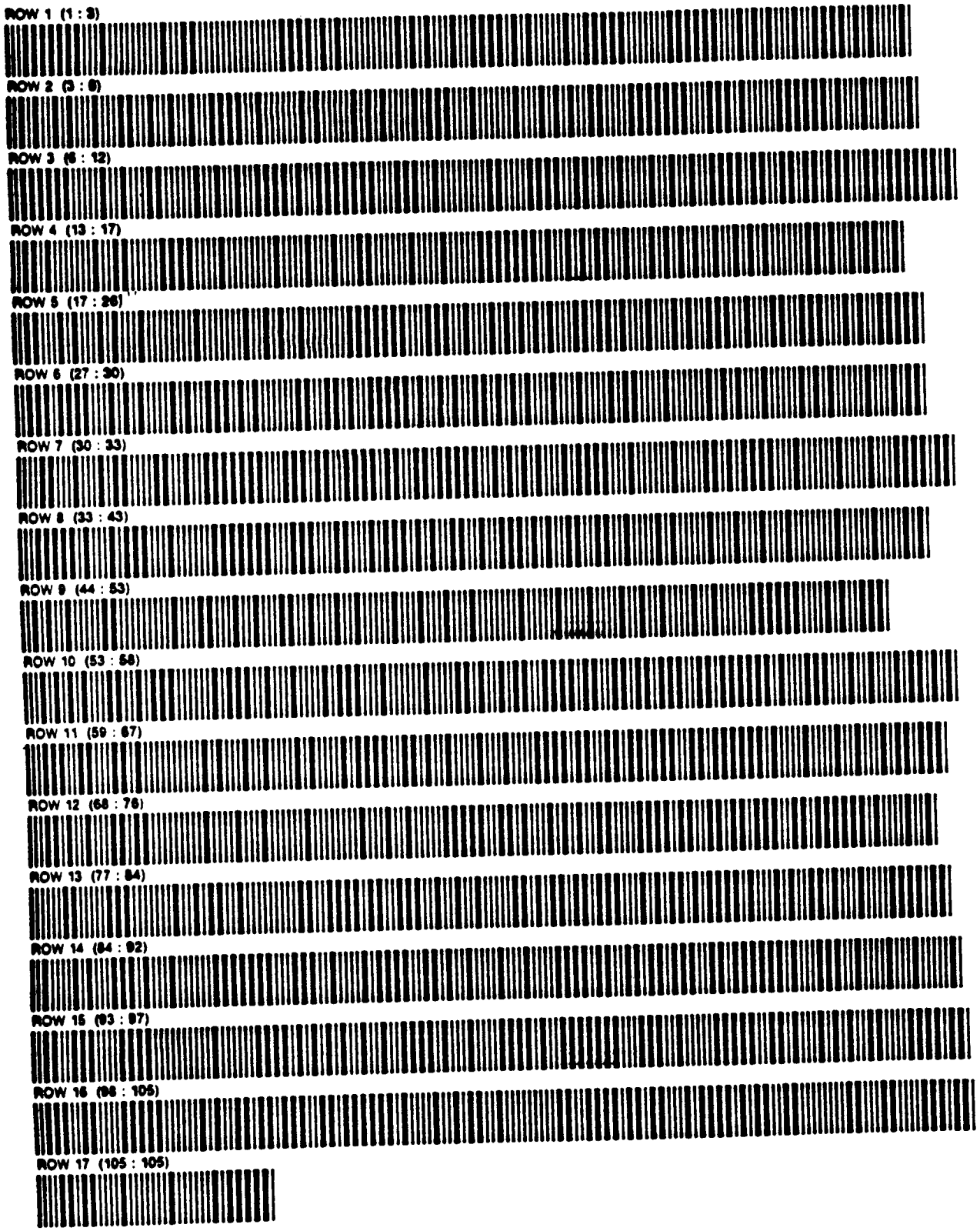
SYSTEM CONFIGURATION



CARD



PROGRAM REGISTERS NEEDED: 30



01701C

Media Manufactured by USA
Software Product of USA

PROGRAM DESCRIPTION I

ogram Title Circular Curve Layout For Baseline or Offset Line

ontributor's Name Lawrence D. Pierce, P.E.

ddress 6953 Mewall Drive

ity San Diego State/Country Calif. Zip Code 92119

rogram Description, Equations, Variables This program provides calculations for circular curve field layout. The program will provide the following: stations, deltas, right deflections, left deflections and chord distances for either baseline or offset line. Data is computed on either a interval or point solution with the end station computed also.

Equations used in program:

$$\text{Delta} = \frac{(\text{Length})(180)}{(\pi)(\text{Radius of Baseline})}$$; Lenght = Difference in baseline stations.

Right Deflection = $\frac{\text{Delta}}{2}$ & Left Deflections = $360 - \left(\frac{\text{Delta}}{2}\right)$

Chord Distance = (2)(Radius of Baseline or Offset) SIN $\left(\frac{\text{Delta}}{2}\right)$

Necessary Accessories 1. Memory module, card reader and printer (optional)

Operating Limits and Warnings Calculations proceed up station only from either beginning of curve or point of curve. Program assumes DEG mode is set and status of flag 21 matches that of flag 55.

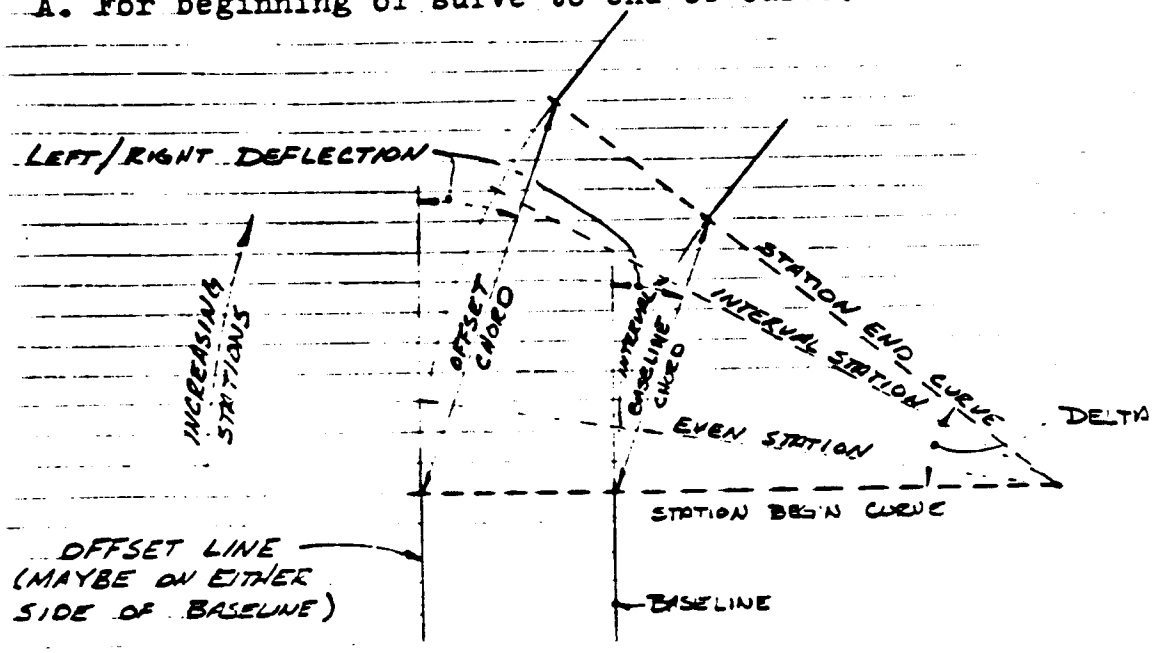
Reference(s)

01701C

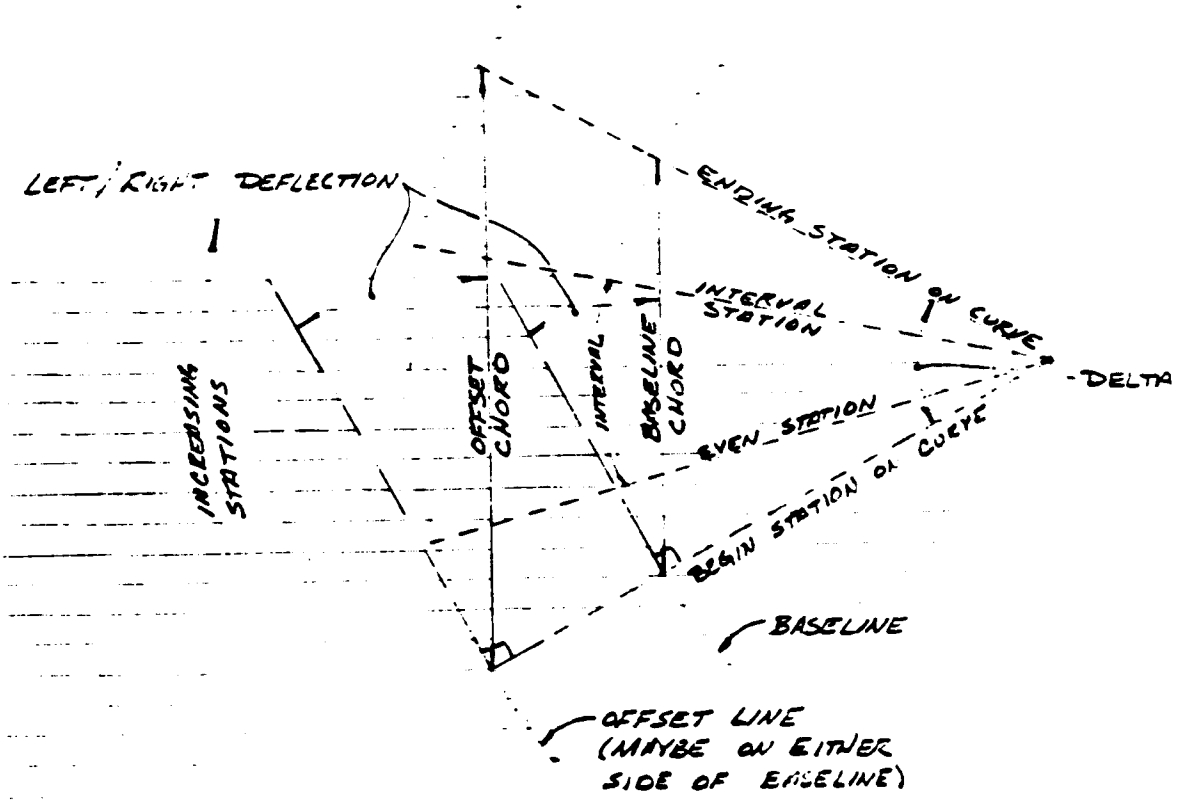
(CONTINUATION PAGE)

The following are two sketchs to show defination for program:

A. For beginning of surve to end of curve.



B. For point on curve to point on curve.

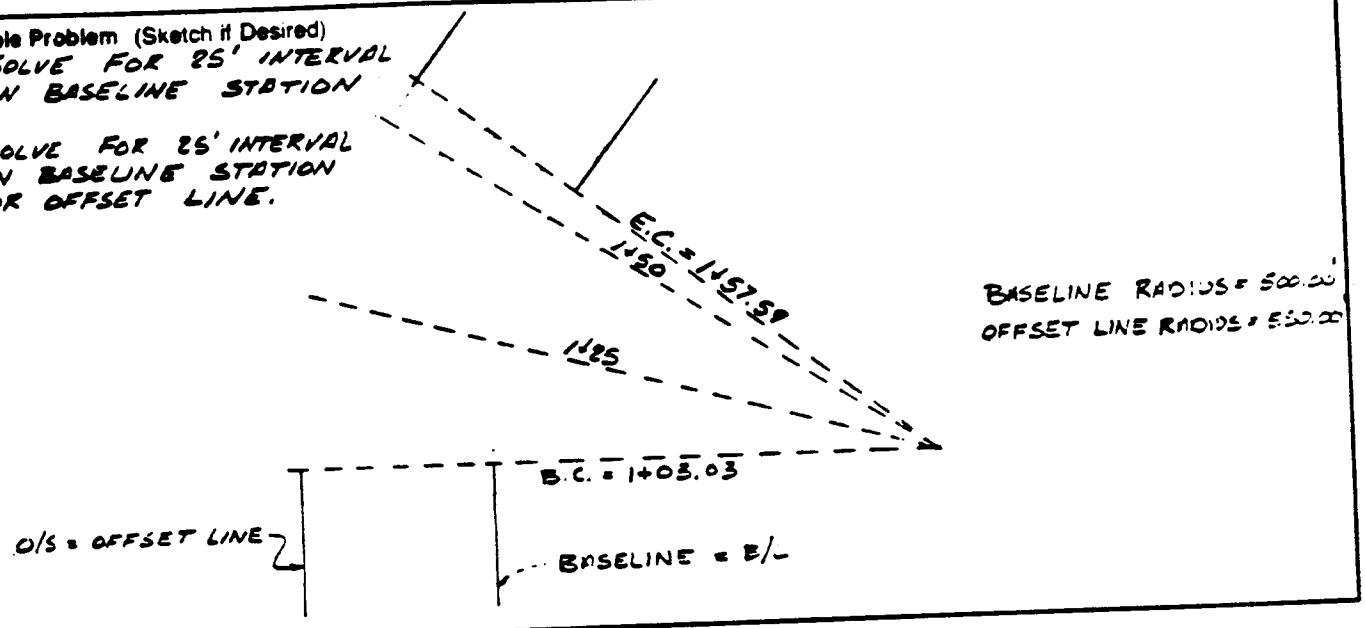


01C PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

1) SOLVE FOR 25' INTERVAL ON BASELINE STATION

2) SOLVE FOR 25' INTERVAL ON BASELINE STATION FOR OFFSET LINE.



SOLUTION:

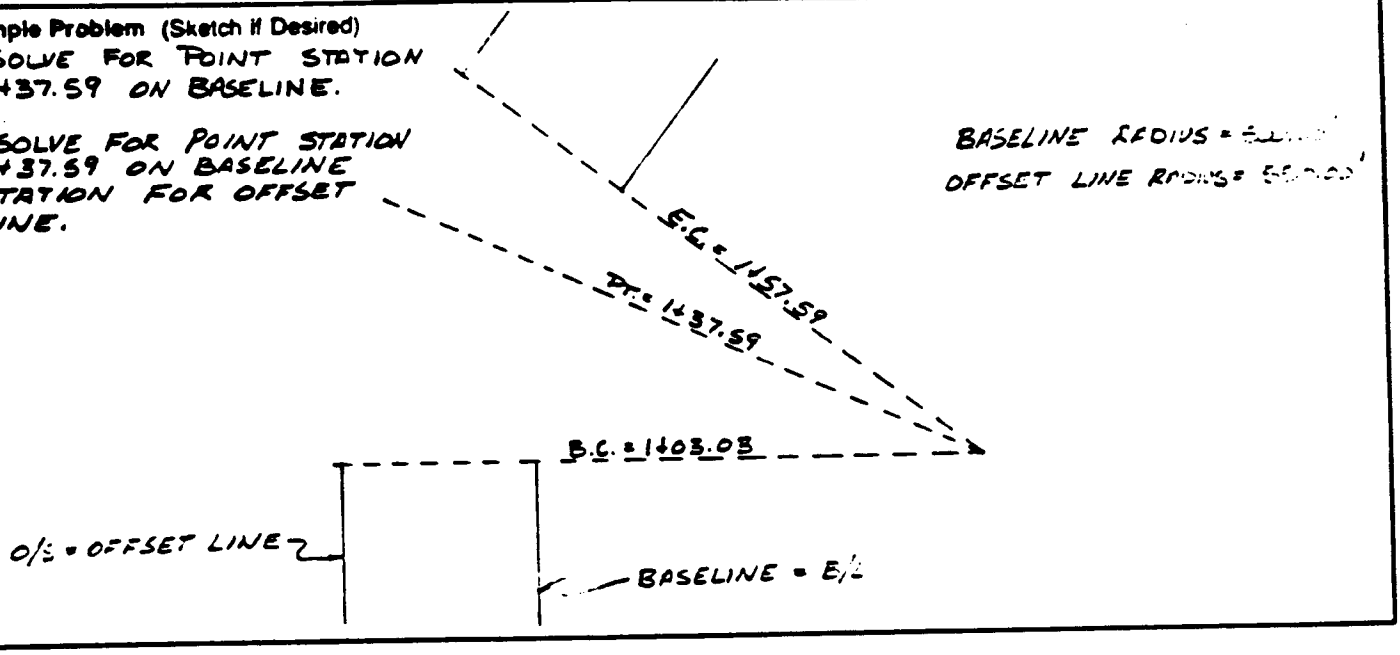
Input	Function	Display	Comments
	[USER]		Set user mode
	[XEQ] SIZE 012		Minimum size required
	[A]		Starts program
		B C STA = ?	Beginning of curve station
103.03	[R/S]	B/L RAD = ?	Baseline radius
500.00	[R/S]	O/S RAD = ?	No input for baseline solu.
	[R/S]		Prints B/L data
		INTERVAL/PT ?	
	[R/S]		Continue program for interval solution
		END STA = ?	End of curve station
157.59	[R/S]	EVEN STA = ?	First point of interval
125.00	[R/S]		Prints first sta. data
		INTERVAL B/L	Interval on baseline
25.00	[R/S]		Prints interval stations & end of curve station data
		NEXT CURVE?	
	[USER]		Set user mode
	[XEQ] SIZE 012		Minimum size required
	[A]		Starts program
		B C STA = ?	Beginning of curve station
103.03	[R/S]	B/L RAD = ?	Baseline radius
500.00	[R/S]	O/S RAD = ?	Offset radius
550.00	[R/S]		Prints O/S data

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

⑤ SOLVE FOR POINT STATION 1+37.59 ON BASELINE.

④ SOLVE FOR POINT STATION 1+37.59 ON BASELINE STATION FOR OFFSET LINE.



SOLUTION:

Input	Function	Display	Comments
Continuation of problem 2.			
	[R/S]	INTERVAL/PT ?	Continue program for interval solution.
	[R/S]	END STA = ?	End of curve station
157.59	[R/S]	EVEN STA = ?	First point of interval
125.00	[R/S]		Prints first point sta. data
		INTERVAL B/L=	Interval on baseline
25.00	[R/S]		Prints interval stations & end of curve station data
		NEXT CURVE?	
	[USER]		Set user mode
	[XEQ] SIZE 012		Minimum size required
	[A]		Starts program
		B.C. STA = ?	Beginning of curve station
103.03	[R/S]	B/L RAD = ?	Baseline radius
500.00	[R/S]	O/S RAD = ?	No input for baseline soltion
	[R/S]		Prints B/L data
		INTERVAL / PT ?	
	[B]		Start point solution
		STA PT = ?	Station of point required
137.56	[R/S]		Prints point station data
		STA PT = ?	Will continue for any number of point solutions

701C PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Contunued from problem no. 3 & 4 on page 4

SOLUTION:

Input	Function	Display	Comments
	[USER]		Set user mode
	[XEQ] SIZE 012		Minimum size required
	[A]		Starts program
		B C STA = ?	Beginning of curve station
103.03	[R/S]	B/L RAD = ?	Baseline radius
500.00	[R/S]	O/S RAD = ?	Offset line radius
550.00	[R/S]		Print O/S data
		INTERVAL / PT ?	
	[B]	STA PT = ?	Start point solution Station on baseline
137.56	[R/S]		Prints point sta O/S data
		STA PT = ?	Will continue for any number of point solutions

01701C

OUTPUT PROBLEM NO. 1

CURVE LAYOUT

B/L DATA
BC STA=103.03
B/L RAD=500.00
****
STA=125.00
DELTA=2.3103
RT. DEFL=1.1532
LT. DEFL=358.4428
B/L CH=21.9682
****
STA=150.00
DELTA=5.2257
RT. DEFL=2.4128
LT. DEFL=357.1832
B/L CH=46.9527
****
STA=157.59
DELTA=6.1508
RT. DEFL=3.0734
LT. DEFL=356.5226
B/L CH=54.5329

OUTPUT PROBLEM NO. 2

CURVE LAYOUT

O/S DATA
BC STA=103.03
B/L RAD=500.00
O/S RAD=556.00
****
STA=125.00
DELTA=2.3103
RT. DEFL=1.1532
LT. DEFL=358.4428
O/S CH=24.1651
****
STA=150.00
DELTA=5.2257
RT. DEFL=2.4128
LT. DEFL=357.1832
O/S CH=51.6480
****
STA=157.59
DELTA=6.1508
RT. DEFL=3.0734
LT. DEFL=356.5226
O/S CH=59.9862

OUTPUT PROBLEM NO. 3

CURVE LAYOUT

B/L DATA
BC STA=103.03
B/L RAD=500.00
****
STA=137.56
DELTA=3.5725
RT. DEFL=1.5842
LT. DEFL=356.0118
B/L CH=34.5231

OUTPUT PROBLEM NO. 4

CURVE LAYOUT

O/S DATA
BC STA=103.03
B/L RAD=500.00
O/S RAD=550.00
****
STA=137.56
DELTA=3.5725
RT. DEFL=1.5842
LT. DEFL=358.0118
O/S CH=37.9755

USER INSTRUCTIONS

SIZE (HP-41C) 012

TEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1.	Enter program, check status and set user mode			
2.	Start program and print title		[A]	Curve layout
3.	Beginning B/L curve station	BC STA	[R/S]	BC STA + ?
4.	Baseline radius	B/L RAD	[R/S]	B/L RAD = ?
5.	Offset radius (* No imput for baseline solution, O/S RAD input for offset line solution)	*	[R/S]	O/S RAD ?
			-- or--	
		O/S*RAD	[R/S]	
6.	Program prints either B/L data or O/S data			BC STA = B/L RAD= O/S RAD =
7.	Interval solution --or-- Point station solution Go to step 14	B/L Interval	[R/S] --or-- [B]	Interval/PT?
8.	End B/L curve station	END STA	[R/S]	END STA = ?
9.	First interval station	EVEN STA	[R/S]	EVEN STA = ?
10.	Program prints first interval station			
11.	Baseline interval required	Inter B/L	[R/S]	INTERVAL B/L=
12.	Program prints all interval B/L stations and end B/L curve station data for either baseline or offset line			STA= DELTA= RT. DEFL= LT. DEFL= O/S or B/L CH=
13.	Return to step 2 to start new calculation		[A]	NEXT CURVE?

USER INSTRUCTIONS

SIZE: (HP-41C) 012

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
14	Station point solution	STA PT	[R/S]	STA PT = ?
15	Program prints point station data for either baseline or offset line			STA = DELTA = RT. DEFL = LT. DEFL = O/S or B/L CH=
16	Return to step 14 to compute additional station points -- or-- return to step 2 to start new calculation.		[B] or [A]	STA PT = ?

PROGRAM LISTING

☐97 ☐41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
01	LBL "CURVE"		
02	LBL A		
03	FIX 2		
04	CF 01		
05	CF 02		
06	CF 03		
07	FS? 21		
08	XEQ "TITLE"		
09	"BC STA=?"		
10	PROMPT		PROMPT FOR BC STA AND RAD.
11	STO 00		
12	"B/L RAD=?"		
13	PROMPT		
14	STO 02		
15	SF 01		
16	CF 22		
17	"O/S RAD=?"		
18	PROMPT		
19	FS?C 22		
20	CF 01		
21	STO 03		
22	FS? 01		
23	GTO 10		
24	"O/S DATA"		
25	AVIEW		PRINT B/L AND O/S DATA
26	PSE		
27	GTO 11		
28	LBL 10		
29	"B/L DATA"		
30	AVIEW		
31	PSE		
32	LBL 11		
33	RCL 00		
34	"BC STA="		
35	ARCL X		
36	AVIEW		
37	PSE		
38	RCL 02		
39	"B/L RAD="		
40	ARCL X		
41	AVIEW		
42	PSE		
43	FS? 01		
44	GTO 12		
45	RCL 03		
46	"O/S RAD="		
47	ARCL X		
48	AVIEW		
49	PSE		
50	LBL 12		
51	"INTERVAL/PT?"		
52	PROMPT		
53	"END STA=?"		
54	PROMPT		PROMPT FOR END AND EVEN STA'S
55	STO 04		
56	"EVEN STA=?"		
57	PROMPT		
58	STO 01		
59	RCL 00		
60	-		
61	XEQ 05		COMPUTE CURVE LENGTHS
62	FS? 01		
63	GTO 01		
64	RCL 03		
65	*		
66	STO 08		
67	XEQ 00		
68	GTO 09		
69	LBL 01		
70	RCL 02		
71	*		
72	STO 08		
73	XEQ 00		
74	GTO 09		
75	LBL 00		
76	FS? 21		
77	XEQ "BAR"		
78	LBL 08		
79	FIX 2		
80	RCL 01		
81	"STA="		
82	ARCL X		
83	AVIEW		

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

☐ 67 ☐ 97 ☐ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
84	PSE		
85	FIX 4		
86	RCL 05		
87	HMS		
88	"DELTA="		
89	ARCL X		
90	AVIEW		
91	PSE		
92	RCL 06		
93	HMS		
94	"RT. DEF L="		
95	ARCL X		
96	AVIEW		PRINT DATA
97	PSE		
98	RCL 07		
99	HMS		
100	"LT. DEF L="		
101	ARCL X		
102	AVIEW		
103	PSE		
104	RCL 08		
105	FS? 01		
106	GTO 02		
107	"O/S CH="		
108	ARCL X		
109	AVIEW		
110	PSE		
111	RTN		
112	◆LBL 02		
113	"B/L CH="		
114	ARCL X		
115	AVIEW		
116	PSE		
117	RTN		
118	◆LBL 09		
119	"INTERVAL B/L="		PROMPT FOR STA. INTERVAL
120	PROMPT		
121	STO 09		
122	◆LBL 13		COMPUTE INTERVAL DELTA
123	180		
124	*		
125	PI		
126	/		
127	RCL 02		
128	/		
129	STO 10		
130	2		COMPUTE INTERVAL DEFL.
131	/		
132	STO 11		
133	◆LBL 03		
134	FS?C 02		
135	GTO 15		
136	RCL 09		
137	ST+ 01		
138	FS? 03		
139	GTO 14		
140	RCL 01		
141	RCL 09		
142	+		
143	RCL 04		
144	X<Y?		
145	SF 02		INCREMENT CURVE DATA
146	◆LBL 14		
147	RCL 10		
148	ST+ 05		
149	RCL 11		
150	ST+ 06		
151	RCL 07		
152	RCL 11		
153	-		
154	STO 07		
155	RCL 06		
156	SIN		
157	2		COMPUTE INTERVAL CHORDS
158	*		
159	FS? 01		
160	GTO 04		
161	RCL 03		
162	*		
163	STO 08		
164	XEQ 00		
165	FS? 03		
166	GTO 16		
167	GTO 03		
168	◆LBL 04		
169	RCL 02		
170	*		
171	STO 08		
172	XEQ 00		
173	FS? 03		
174	GTO 16		
175	GTO 03		
176	◆LBL B		

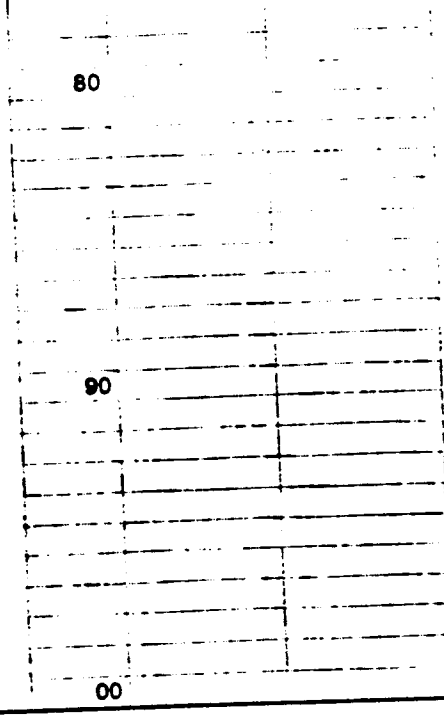
Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

PROGRAM LISTING

☐ 97 ☐ 41C

KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
177 "STA PT= ?"		
178 PROMPT		
179 STO 01		
180 RCL 00		
181 -		
182 XEQ 05		
183 FS? 01		
184 GTO 06		COMPUTE STA. PT DATA
185 RCL 03		
186 *		
187 STO 08		
188 XEQ 00		
189 GTO B		
190◆LBL 06		
191 RCL 02		
192 *		
193 STO 08		
194 XEQ 00		
195 GTO B		
196◆LBL 05		
197 180		
198 *		COMPUTE STA. PT. DELTA AND DEFL.
199 PI		
200 /		
201 RCL 02		
202 /		
203 STO 05		
204 2		
205 /		
206 STO 06		
207 360		
208 X<>Y		
209 -		
210 STO 07		
211 RCL 06		
212 SIN		COMPUTE STA. PT. CHORD
213 2		
214 *		
215 RTN		
216◆LBL 15		
217 RCL 04		
218 RCL 01		
219 -		
220 STO 09		
221 SF 03		
222 GTO 13		
223◆LBL 16		

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
	224 "NEXT CURVE ?"		
	225 PROMPT		
	226◆LBL "TITLE"		
	227 ADV		
	228 SF 12		PRINT TITLE
	229 FS? 55		
	230 "CURVE LAYOUT"		
	231 ASTO X		
	232 PRA		
	233 CF 12		
	234 ADV		
	235 RTN		
	236◆LBL "BAR"		
	237 .023		
	238 31		
	239◆LBL 07		PRINT BAR
	240 ACCHR		
	241 ISG Y		
	242 GTO 07		
	243 PRBUF		
	244 RTN		
	245 END		



50

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00 B.C. STA
01 EVEN STA/STA
02 B/L RADIUS
03 O/S RADIUS
04 END CURVE STA.
05 DELTA
06 RT. DEFL.
07 LT. DEFL.
08 O/S or B/L CHORD
09 B/L INTERVAL
10 INCREMENT DELTA
11 INCREMENT DEFL.

STATUS

SIZE 012	TOT REG. 92		USER MODE
ENG	FIX	SCI	ON X OFF
DEG	RAD	GRAD	

PROG

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
01	C	B/L RAD USED	O/S RAD USED
02	C	END STA NEXT	INCREMENT STA
03	C	STOP INCREMENT	CONT. INCREMENT
12	C	DOUBLE WIDE	SINGLE WIDE
21	S	PRINTER	NO PRINTER
22	C	DIGIT ENTERED	O/S RAD ENTERED
55			

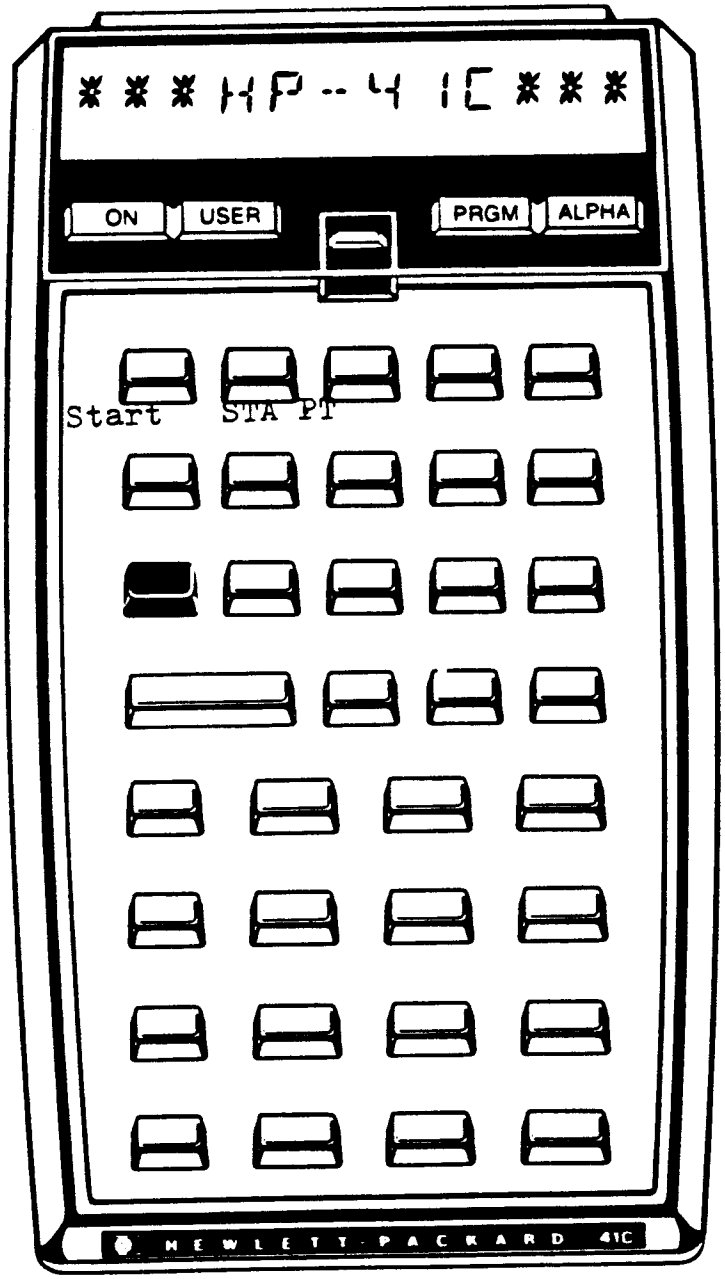
ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

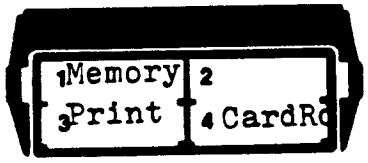
1701C

KEYBOARD CARD LABELING

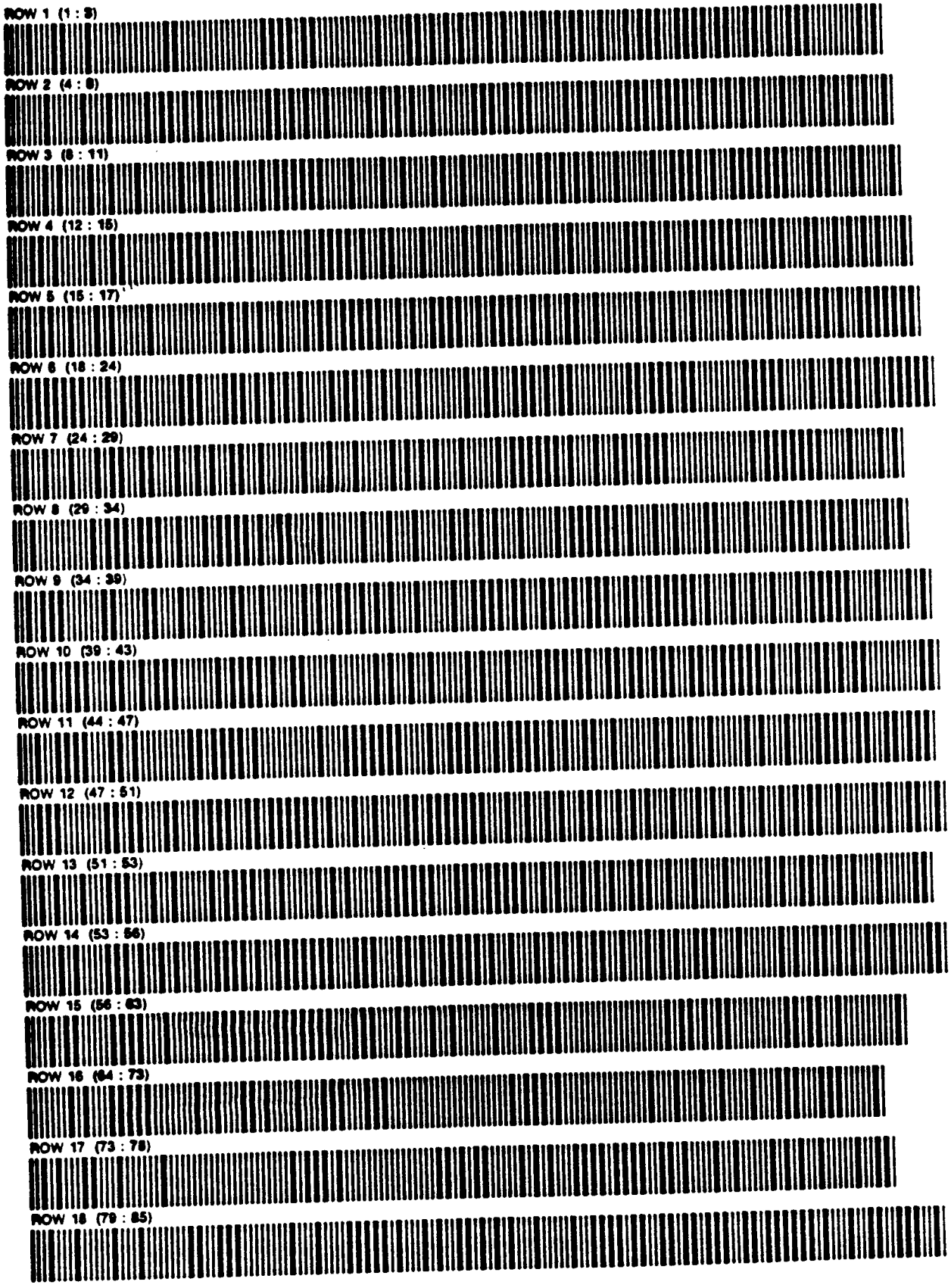
KEYBOARD

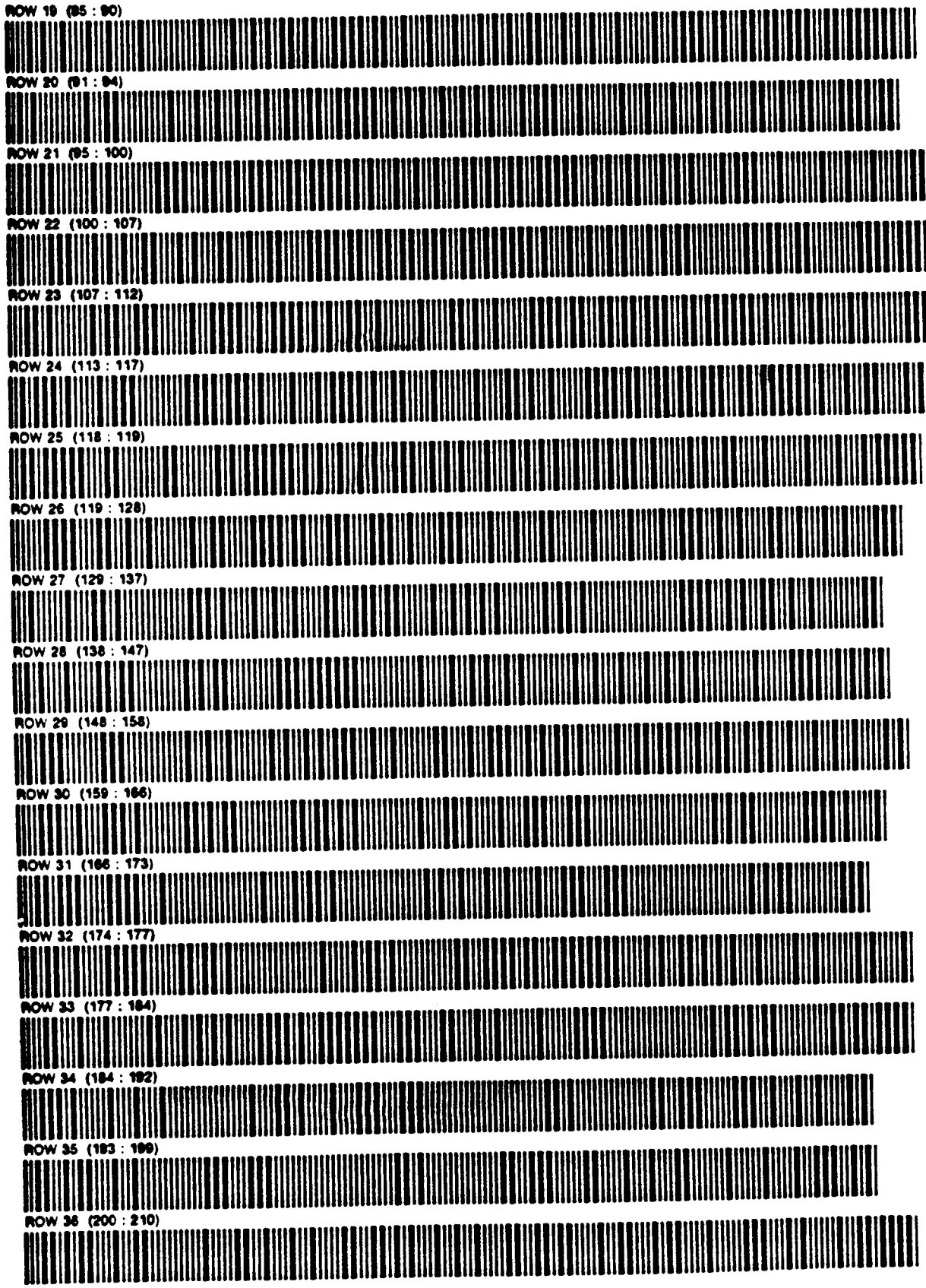


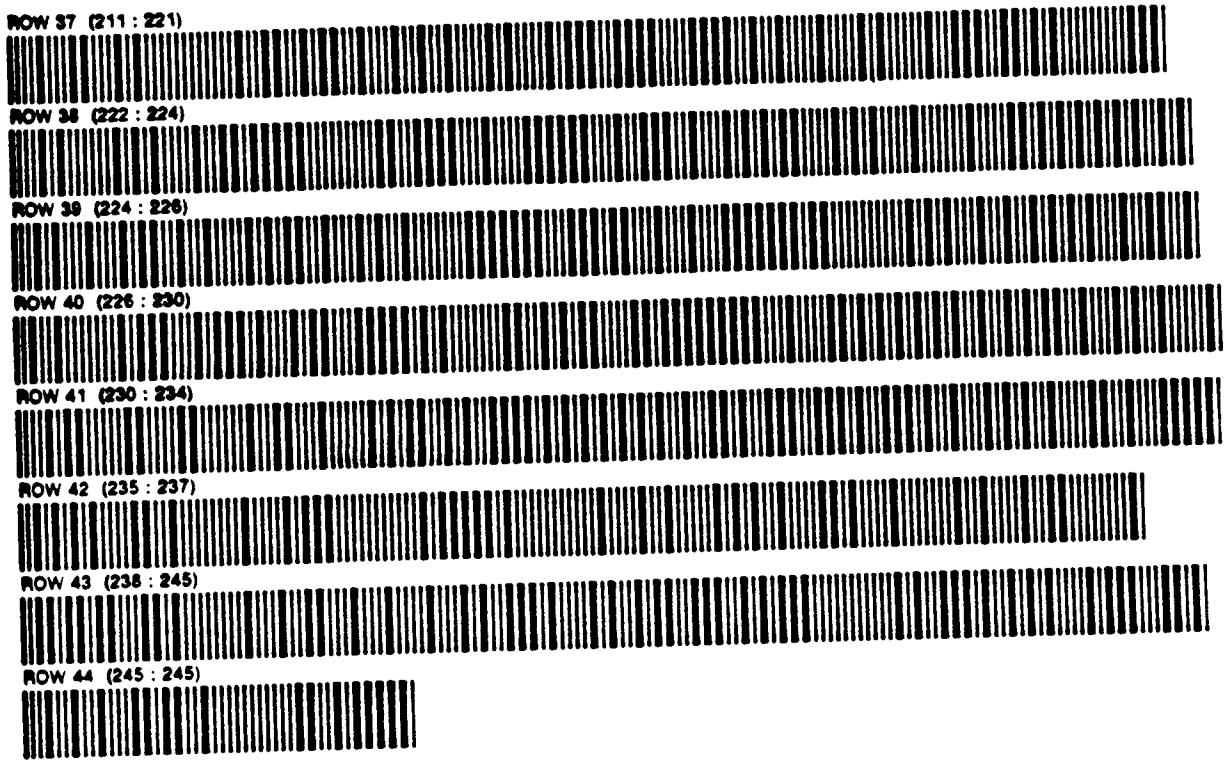
SYSTEM CONFIGURATION



CARD


ROW 1 (1 : 3)
ROW 2 (4 : 8)
ROW 3 (8 : 11)
ROW 4 (12 : 15)
ROW 5 (15 : 17)
ROW 6 (18 : 24)
ROW 7 (24 : 29)
ROW 8 (29 : 34)
ROW 9 (34 : 39)
ROW 10 (39 : 43)
ROW 11 (44 : 47)
ROW 12 (47 : 51)
ROW 13 (51 : 53)
ROW 14 (53 : 56)
ROW 15 (56 : 63)
ROW 16 (64 : 73)
ROW 17 (73 : 78)
ROW 18 (79 : 85)


ROW 19 (85 : 90)
ROW 20 (91 : 94)
ROW 21 (95 : 100)
ROW 22 (100 : 107)
ROW 23 (107 : 112)
ROW 24 (113 : 117)
ROW 25 (118 : 119)
ROW 26 (119 : 128)
ROW 27 (129 : 137)
ROW 28 (138 : 147)
ROW 29 (148 : 158)
ROW 30 (159 : 166)
ROW 31 (166 : 173)
ROW 32 (174 : 177)
ROW 33 (177 : 184)
ROW 34 (184 : 192)
ROW 35 (193 : 199)
ROW 36 (200 : 210)


ROW 37 (211 : 221)
ROW 38 (222 : 224)
ROW 39 (224 : 226)
ROW 40 (226 : 230)
ROW 41 (230 : 234)
ROW 42 (235 : 237)
ROW 43 (238 : 245)
ROW 44 (245 : 245)

PROGRAM DESCRIPTION I

Program Title: SPIRALS

Contributor's Name: Bruce E. Thompson

Address: 185 Gregory Ln. S.E.

City: Salem State/Country: Oregon Zip Code: 97302

Program Description, Equations, Variables: This program calculates field data for Spirals and Offset Spirals.

Inputs:
1. Q = Offset distance in feet
2. a = Degree of curve / Length of spiral
3. PS/PT station
4. Transit station
5. Sight station
6. Start station (to begin chaining from)
7. Desired station

Outputs:
1. Current station
2. X = Tangent offset
3. Y = Tangent distance
4. Deflection angle
5. Chord distance

Equations:

1. $a = 100\ D/L$ where: D = Degree of central curve, L = Length of spiral in feet
2. S = Spiral angle = $al^2/2$ where: l = Length (in stations) from PS/PT to current station

(continued on page 2)

Necessary Accessories: One memory module, (printer useful)

Operating Limits and Warnings: Calculations with this program are accurate for any practical application.

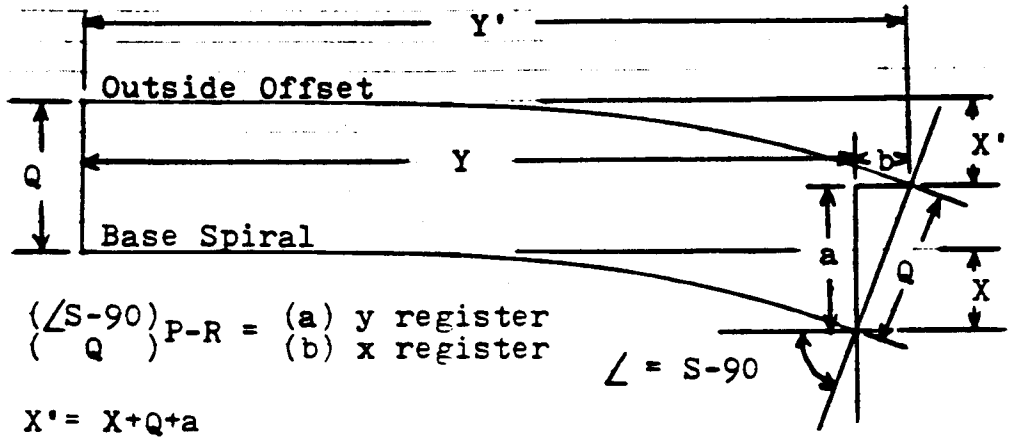
Reference(s): Standard Highway Spiral, Oregon State Highway Division, Technical Bulletin No. 20 - Revised 1973.

Equations:

3. $X = l\left(\frac{\theta}{3} - \frac{\theta^3}{42} + \frac{\theta^5}{1320} - \frac{\theta^7}{75600} + \frac{\theta^9}{6894720}\right)$

4. $Y = l\left(1 - \frac{\theta^2}{10} + \frac{\theta^4}{216} - \frac{\theta^6}{9360} + \frac{\theta^8}{685440}\right)$

where: θ = S angle in radians



5. $\begin{pmatrix} \angle S\text{-}90 \\ Q \end{pmatrix}_{P\text{-}R}$ = (a) y register, (b) x register

6. $X' = X+Q+a$

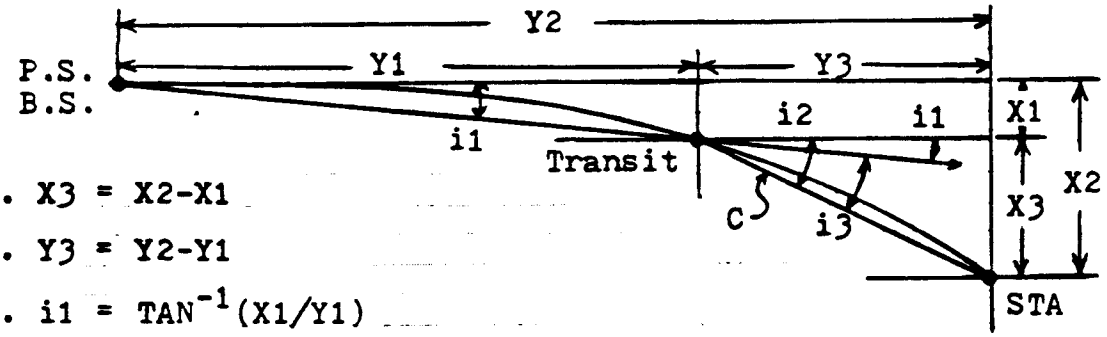
where: a is opposite sign of Q

7. $Y' = Y+b$

8. $\begin{pmatrix} X' \\ Y' \end{pmatrix}_{R\text{-}P}$ = (i) Deflection or angle from backsight, (C) Chord distance

INTERMEDIATE SETUP

Backsight toward P.S.



9. $X3 = X2-X1$

10. $Y3 = Y2-Y1$

11. $i1 = TAN^{-1}(X1/Y1)$

12. $i2 = TAN^{-1}(X3/Y3)$

13. $i3 = i2-i1$ = Deflection from backsight

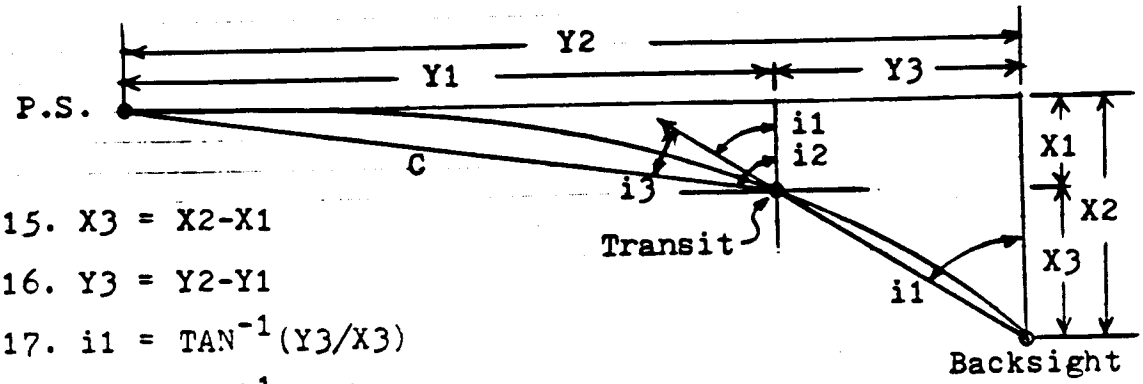
14. $C = \sqrt{X3^2+Y3^2}$

(continued on page 3)

Equations:

INTERMEDIATE SETUPS

Backsight away from P.S.



15. X3 = X2-X1

16. Y3 = Y2-Y1

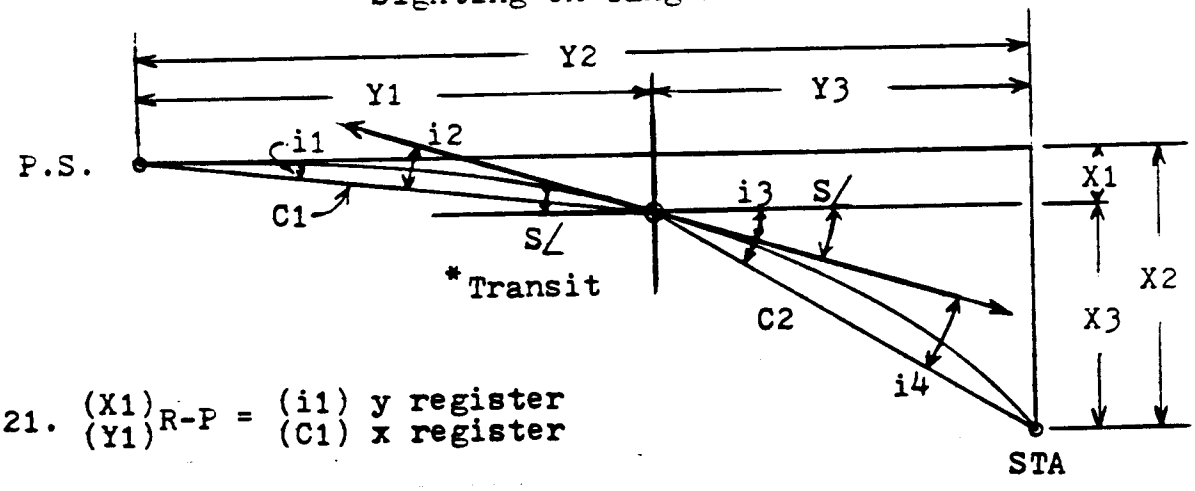
17. i1 = $TAN^{-1}(Y3/X3)$

18. i2 = $TAN^{-1}(Y1/X1)$

19. i3 = i2-i1 = Deflection from backsight

20. C = $\sqrt{X1^2+Y1^2}$

Sighting on Tangent



21. $\begin{matrix}(X1)\\(Y1)\end{matrix}_{R-P} = \begin{matrix}(i1)\ \text{y register}\\(C1)\ \text{x register}\end{matrix}$

22. i2 = S-i1 = Deflection from tangent toward P.S.

23. X3 = X2-X1

24. Y3 = Y2-Y1

25. $\begin{matrix}(X3)\\(Y3)\end{matrix}_{R-P} = \begin{matrix}(i3)\\(C2)\end{matrix}$

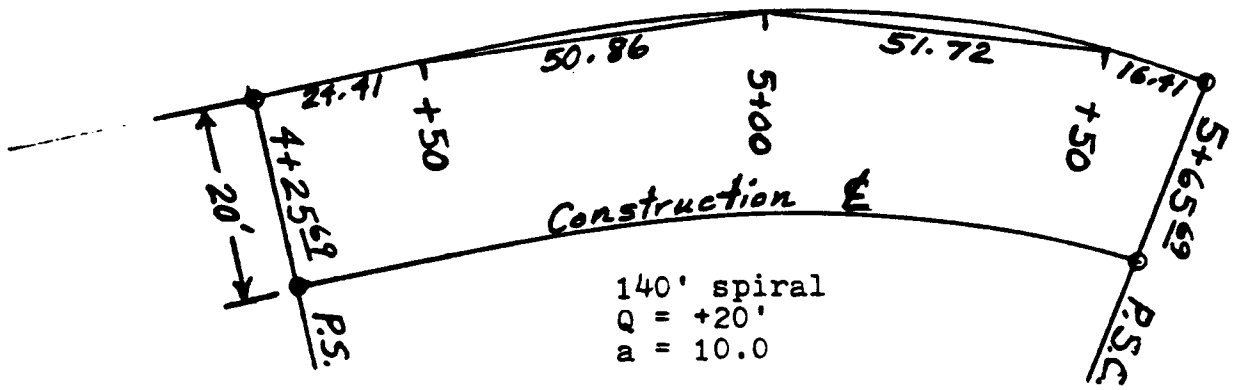
26. i4 = i3-S = Deflection from tangent toward P.S.C.

* Transit could be on P.S.C. and sighting tangent.

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Transit set on P.S. of 20' outside offset. Sighting tangent. Start chaining from P.S. and continue chaining from successive stations. Calculate field data for 50' stations and P.S.C.



SOLUTION:

Input	Function	Display	Comments
	(XEQ)"SP"	Q=?	Input offset distance
20	(R/S)	a=?	Input "a" value
10.0	(R/S)	PS,PT STA=?	Input PS or PT station
4.2569	(R/S)	TRNST STA=?	Transit station = P.S. Press (R/S)
	(R/S)	4+25.69 SITE STA=?	Sighting on tangent Press (R/S)
	(R/S)	4+25.69 START STA=?	Start chaining from transit station, Press (R/S)
	(R/S)	4+25.69 4+25.69-STA=?	Input station chaining to
4.5000	(R/S)	4+50.00 X=0.04 Y=24.41 ∠D.MS=0.0555	Deflection
	(R/S)@	C=24.41	Chord
50	(I)	5+0.00 X=1.22 Y=75.26 ∠D.MS=0.5534	Auto increment by 50'
	(R/S)@	C=50.86	
	(R/S)@	5+50.00 X=5.76 Y=126.77 ∠D.MS=2.3609	
	(R/S)@	C=51.72	

@ This (R/S) not required when the printer is used.

INPUT	FUNTION	DISPLAY	COMMENTS
	*(R/S)	C=51.72	*When printer is used Press (R/S) immediately during BEEP when the last chord is displayed. Then Press (D)
	(D)	5+50.00-STA=?	Input P.S.C. station
5.6569	(R/S)	5+65.69 X=8.26 Y=143.00 ∠D.MS=3.1817	
	(R/S)@	C=16.41	

SAMPLE PRINTOUT

Printer set to NORM mode.

```
                XEQ "SP"
Q=?
          20.00    RUN
a=?
          10.00    RUN
PS,PT STA=?
        4.2569     RUN
TRNST STA=?
                   RUN

4+25.69
SITE STA=?
                   RUN

4+25.69
START STA=?
                   RUN

4+25.69
4+25.69-STA=?
            4.50   RUN
4+50.00
X=0.04
Y=24.41
∠D.MS=0.0555
C=24.41

4+50.00-STA=?
```

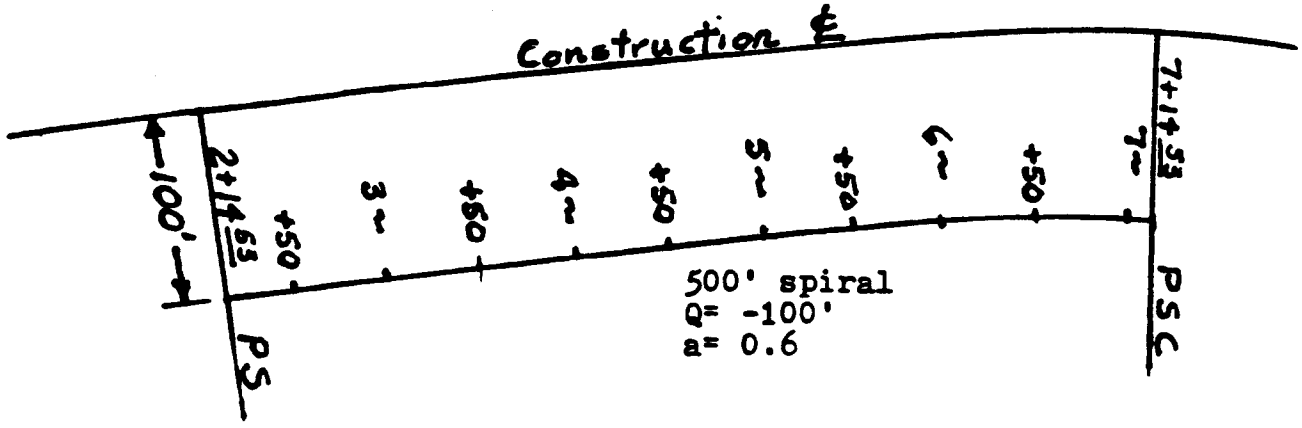
```
                50.00  XEQ I
5+0.00
X=1.22
Y=75.26
∠D.MS=6.5534
C=50.96

5+50.00
X=5.76
Y=126.77
∠D.MS=2.3609
C=51.72

                       XEQ D
5+50.00-STA=?
        5.6569     RUN
5+65.69
X=8.26
Y=143.00
∠D.MS=3.1817
C=16.41
```

@ This (R/S) not required when the printer is used.

017060

Example No.2

Transit set on PSC of 100' inside offset, sighting tangent. Start chaining at PSC and move chaining station ahead to each even station. Then move transit ahead to station 5+00, sighting on PSC. Continue as before to the PS.



INPUT	FUNCTION	DISPLAY	COMMENTS
	(XEQ)"SP"	Q=?	Input offset distance
100	(CHS)(R/S)	a=?	Input "a" value
0.6	(R/S)	PS,PT STA=?	Input PS or PT station
2.1453	(R/S)	TRNST STA=?	
7.1453	(R/S)	7+14.53 X=20.93 Y=486.09 SITE STA=?	Transit on PSC
	(R/S)	7+14.53 START STA=?	Sighting on tangent
	(R/S)	7+14.53 7+14.53-STA=?	Starting at Transit
7	(R/S)	7+0.00 X=19.19 Y=472.42 ∠D.MS=0.1257	
	(R/S)@	C=13.78	
	(J)#	7+0.00-STA=?	Chaining from STA 7+00
50	(CHS)(I)	6+50.00 X=13.91 Y=425.13 ∠D.MS=0.5539	Auto decrement by 50'
	(R/S)@	C=47.59	

@ This (R/S) not required when printer is used.
# Press this key during BEEP when chord is displayed, when printer is used

706C

Example No.2

INPUT	FUNCTION	DISPLAY	COMMENTS
	(J)#	6+0.00 X=9.69 Y=377.46 ∠D.MS=1.3524	Falg 04 should be clear
	(R/S)@	C=95.43	
	(J)#	5+50.00 X=6.41 Y=329.46 ∠D.MS=2.1212	Flag 04 should be set
	(R/S)@	C=48.11	
	(J)#	5+0.00 X=3.97 Y=281.15 ∠D.MS=2.4603	Flag 04 should be clear
	(R/S)@	C=96.48	
	(A)#	TRNST STA=?	Move ahead to new Transit station
5	(R/S)	5+0.00 X=3.97 Y=281.15 SITE STA=?	
7.1453	(R/S)	7+14.53 X=20.93 Y=486.09 START STA=?	Sighting on PSC
	(R/S)	5+0.00 5+0.00-STA=?	Start chaining at Transit
	(J)	5+0.00-STA=?	Flag 04 should be set
50	(CHS)(I)	4+50.00 X=2.24 Y=232.55 ∠D.MS=2.4128	
	(R/S)@	C=48.64	
	(J)#	4+0.00 X=1.10 Y=183.66 ∠D.MS=3.0243	
	(R/S)@	C=97.53	

@ This (R/S) not required when printer is used.
# Press this key during BEEP when chord is displayed, when printer is used.

01706C

INPUT	FUNCTION	DISPLAY	COMMENTS
	(J)#	3+50.00 X=0.43 Y=134.51 ∠D.MS=3.2059	Flag 04 should be set
	(R/S)@	C=49.16	
	(J)#	3+0.00 X=0.11 Y=85.09 ∠D.MS=3.3616	Flag 04 should be clear
	(R/S)@	C=98.58	
	(J)#	2+50.00 X=0.01 Y=35.40 ∠D.MS=3.4832	Flag 04 should be set
	(R/S)@	C=49.68	
	(D)#	3+0.00-STA=?	Input PS station
2.1453	(R/S)	2+14.53 ∠D.MS=3.5525	
	(R/S)@	C=85.09	

@ this (R/S) not required when printer is used.
# Press this key during BEEP when chord is displayed, when printer is use

```
                XEQ "SP"
Q=?
          -100.00    RUN
a=?
              .60    RUN
PS.PT STA=?
           2.1453    RUN
TRNST STA=?
           7.1453    RUN
7+14.53
X=20.93
Y=486.09
SITE STA=?
                     RUN
7+14.53
START STA=?
                     RUN
7+14.53
7+14.53-STA=?
             7.00    RUN
7+0.00
X=19.19
Y=472.42
∠D.MS=0.1257
C=13.78
                    XEQ J
7+0.00-STA=?
          -50.00  XEQ I
6+50.00
X=13.91
Y=425.13
∠D.MS=0.5539
C=47.59
                    XEQ J
6+0.00
X=9.69
Y=377.46
∠D.MS=1.3524
C=95.43
                    XEQ J
5+50.00
X=6.41
Y=329.46
∠D.MS=2.1212
C=48.11
                    XEQ J
5+0.00
X=3.97
Y=281.15
∠D.MS=2.2603
C=96.48
                    XEQ A
TRNST STA=?
           5.00     RUN
5+0.00
X=3.97
Y=281.15
SITE STA=?
           7.1453   RUN
7+14.53
X=20.93
Y=486.09
START STA=?
                     RUN
5+0.00
5+0.00-STA=?
                    XEQ J
5+0.00-STA=?
          -50.00  XEQ I
4+50.00
X=2.24
Y=232.55
∠D.MS=2.4128
C=48.64
                    XEQ J
4+0.00
X=1.10
Y=183.66
∠D.MS=3.0243
C=97.53
                    XEQ J
3+50.00
X=0.43
Y=134.51
∠D.MS=3.2059
C=49.16
                    XEQ J
3+0.00
X=0.11
Y=85.09
∠D.MS=3.3616
C=98.58
                    XEQ J
2+50.00
X=0.01
Y=35.40
∠D.MS=3.4832
C=49.68
                    XEQ D
3+0.00-STA=?
           2.1453   RUN
2+14.53
∠D.MS=3.5525
C=85.09
```

USER INSTRUCTIONS

SIZE: (HP-41C) 022

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Enter Spiral Program.			
2	Begin Spiral Program.		(XEQ)"SP"	Q=?
3	Input Q (offset distance in feet, + for outside, - for inside). If Q=0 then press (R/S).	±Q	(R/S)	a=?
4	Input "a" value of spiral.	a	(R/S)	PS,PT STA=?
5	Input PS or PT station. NOTE: (3+19.81 = 3.1981)	STA	(R/S)	TRNST STA=?
6	Input Transit station as per above. If Transit station = PS,PT then press (R/S).	STA	(R/S)	(STA) *X= *Y= SITE STA=?
7	Input station sighting. If sighting on tangent then press (R/S), program displays transit station.	STA	(R/S)	(STA) *X= *Y= START STA=?
8	Input station to start chaining from. If start station = transit station then press (R/S).	STA	(R/S)	(STA) *X= *Y= (STA)-STA=?
9	FOR CHAINING FROM SUCCESSIVE STATIONS: Goto STEP 10			
	or			
9	FOR CHAINING FROM ONE STATION: Goto STEP 12			
	or			
9	FOR AUTO-STATIONING: Goto STEP 17			
10	(flag 04 must be clear before proceeding). Input station chaining to.	STA	(R/S) (R/S)@ (R/S)@	(STA) X= Y= ∠D.MS= C= (STA)-STA=?
11	Repeat STEP 10 for next station.			

Program Continuation Form

SIZE: 022

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
12	(flag 04 must be clear before proceeding) Press (J)		(J)	(STA)-STA=?
13	Input station chaining to.	STA	(R/S)	(STA) X= Y= ∠D.MS=
			(R/S)@	C=
			(R/S)@	(STA)-STA=?
14	Repeat STEP 13 for next station. or			
14	TO MOVE AHEAD to new chaining press (J).		(J)	(STA)-STA=?
15	Input new chaining station.	STA	(R/S)	(STA) X= Y= ∠D.MS=
			(R/S)@	C=
			(R/S)@	(STA)-STA=?
16	Go to STEP 12			
17	Input stationing interval in feet. (+ for ahead, - for back)	INT	(I)	(STA) X= Y= ∠D.MS=
			(R/S)@	C=
			(R/S)@	(STA)
18	For each succeeding station press (R/S)@ after chord is displayed.			....
19	To input an odd station press (D) after chord is displayed and Go to STEP 10 or 13.		(D)	(STA)-STA=?
20	To review deflection and chord. press (E) and Go to STEP 10, 13, or 18.		(E) (R/S)@	∠D.MS= C=
21	To input a new start station press (C) and Go to STEP 8		(C)	START STA=?
22	To input a new sight station press (B) and Go to STEP 7.		(B)	SITE STA=?
23	To input a new transit station press (A) and Go to STEP 6.		(A)	TRNST STA=?

Program Continuation Form

SIZE: 022

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAYED
24	For a new spiral Go to STEP 2.			
*	If a station was input program calculates and displays X & Y.			
@	This (R/S) not required when the printer is used.			

PROGRAM LISTING

67 ☐ 97 ■ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
01	◆LBL "SP"		
02	DEG		
03	SF 27		
04	SF 29		
05	CF 00		
06	CLX		
07	"Q=?"		
08	PROMPT		Input Offset
09	X≠0?		
10	SF 00		
11	1		
12	%		
13	STO 13		
14	"a=?"		
15	PROMPT		Input "a" value
16	STO 14		
17	"STA=?"		
18	ASTO 17		
19	"PS,PT "		
20	ARCL 17		
21	PROMPT		Input PS or PT station
22	STO 00		
23	STO 04		
24	◆LBL A		For new Trans. station
25	0		
26	STO 10		
27	SF 05		
28	"TRNST "		
29	2		
30	XEQ 01		
31	RCL 16		
32	STO 04		
33	◆LBL B		For new Site station
34	SF 05		
35	"SITE "		
36	7		
37	XEQ 01		
38	RCL 10		
39	FS? 22		
40	XEQ 12		
41	FS? 22		
42	X<>Y		
43	STO 01		
44	◆LBL C		For new Start station
45	SF 05		
46	"START "		
47	5		
48	XEQ 01		
49	◆LBL D		For new Desired station
50	SF 05		
51	◆LBL 02		
52	RCL 16		
53	XEQ 20		
54	"⊢—"		
55	◆LBL 03		
56	7		
57	XEQ 01		
58	XEQ 12		
59	X<>Y		
60	X=0?		
61	GTO 14		
62	RCL 01		
63	−		
64	ABS		
65	◆LBL 14		
66	STO 18		
67	RCL 07		
68	ENTER↑		
69	FS? 04		
70	RCL 05		
71	X<> 05		
72	RCL 08		
73	FC? 04		
74	ENTER↑		
75	FS? 04		
76	RCL 06		
77	X<> 06		
78	XEQ 13		
79	1 E2		
80	*		
81	STO 19		
82	◆LBL E		Review Deflect. and Chord
83	SF 21		
84	CF 22		
85	FIX 4		
86	RCL 18		
87	HMS		
88	RND		
89	HR		
90	HMS		
91	"∠D.MS="		
92	ARCL X		
93	AVIEW		
94	FIX 2		
95	"C="		
96	ARCL 19		
97	AVIEW		
98	ADV		

PROGRAM LISTING

☐ 67 ☐ 97 ■ 41C

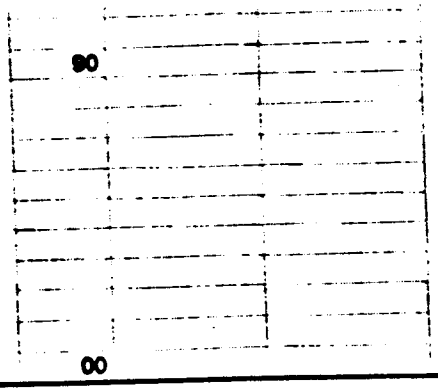
STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
99	FS? 55		
100	BEEP		
101	FS? 55		
102	PSE		
103	FC? 03		
104	GTO D		
105	GTO 14		
106	◆LBL I		Auto-station routine
107	"INT=?"		
108	FC?C 22		
109	PROMPT		
110	SF 03		
111	1		
112	%		
113	STO 20		
114	GTO 14		
115	◆LBL J		Change chaining mode (toggles flag 04)
116	FC?C 04		
117	SF 04		
118	FC? 03		
119	GTO 02		
120	◆LBL 14		
121	RCL 21		
122	RCL 20		
123	+		
124	GTO 03		
125	◆LBL 12		
126	RCL 07		
127	RCL 02		
128	RCL 08		
129	RCL 03		
130	◆LBL 13		
131	-		
132	ABS		
133	RDN		
134	-		
135	ABS		
136	R↑		
137	R-P		
138	RTN		
139	◆LBL 01		Main subroutine
140	FS? 05		
141	CF 03		
142	FS?C 05		
143	CF 04		
144	STO 09		
145	FC? 55		
146	CF 21		
147	CF 22		
148	FS? 03		
149	SF 22		
150	FS? 03		
151	RDN		
152	ARCL 17		
153	FC? 03		
154	PROMPT		Input station
155	FC? 22		
156	RCL 04		
157	FC? 04		
158	STO 16		
159	STO 21		
160	XEQ 20		
161	AVIEW		View station
162	RCL 00		
163	-		
164	X=0?		
165	STO Y		
166	X=0?		
167	GTO 11		
168	ABS		
169	STO 15		calculate "S" angle
170	X↑2		
171	RCL 14		
172	*		$S=al^2/2$
173	2		
174	/		
175	STO 10		
176	FS? 22		
177	GTO 14		
178	RCL 03		
179	RCL 02		
180	◆LBL 11		
181	STO IND 09		
182	ISG 09		
183	DEG		
184	X<>Y		
185	STO IND 09		
186	RTN		
187	◆LBL 14		
188	SF 01		Calculate X
189	XEQ 04		
190	◆LBL 04		Calculate Y
191	CF 02		
192	3		
193	1		
194	FC? 01		

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

1706C PROGRAM LISTING

97 □97 ■41C

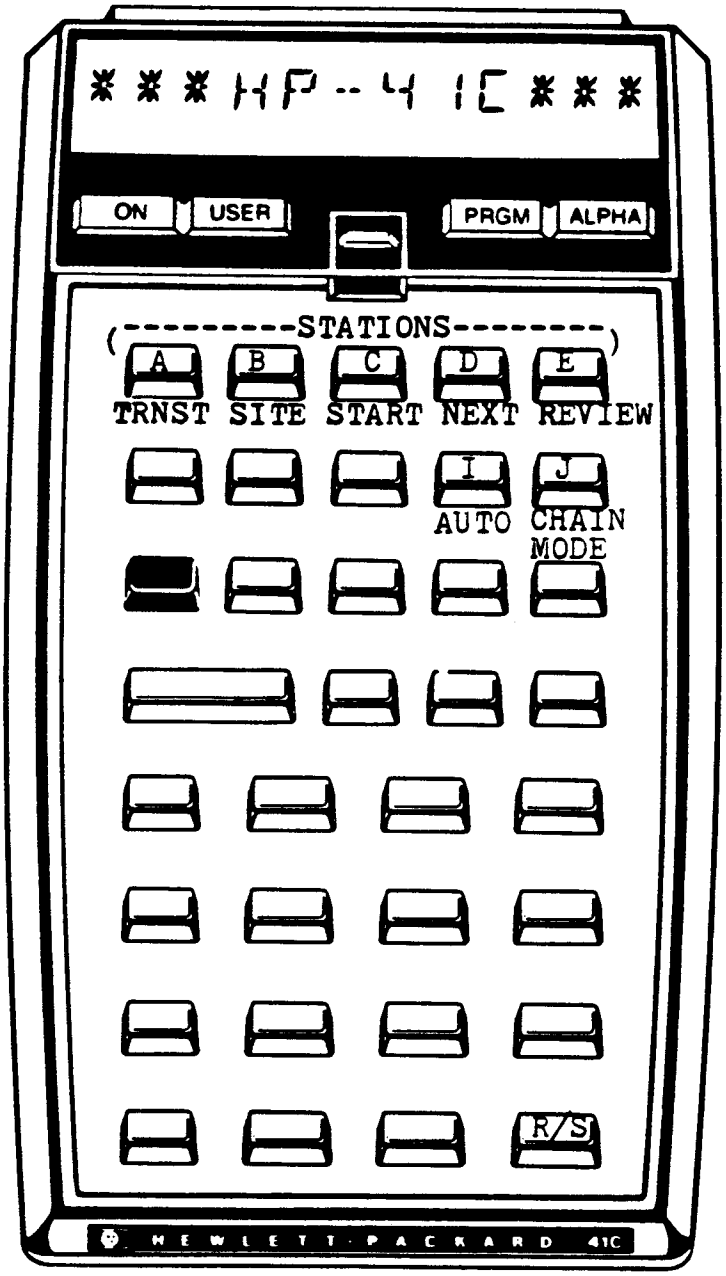
STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
195	0		
196	902 E-5		
197	+		
198	STO 11		
199	X<>Y		
200	STO 12		
201	CLX		
202	STO IND 09		
203	◆LBL 06		
204	RCL 10		
205	D-R		
206	RCL 11		
207	INT		
208	STO Z		
209	Y↑X		
210	X<>Y		
211	FACT		
212	RCL 12		
213	FS? 02		
214	CHS		
215	*		
216	/		
217	ST+ IND 09		
218	4		
219	ST+ 12		
220	FC?C 02		
221	SF 02		
222	ISG 11		
223	GTO 06		
224	RCL 15		
225	ST* IND 09		
226	FC? 00		If no offset
227	GTO 07		
228	RCL 10		
229	90		
230	-		
231	RCL 13		
232	FS? 01		
233	ST+ IND 09		
234	P-R		
235	FS? 01		
236	X<>Y		
237	ST+ IND 09		
238	◆LBL 07		
239	RCL IND 09		
240	1 E2		
241	*		
242	FIX 2		
243	"X="		
244	FC?C 01		
245	"Y="		
246	ARCL X		
247	TONE 2		
248	AVIEW		
249	1		
250	ST+ 09		
251	RTN		
252	◆LBL 20		Display station in standard format
253	CF 29		
254	FIX 0		
255	INT		
256	CLA		
257	ARCL X		
258	"⊢+"		
259	LASTX		
260	FRC		
261	1 E2		
262	*		
263	FIX 2		
264	ARCL X		
265	1 E2		
266	/		
267	+		
268	SF 29		
269	END		



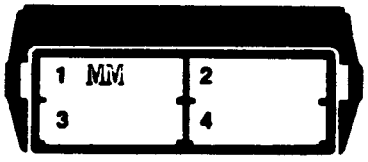
Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

KEYBOARD CARD LABELING

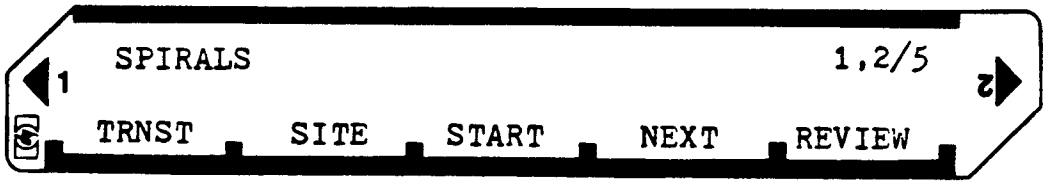
KEYBOARD



SYSTEM CONFIGURATION



CARD



D1706C

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	PS/PT STA
01	Z }
02	X } -Transit
03	Y }
04	STA }
05	X1 } -Chaining Station
06	Y1 }
07	X2 }
08	Y2 } -Desired Station
09	IND Storage
10	S angle
11	Loop counter
12	Used
13	Q (offset)
14	"a" value
15	L in stations
16	Chaining STA
17	"STA=?"
18	Deflection
19	Chord
20	Stationing interval
21	Current Station

STATUS

SIZE	022	TOT. REG.	90	USER MODE	
ENG		FIX	4	SCI	ON X OFF
DEG	X	RAD		GRAD	

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
00	C	Offset	No Offset
01	C	Calculating X	Calculating Y
02	C	na	na
03	C	Auto Station	Not
04	C	Chaining from One Station	Chaining from Successive Stations
05	C	Clear flags 3 & 4	Dont
21	*	Stop on AVIEW	Dont
22	C	Numeric input	Not
55	*	Printer attached	Not

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY
Input Trans Station	(A)	Input STA Interval	(I)
Input Sight Station	(B)	Switch Chain Mode	(J)
Input Start Station	(C)		
Input Next Station	(D)		
Review Defl. and Chord	(E)		

PROGRAM REGISTERS NEEDED: 68

ROW 1 (1 : 5)

ROW 2 (6 : 14)

ROW 3 (14 : 18)

ROW 4 (19 : 24)

ROW 5 (24 : 29)

ROW 6 (30 : 35)

ROW 7 (35 : 40)

ROW 8 (41 : 46)

ROW 9 (46 : 52)

ROW 10 (53 : 58)

ROW 11 (58 : 68)

ROW 12 (69 : 77)

ROW 13 (77 : 83)

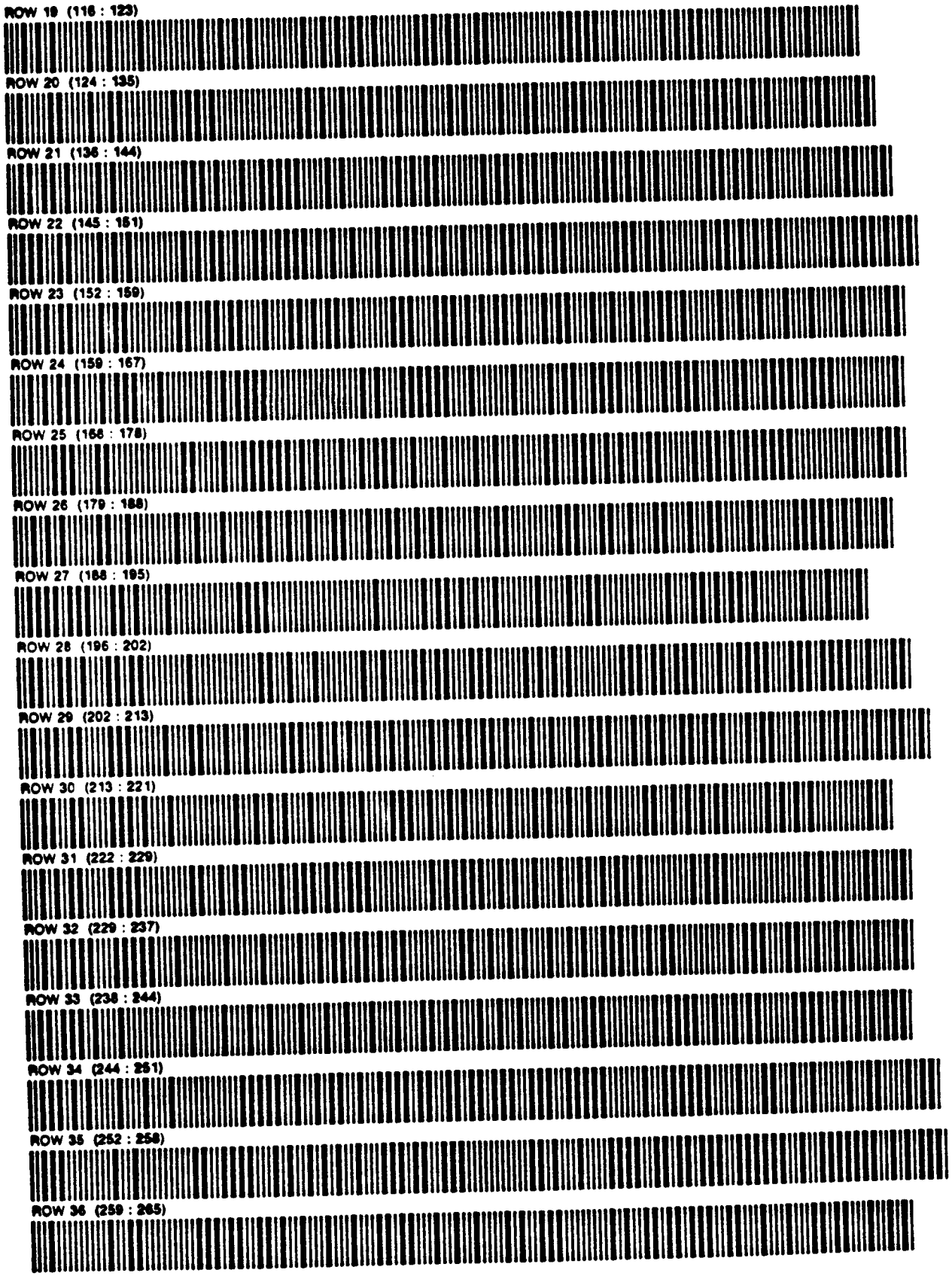
ROW 14 (83 : 91)

ROW 15 (91 : 95)

ROW 16 (96 : 104)

ROW 17 (104 : 108)

ROW 18 (108 : 116)


ROW 19 (116 : 123)
ROW 20 (124 : 135)
ROW 21 (136 : 144)
ROW 22 (145 : 151)
ROW 23 (152 : 159)
ROW 24 (159 : 167)
ROW 25 (168 : 178)
ROW 26 (179 : 188)
ROW 27 (188 : 195)
ROW 28 (196 : 202)
ROW 29 (202 : 213)
ROW 30 (213 : 221)
ROW 31 (222 : 229)
ROW 32 (229 : 237)
ROW 33 (238 : 244)
ROW 34 (244 : 251)
ROW 35 (252 : 258)
ROW 36 (259 : 265)


ROW 37 (266 : 269)

Media Manufactured by Software, Product of RUSA USA

3 8 6 C

PROGRAM DESCRIPTION I

Program Title Contours

Contributor's Name Jonathan N Junker

Address 2517 South Dillon Street

City Aurora State/Country CO Zip Code 80014

Program Description, Equations, Variables This program is designed to find contours on a topo map whether the elevation shots be on a grid or shot in by stadia. The equation used is (high elevation - low elevation) ÷ distance = %

(next contour - low elevation) ÷ % = distance to the next contour

Necessary Accessories none

Operating Limits and Warnings none

Reference(s)

TO OUR CUSTOMERS:

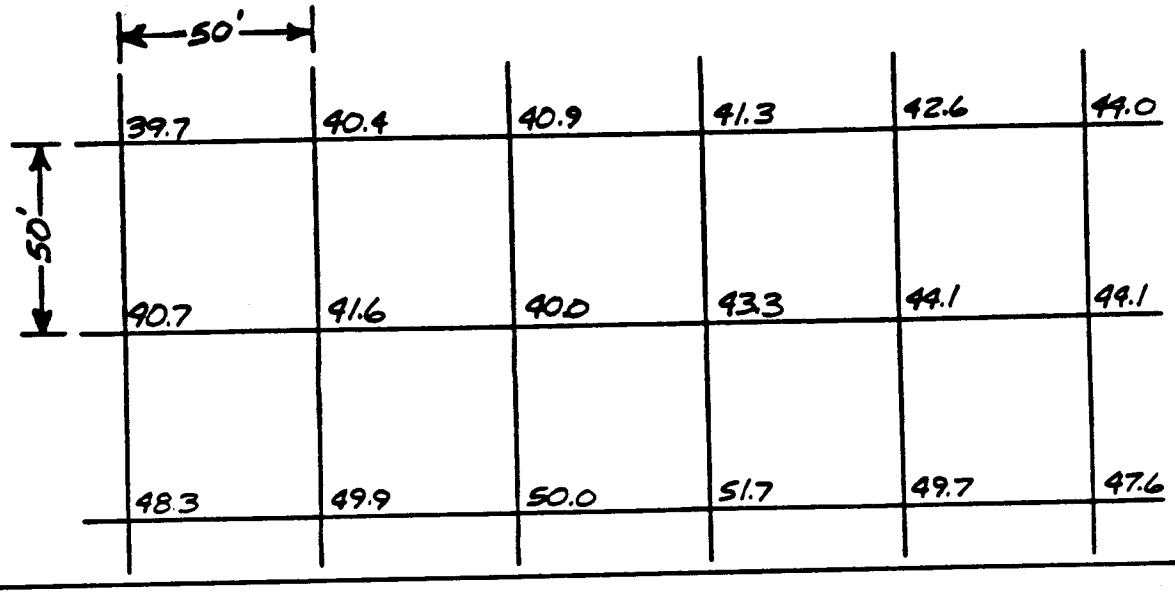
The following information was supplied by our reviewer for your use with this program. The comments are intended to be helpful in avoiding any complications that may inadvertently arise.

THE HEWLETT PACKARD USERS' LIBRARY STAFF

This program does not consider the status of flag 21 in conjunction with its use of VIEW/AVIEW.

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)



SOLUTION:

Input	Function	Display	Comments
	[XEQ] SIZE 007		Minimum size
	[XEQ] CON	CON. INT.=?	Contour interval (i.e. 1,2,5,10 ft.)
1	R/S	DIS.=?	Distance between the two elevations
50	R/S	LOW ELEV.=?	Low elevation
39.7	R/S	HIGH ELEV.=?	High elevation
40.7	R/S	CON. 40.0=15.0	Contour 40 15 feet from low elev.
			Tone 7 with display
			Beep @ end of calculations
	R/S	DIS.=?	
50	R/S	LOW ELEV.=?	
40.7	R/S	HIGH ELEV.=?	
48.3	R/S	CON.41.0=2.0	Tone 7
		CON.42.0=8.2	' '
		CON.43.0=15.1	! !
		CON.44.0=21.7	' '
		:	
		:	steps omitted
		CON.48.0=48.0	Tone 7 . . . Beep
	R/S	DIS.=?	
			To change contour interval
			start program over.

USER INSTRUCTIONS

SIZE: (HP-41C) 007

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1.	Enter the program			
2.	Initate program		XEQ CON	CON. INT.=?
	Key in the contour interval	CON INT	R/S	DIS=?
	Key in the distance between the high			
	elevation and the low elevation.	DIS	R/S	LOW ELEV.=?
	Key in the low elevation	LOW ELEV	R/S	HIGH ELEV.=?
	Key in the high elevation	HIGH ELEV	R/S	CON X.X=x.x(dis)
	Continue for new calculations		R/S	DIS=?
		DIS	R/S	LOW ELEV.=?
		LOW ELEV	R/S	HIGH ELEV.=?
		HIGH ELEV	R/S	CON X.X=x.x(dis)
3.	For new contour interval press [R/S] and go to step 2.			

00886C

PROGRAM LISTING

▮ 7 ☐ 97 ⁂ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
01	LBL CON		
	FIX 1		
	CON. INT.=?		
	PROMPT		
	STO 00		Contour interval
	LBL 00		
	DIS.=?		
	PROMPT		
	STO 01		Distance
10	LOW ELEV.=?		
	PROMPT		
	STO 02		Low elevation
	HIGH ELEV.=?		
	PROMPT		
	STO 03		High elevation
	RCL 02		
	-		
	RCL 01		
	/		
20	STO 04		Slope %
	RCL 02		
	10		
	/		
	INT		
	10		
	*		
	STO 05		Trial contour
	LBL 01		
	RCL 05		
30	RCL 02		
	X<=Y?		is trial contour<=
	GTO 02		low elevation?
	RCL 00		
	ST+ 05		Next contour
	GTO 01		
	LBL 02		
	RCL 05		
	RCL 03		
	X<=Y?		is trial contour>=
40	GTO 03		high elevation?
	RCL 05		
	RCL 02		
	-		
	RCL 04		
	/		
	STO 06		distance to contour
	RCL 01		
	X<=Y?		is total distance <
	GTO 03		calculated distance?
50	CON.		

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
51	ARCL 05		
	#=		
	ARCL 06		
	AVIEW		
	TONE 7		
	PSE		
	PSE		
	PSE		
	RCL 00		
60	ST+ 05		
	RCL 03		
	X>Y?		IS next contour <
	GTO 02		high elevation?
*	LBL 03		
	BEEP		
	STOP		
	GTO 00		
	END		
70			
80			
90			
00			

00883C

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	Contour interval
01	Distance
02	Low elevation
03	High elevation
04	Slope %
05	Trial Contour
06	Distance to next contour

STATUS

SIZE 007 TOT. REG. 035 USER MODE

ENG ____ FIX 1 SCI ____ ON ____ OFF

DEG ____ RAD ____ GRAD ____

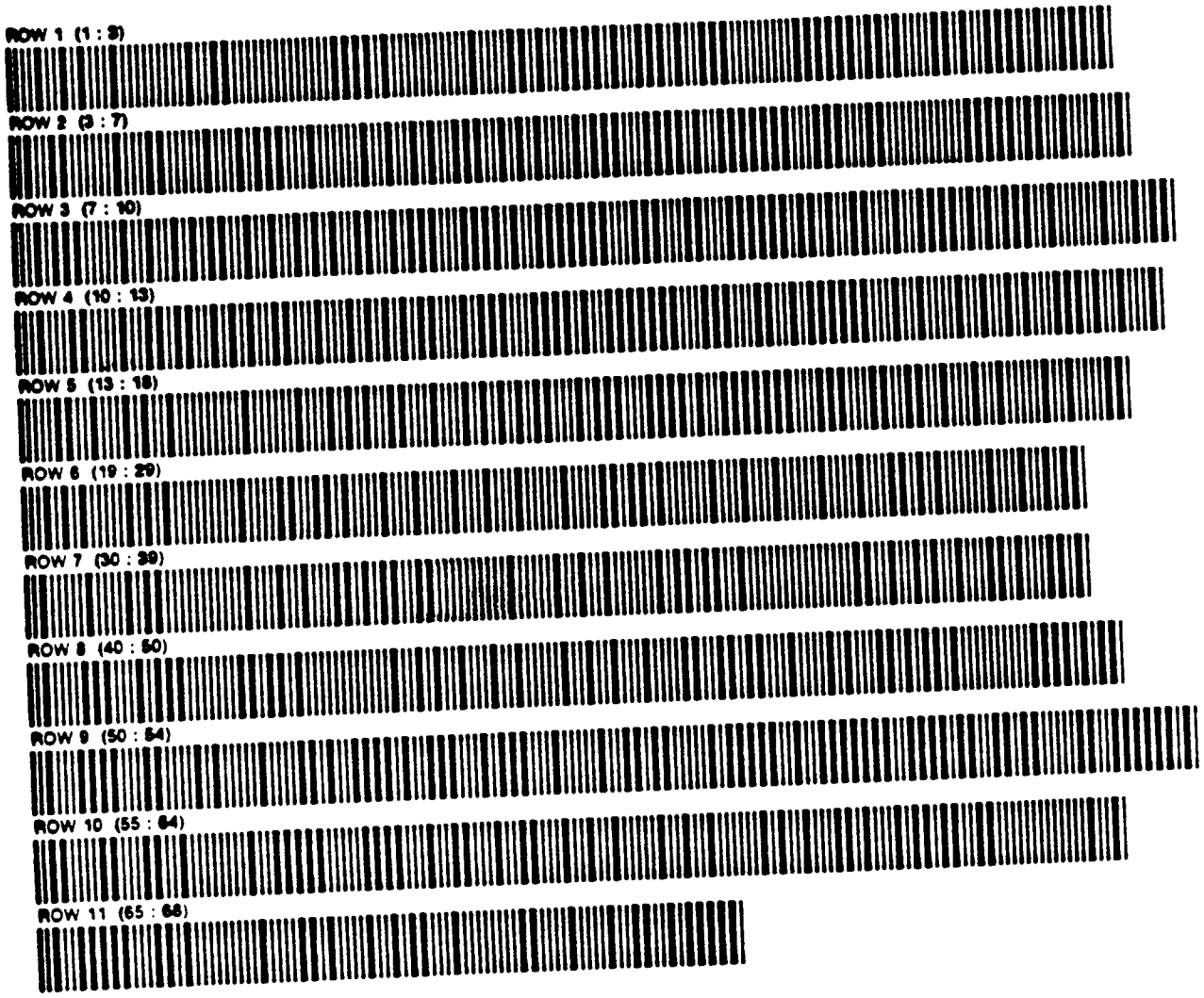
FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

PROGRAM REGISTERS NEEDED: 20



02417C

Media Manufactured in U.S.A.
Software, Product of U.S.A.

PROGRAM DESCRIPTION I

gram Title HORIZONTAL CURVE - SPIRALLED OR SIMPLE

ntributor's Name Michael Shrout

dress 200 N. 35th. Ave. #98

y Greeley State/Country Co Zip Code 80631

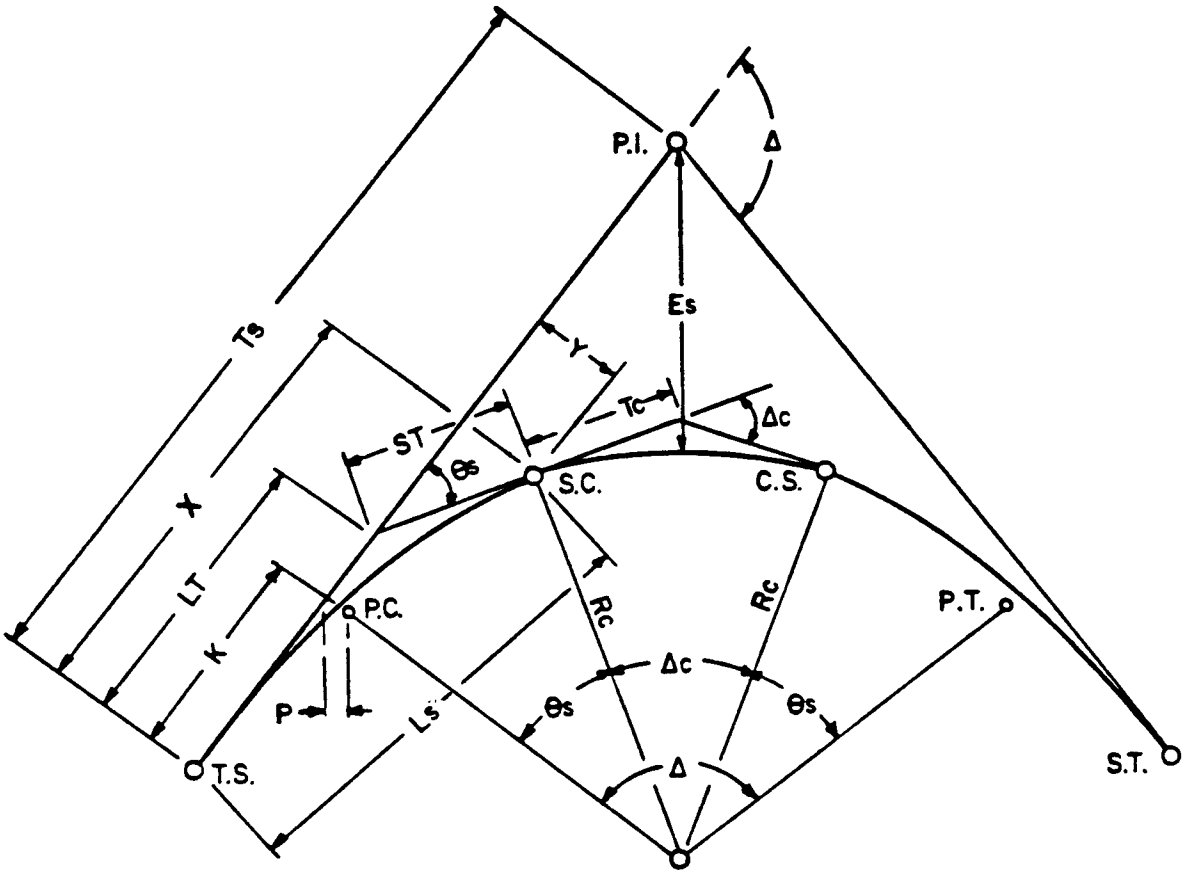
gram Description, Equations, Variables This program solves horizontal curves, either
iralled or simple. Curve based on arc definition, ie:
radius of 1 degree curve = 5729.578 feet
1 degree curve subtends 100 feet of arc for each degree of central angle.
f the length of spiral is entered as 0, program will compute the elements of a
mple curve. If Dc, the degree of curvature, is input as 0, the program will
rompt for radius, and proceed to compute the elements of a simple curve.
IX format is changed by the program several times during output. Any degree output
s shown in FIX 4 (rounded to the nearest second). Other output is in FIX 2.
ote that the program sets DEG mode.
OTE: By setting Flag 00 for spiralled curve, or Flag 04 for simple curve, this
rogram can use "PCURSTA", User's Library No. 01945C, to print out curve stations.
ee documentation for "PCURSTA" for further details.

ecessary Accessories 1 Memory Module. Printer recommended.

perating Limits and Warnings This program does not test for spiral overlaps. It must be
the responsibility of the user to ascertain that spiral lengths are proper for
the deflection and degree of curvature.

Reference(s) Colorado Department of Highways Design Manual, CDOH Survey Manual
Transition Curves for Highways, by Joseph Barnett
(Federal Works Agency, Public Roads Administration)

PROGRAM DESCRIPTION I
(continuation page)



Transition Symbols

P.I.	Point of intersection of the two main tangents
T.S.	Tangent to Spiral, common point of tangent and near transition
S.C.	Spiral to Curve, common point of near transition and circular curve
C.S.	Curve to Spiral, common point of circular curve and far transition
S.T.	Spiral to Tangent, common point of far transition and tangent
Δ	Deflection angle between two main tangents
Ts	Tangent distance to the entire curve (S.T. to P.I. or P.I. to S.T.)
Es	External distance (P.I. to midpoint of circular curve)
Δc	Deflection angle between tangents of circular curve portion. Is also the central angle of the circular curve portion.
Tc	Tangent distance to the circular curve portion
Ec	External distance of the circular curve portion (from P.I. of the circular curve to the midpoint of the circular curve)

PROGRAM DESCRIPTION I
(continuation page)

Dc	Degree of curvature of the circular curve (same as degree of curvature of the spirals at the S.C. or C.S.) (arc definition)
Lc	Length of arc of the circular curve portion
Rc	Radius of the circular curve portion
θs	Spiral angle - the intersection angle between the tangent of the complete curve and the tangent at the S.C. or C.S. (called SA for this program)
Ls	Length of spiral between T.S. and S.C or C.S. and S.T.
LT	Long tangent distance of spiral only
ST	Short tangent distance of spiral only
P	Offset distance from the tangent to P.C. of circular curve produced
K	Distance from T.S. to point on tangent opposite the P.C. of the circular curve produced
X,Y	Coordinates of S.C from T.S. relative to main tangent (also of C.S. from S.T.)

PROGRAM DESCRIPTION I
(continuation page)

FORMULAE:
(in order used)

$\left.\begin{matrix}\Delta \\ Dc \\ Ls\end{matrix}\right\}$ Given

$$Rc = \frac{5729.578}{Dc}$$

$$\theta s = \frac{DcLs}{200}$$

$$\Delta c = \Delta - 2\theta s$$

$$Tc = Rc \tan \frac{\Delta c}{2}$$

$$Lc = 100 \frac{\Delta c}{Dc}$$

$$Ec = \frac{Rc}{\cos \frac{\Delta c}{2}} - Rc$$

$$X = \frac{Ls}{100} \left(100 - 0.30461741980s^2(10)^{-2} + 0.4295915390s^4(10)^{-7} - 0.3019870760s^6(10)^{-12} + 0.135721\theta s^8(10)^{-17} \right)$$

$$Y = \frac{Ls}{100} \left(0.58177641730s - 0.1265851650^3(10)^{-4} + 0.1226910570s^5(10)^{-9} - 0.652559\theta^7(10)^{-15} \right)$$

$$P = Y - Rc (1 - \cos \theta s)$$

$$K = X - Rc \sin \theta s$$

$$Ts = (Rc + P) \tan \frac{\Delta}{2} + K$$

$$Es = \frac{Rc + P}{\cos \frac{\Delta}{2}} - Rc$$

$$ST = \frac{Y}{\sin \theta s}$$

$$LT = X - \frac{Y}{\tan \theta s}$$

NOTE: If Ls=0, then Ts=Tc, Es=Ec, DELTA=DELTAc, θs=0, P=0, K=0, X=0,Y=0. LT and ST are not calculated, forcing LT=0 and ST=0, and thus defaulting to the parameters of a simple curve.

PROGRAM DESCRIPTION II

mple Problem (Sketch if Desired)

1. Solve the following horizontal curve:
   Δ = 30°00'
   Dc = 5°00'
   Ls = 300'

2. Solve the following horizontal curve:
   Δ = 30°00'
   Dc = 5°00'
   (Ls = 0)

3. Solve the following horizontal curve:
   Δ = 30°00'
   Rc = 150'
   (Ls = 0)

UTION: Printed samples of output are shown

Input	Function	Display	Comments
	[XEQ] "HC"	DELTA?	
30	[R/S]	DEGREE?	Enter deflection in D.MS
5	[R/S]	L (SP)?	Enter degree of curvature in D.MS
300	[R/S]		Enter length of spiral. Machine beeps when done. Read output.
			SAMPLE OF OUTPUT
			DELTA=30.0000
			T (SP)=457.84
			E (SP)=43.81
			DELTAc=15.0000
			Dc=5.0000
			Tc=150.86
			Lc=300.00
			Rc=1145.92
			Ec=9.89
			P=3.27
			K=149.91
			X=299.49
			Y=13.07
			SA=7.3000
			L (SP)=300.00
			LT=200.18
			ST=100.16

PROGRAM DESCRIPTION II
(CONTINUATION PAGE)

	Input	Function	Display	Comments
2.		[XEQ] "HC"	DELTA?	
	30	[R/S]	DEGREE?	Enter deflection in D.MS
	5	[R/S]	L (SP)?	Enter degree of curvature in D.MS
	0	[R/S]		Enter length of spiral as 0. Machine beeps when done. Read output.
				SAMPLE OF OUTPUT DELTAc=30.0000 Dc=5.0000 Tc=307.05 Lc=600.00 Rc=1145.92 Ec=40.42
3.		[XEQ] "HC"	DELTA?	
	30	[R/S]	DEGREE?	Enter deflection in D.MS
	0	[R/S]	RADIUS?	Curve defined by radius, so enter 0 See prompt for radius
	150	[R/S]		Enter radius. Machine beeps when done. Read output. SAMPLE OF OUTPUT DELTAc=30.0000 Dc=38.1150 Tc=40.19 Lc=78.54 Rc=150.00 Ec=5.29

USER INSTRUCTIONS

SIZE (HP-41C) 018

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1.	Load the program			
1.	Initialize		[XEQ] "HC"	DELTA?
1.	Enter deflection in D.MS	defl	[R/S]	DEGREE?
2a.	CURVE DEFINED BY DEGREE OF CURVATURE Enter degree of curvature in D.MS	deg	[R/S]	L (SP)?
2b.	CURVE DEFINED BY RADIUS Enter 0	0	[R/S]	RADIUS?
	Enter radius	rad	[R/S]	
3a.	Enter length of spiral	len	[R/S]	
	If curve is non-spiraled, enter 0	0	[R/S]	
6.	Machine beeps when done. Samples of output are shown elsewhere.			
	NOTE: If printer is connected, all data print out automatically without using [R/S] between each item.			
	OPTIONAL FOR USE WITH PRINTER ONLY			
(7.)	By manually setting either Flag 00 or 04, this program can use "PCURSTA", User's Library No. 01945C, to print curve stations. See note on p.1.			

PROGRAM LISTING

☐ 67 ☐ 97 ■ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
	01◆LBL "HC"		
	02 SF 21		
	03 DEG		
	04 "DELTA?"		
	05 PROMPT		Enter defl.
	06 HR		
	07 STO 03		
	08 5729.578		
	09 "DEGREE?		
"			
	10 PROMPT		Enter degree
	11 X=0?		
	12 GTO 01		
	13 HR		
	14 STO 06		
	15 /		
	16 STO 08		Find Rc
	17 "L <SP>?		
"			
	18 PROMPT		Enter Ls
	19 X=0?		
	20 GTO 02		
	21 GTO 03		
	22◆LBL 01		
	23 5729.578		
	24 "RADIUS?		
"			
	25 PROMPT		Enter Rc
	26 STO 08		
	27 /		
	28 STO 06		Find Dc
	29◆LBL 02		
	30 RCL 08		
	31 RCL 03		
	32 2		
	33 /		
	34 TAN		
	35 *		
	36 STO 04		Find Tc
	37 100		
	38 RCL 03		
	39 *		
	40 RCL 06		
	41 /		
	42 STO 07		Find Lc
	43 RCL 03		
	44 2		
	45 /		
	46 COS		
	47 1/X		
	48 1		
	49 -		
	50 RCL 08		
	51 *		
	52 STO 05		Find Ec
	53 RCL 03		
	54 HMS		Change Δc, Dc
	55 STO 03		from decimal to
	56 RCL 06		D.MS
	57 HMS		
	58 STO 06		
	59 XEQ 07		
	60 GTO 06		
	61◆LBL 03		
	62 STO 14		Store Ls
	63 RCL 03		
	64 STO 00		
	65 RCL 14		
	66 RCL 06		
	67 *		
	68 .5		
	69 %		
	70 STO 15		Find θs
	71 2		
	72 *		
	73 CHS		
	74 RCL 00		
	75 +		
	76 STO 03		Find Δc
	77 2		
	78 /		
	79 TAN		
	80 RCL 08		
	81 *		
	82 STO 04		Find Tc
	83 RCL 03		
	84 RCL 06		
	85 /		
	86 100		
	87 *		
	88 STO 07		Find Lc
	89 RCL 03		
	90 2		
	91 /		
	92 COS		
	93 1/X		
	94 1		
	95 -		
	96 RCL 08		
	97 *		
	98 STO 05		Find Ec
	99 100		

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

■ □97 ■41C

STEP/LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
100	RCL 15		
101	X↑2		
102	.3046174		
198	E-2		
103	*		
104	-		
105	RCL 15		
106	4		
107	Y↑X		
108	.4295915		
39	E-7		
109	*		
110	+		
111	RCL 15		
112	6		
113	Y↑X		
114	.3019870		
76	E-12		
115	*		
116	-		
117	RCL 15		
118	8		
119	Y↑X		
120	.135721		
E-17			
121	*		
122	+		
123	RCL 14		
124	*		
125	1		
126	%		
127	STO 12		Find X
128	RCL 15		
129	.5817764		
173			
130	*		
131	RCL 15		
132	3		
133	Y↑X		
134	.1265851		
65	E-4		
135	*		
136	-		
137	RCL 15		
138	5		
139	Y↑X		
140	.1226910		
57	E-9		
141	*		
142	+		
143	RCL 15		
144	7		
145	Y↑X		
146	.652559		
E-15			
147	*		
148	-		
149	RCL 14		
150	*		
151	1		
152	%		
153	STO 13		Find Y
154	RCL 08		
155	1		
156	RCL 15		
157	COS		
158	-		
159	*		
160	-		
161	STO 10		Find P
162	RCL 12		
163	RCL 08		
164	RCL 15		
165	SIN		
166	*		
167	-		
168	STO 11		Find K
169	RCL 00		
170	2		
171	/		
172	TAN		
173	RCL 08		
174	RCL 10		
175	+		
176	*		
177	RCL 11		
178	+		
179	STO 01		Find Ts
180	RCL 00		
181	2		
182	/		
183	COS		
184	1/X		
185	RCL 08		
186	RCL 10		
187	+		
188	*		
189	RCL 08		
190	-		
191	STO 02		Find Es
192	RCL 15		
193	X=0?		

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

02417C PROGRAM LISTING

☐ 67 ☐ 97 ■ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
194	GTO 04		
195	SIN		
196	RCL 13		
197	/		
198	1/X		
199	STO 17		Find ST
200	RCL 15		
201	TAN		
202	RCL 13		
203	/		
204	1/X		
205	CHS		
206	RCL 12		
207	+		
208	STO 16		Find LT
209	GTO 05		
210◆	LBL 04		
211	0		
212	STO 17		
213	STO 16		
214◆	LBL 05		
215	RCL 00		
216	HMS		
217	STO 00		Convert Δ, Δc,
218	RCL 03		Dc, θs from
219	HMS		decimal to D.MS
220	STO 03		
221	RCL 06		
222	HMS		
223	STO 06		
224	RCL 15		
225	HMS		
226	STO 15		
227	BEEP		
228	FIX 4		
229	"DELTA="		Display output
230	ARCL 00		
231	AVIEW		
232	FIX 2		
233	"T <SP>=		
"			
234	ARCL 01		
235	AVIEW		
236	"E <SP>=		
"			
237	ARCL 02		
238	AVIEW		
239	XEQ 07		
240	"P="		
241	ARCL 10		
242	AVIEW		
243	"K="		
244	ARCL 11		
245	AVIEW		
246	"X="		
247	ARCL 12		
248	AVIEW		
249	"Y="		
250	ARCL 13		
251	AVIEW		
252	FIX 4		
253	ADV		
254	"SA="		
255	ARCL 15		
256	AVIEW		
257	FIX 2		
258	"L <SP>=		
"			
259	ARCL 14		
260	AVIEW		
261	"LT="		
262	ARCL 16		
263	AVIEW		
264	"ST="		
265	ARCL 17		
266	AVIEW		
267	GTO 06		
268◆	LBL 07		Display simple
269	FIX 4		curve output
270	ADV		
271	"DELTAc=		
"			
272	ARCL 03		
273	AVIEW		
274	"Dc="		
275	ARCL 06		
276	AVIEW		
277	FIX 2		
278	"Tc="		
279	ARCL 04		
280	AVIEW		
281	"Lc="		
282	ARCL 07		
283	AVIEW		
284	"Rc="		
285	ARCL 08		
286	AVIEW		
287	"Ec="		
288	ARCL 05		
289	AVIEW		
290	ADV		
291	RTN		
292◆	LBL 06		
293	END		

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

R00= A
R01= Ts
R02= Es
R03= Ac
R04= Tc
R05= Ec
R06= Dc
R07= Lc
R08= Rc
R09=
R10= P
R11= M
R12= X
R13= Y
R14= Ls
R15= ds
R16= LT
R17= ST

NOTE: REG. 9 IS NOT USED. THE ARRANGEMENT IS TO MAKE THIS PROGRAM COMPATABLE WITH OTHER PROGRAMS.

STATUS

545 bytes

SIZE	018	TOT. REG.	96	USER MODE	
ENG		FIX	auto	SCI	ON ... OFF ...
DEG	X	RAD		GRAD	

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
21	S	Print enable	
00	C		
04	C	See note on p.1.	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

ROW 1 (1 : 4)

ROW 2 (4 : 8)

ROW 3 (8 : 12)

ROW 4 (13 : 18)

ROW 5 (19 : 23)

ROW 6 (23 : 28)

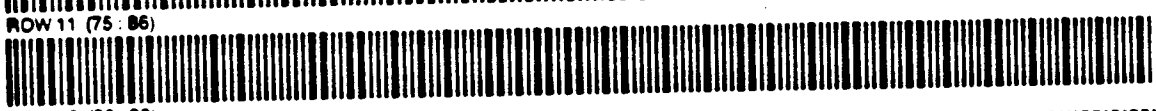
ROW 7 (29 : 39)

ROW 8 (40 : 52)

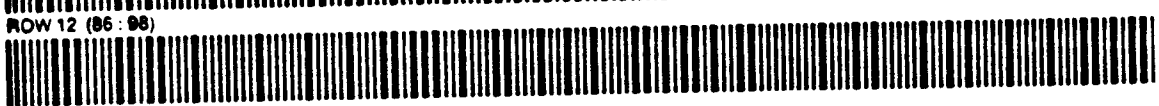
ROW 9 (53 : 62)

ROW 10 (63 : 74)

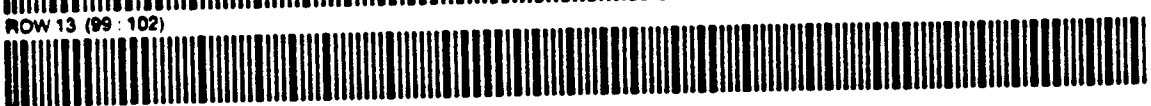
ROW 11 (75 : 86)



ROW 12 (86 : 98)

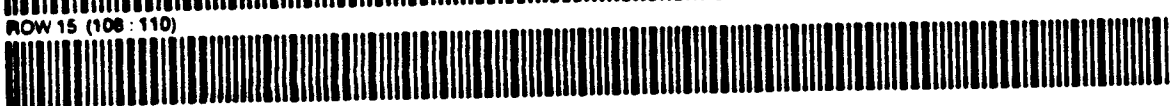


ROW 13 (99 : 102)

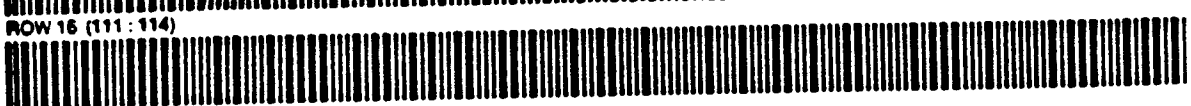


ROW 14 (102 : 106)

ROW 15 (106 : 110)

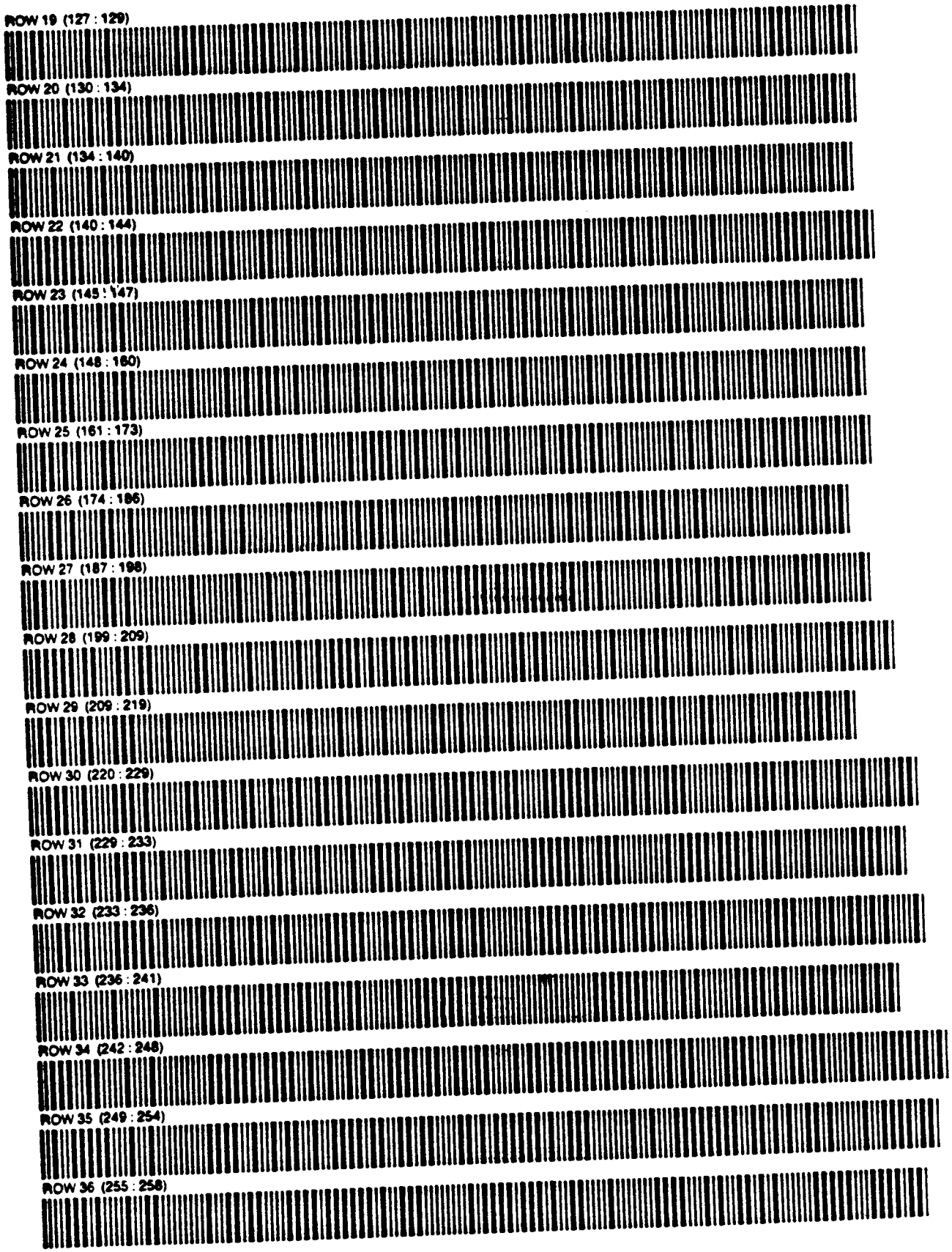


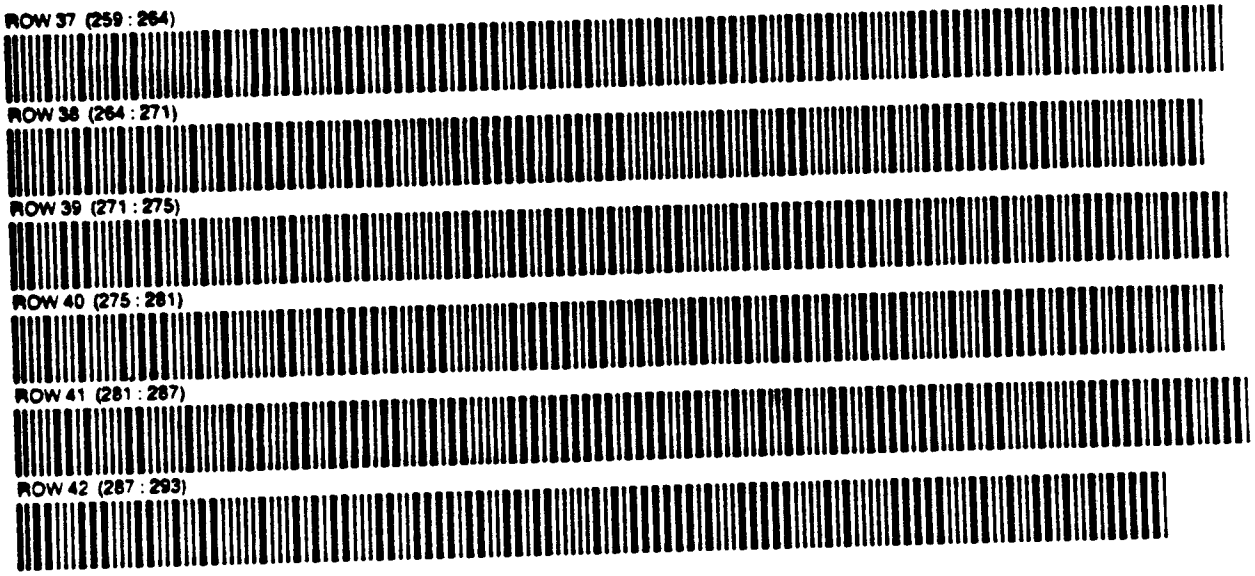
ROW 16 (111 : 114)



ROW 17 (114 : 120)

ROW 18 (120 : 126)


ROW 19 (127 : 129)
ROW 20 (130 : 134)
ROW 21 (134 : 140)
ROW 22 (140 : 144)
ROW 23 (145 : 147)
ROW 24 (148 : 160)
ROW 25 (161 : 173)
ROW 26 (174 : 186)
ROW 27 (187 : 198)
ROW 28 (199 : 209)
ROW 29 (209 : 219)
ROW 30 (220 : 229)
ROW 31 (229 : 233)
ROW 32 (233 : 236)
ROW 33 (236 : 241)
ROW 34 (242 : 248)
ROW 35 (249 : 254)
ROW 36 (255 : 258)


ROW 37 (259 : 264)
ROW 38 (264 : 271)
ROW 39 (271 : 275)
ROW 40 (275 : 281)
ROW 41 (281 : 287)
ROW 42 (287 : 293)

02796C

PROGRAM DESCRIPTION I

ogram Title Stadia Reduction and Elevation Adjustment.

ontributor's Name Michael Quinlan

ddress 4 Thorne Place

ity New Monmouth State/Country New Jersey Zip Code 07748

rogram Description, Equations, Variables Program calculates V, the vertical distance from center of instrument to rod reading, HD, the horizontal distance from center of instrument to rod, DE, the difference in elevation between transit station and rod station, and the elevation of the rod station. (see next page for diagram.)

Adjusted DE's and elevations can be calculated, after the reduction program has been run, requiring the end elevation as input (only if traverse is open. Otherwise, no numerical input is required)

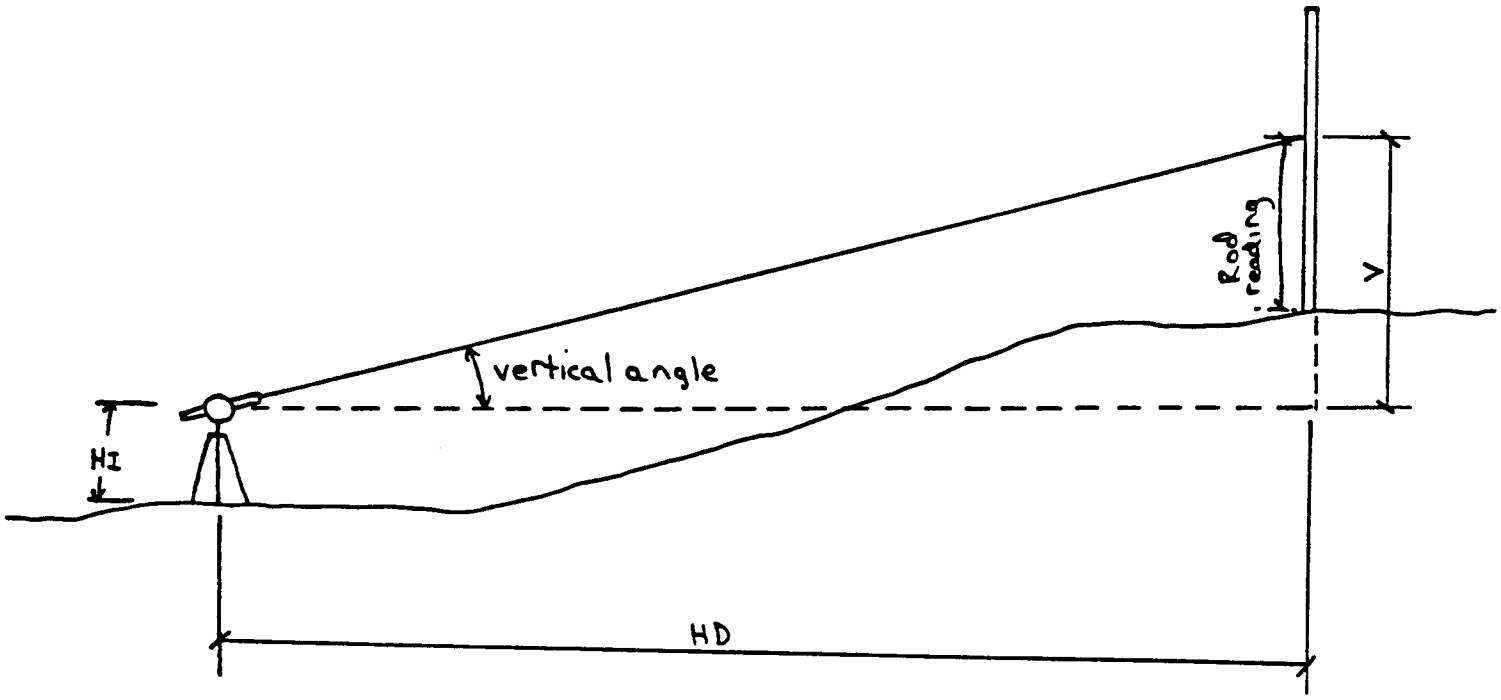
Adjustment program can be used for any traverse for which HD's and DE's are known.

(continued on next page)

Necessary Accessories One memory module. Additional modules required as number of traverse points increases (>11)

Operating Limits and Warnings Program does not test for unacceptable error. Data entered incorrectley cannot be corrected.

Reference(s) Moffitt, Francis H. and Bouchard, Harry, Surveying, Seventh Edition, Harper + Row, Publishers, Inc., New York, 1982



HI = hieght of instrument above ground

HD = horizontal distance

V = vertical distance

α = vertical angle

R = rod reading

K = stadia interval factor

C = stadia constant

S = stadia interval

Equations

$$HD = KS\cos^2\alpha + C$$

$$V = KS\cos\alpha\sin\alpha$$

$$DE = HI + V - R$$

$$ELEV_n = ELEV_{n-1} + DE_{n-1\to n}$$

$$\text{Adjusted } DE_n = \frac{HD_{n-1\to n}}{\Sigma HD}(-\text{error}) + DE_n$$

If closed traverse

error = ΣDE

If open

error = ΣDE − END ELEV + BEG ELEV

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

1. Given, K = 100, C = 1.1, and data in the table below, what are the unadjusted and adjusted elevations of the points? Output display: FIX 2

COURSE	Stadia interval	vertical angle
1 → 2	3.71	7°03'
2 → 3	2.53	- 2° 47'
3 → 4	4.37	4° 30'

ELEV 1 = 103.50 ELEV 4 = 172.00

HI = R

SOLUTION:

Display	Input	Function	Comments
		[XEQ] 'STADIA'	
NO. PTS = ?	4	R/S	
SET SIZE 21		[XEQ] SIZE 021	If SIZE ≥ 21, these two steps may be skipped.
21		R/S	
FIX 1,2?	2	R/S	
K=?	100	R/S	
C=?	1.1	R/S	
DSP V?	N	R/S	
DSP HD?	N	R/S	
DSP DE?	N	R/S	
DSP ELEV?	Y	R/S	Sets flag 04
BEG ELEV=?	103.5	R/S	
INT=?	3.71	R/S	INPUT STADIA INTERVAL
VERT. ∠=?	7.03	R/S	
HI=?		R/S	
ROD=?		R/S	
ELEV 2 = 148.69		R/S	
INT=?	2.53	R/S	
VERT. ∠=?	2.47	[CHS] R/S	
HI=?		R/S	
ROD=?		R/S	
ELEV 3 = 136.42		R/S	
INT=?	4.37	R/S	
VERT. ∠=?	4.3	R/S	
HI=?		R/S	
ROD=?		R/S	
ELEV 4 = 170.60		[XEQ] 'ADJ'	
DATA IN?	Y	R/S	
ΣHD = 1,055.42		R/S	
ΣDE = 67.10		R/S	
OPEN?	Y	R/S	
END ELEV=?	172	R/S	
ERROR= -1.40		R/S	
DSP ADJ DE?	N	R/S	
ADJUST		R/S	

(continued)

DISPLAY	INPUT	FUNCTION	COMMENTS
ELEV 2 = 149.18 ELEV 3 = 137.24 ELEV 4 = 172.00		R/S R/S	

2. Given the following data for a level run:

COURSE	HD	DE	
1→2	350.0	27.3	ELEV 1 = 157.2
2→3	272.3	-19.7	
3→4	117.4	-15.9	
4→1	180.0	7.8	
	ΣHD = 919.7	ΣDE = -0.5	

What are the adjusted DE's and Elevations of the points?

In a closed level run, ΣDE = error

DISPLAY	INPUT	FUNCTION	COMMENTS
		[XEQ] SIZE 08 [XEQ] 'ADJ'	minimum size requirement
FIX 1,2?	1	R/S	same as data
DATA IN?	N	R/S	
ΣHD=?	919.7	R/S	
ERROR=?	0.5	[CHS] R/S	
BEG ELEV=?	157.2	R/S	
DSP ADJ DE?	Y	R/S	sets flag 02
ADJUST		R/S	
HD 1-2=?	350	R/S	
DE 1-2=?	27.3	R/S	
ADJ DE = 27.5		R/S	
ELEV 2 = 184.7		R/S	
HD 2-3=?	272.3	R/S	
DE 2-3=?	19.7	[CHS] R/S	
ADJ DE = -19.6		R/S	
ELEV 3 = 165.1		R/S	
HD 3-4=?	117.4	R/S	
DE 3-4=?	15.9	[CHS] R/S	
ADJ DE = -15.8		R/S	
ELEV 4 = 149.3		R/S	
HD 4-5=?	180	R/S	input HD 4-1
DE 4-5=?	7.8	R/S	input DE 4-1
ADJ DE = 7.9		R/S	
ELEV 5 = 157.2			ELEV 5 = ELEV 1

02796C

USER INSTRUCTIONS

EP	INSTRUCTIONS	INPUT	FUNCTION	SIZE (HP-41C) Zn + 13 DISPLAY
1	Enter program. If HD's and DE's			
	are known go to step 18, if not			
	go to step 2.			
2	Begin program.		[XEQ] 'STADIA'	NO. PTS = ?
3	Input number of traverse points	n	[R/S]	SET SIZE bbb
4	Set size and continue		[XEQ] SIZE bbb	
			[R/S]	
5	Input number of decimal places			
	results should be displayed to.	a	[R/S]	K = ?
6	Input stadia interval factor	K	[R/S]	C = ?
7	Input stadia constant	C	[R/S]	DSP V?
8a	Choose to display V or not to	Y or N	[R/S]	DSP HD?
	display V.			
8b	Choose to display HD or not	Y or N	[R/S]	DSP DE?
	to display HD.			
8c	Choose to display DE or not	Y or N	[R/S]	DSP ELEV?
	to display DE.			
8d	Choose to display elevation or	Y or N	[R/S]	BEG ELEV = ?
	not to display elevation.			
9	Input beginning elevation	ELEV 1	[R/S]	INT = ?
10	Input stadia interval	S	[R/S]	VERT. Δ = ?
11	Input vertical angle	α	[R/S]	V =
12	Display HD		[R/S]	HD =
13	Continue		[R/S]	HI = ?
14	Input hieght of instrument (if	HI	[R/S]	ROD = ?
	$HI_n = HI_{n-1}$ or rod reading,			
	no input is necessary.)			

USER INSTRUCTIONS

(continued)

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
15	Input rod reading (if R=HI, no input is necessary)	R	[R/S]	DE=
16	Display elevation (k+1)		[R/S]	ELEV(k+1)=
17	Go to step 10 for succesive courses		[R/S]	INT=?
	Go to step 18 to adjust DE's and ELEV's			
18	Begin adjustment program		[XEQ] 'ADJ'	DATA IN?
19a	(If reduction program has been run) Go to step 20	Y	[R/S]	ΣHD=
19b	(If reduction program has not been run) Go to step 28	N	[R/S]	FIX 1,2?
20	Continue		[R/S]	ΣDE=
21	Continue		[R/S]	OPEN?
22a	(If traverse closed) Go to step	N	[R/S]	ERROR=
22b	(If traverse open)	Y	[R/S]	END ELEV=?
23	Input elevation of ending point	ELEV n	[R/S]	ERROR=
24	Continue		[R/S]	DSP ADJ DE?
25	Choose to display or not to display adjusted differences in elevations.	Y or N	[R/S]	ADJUST
26	Display adjusted DE's		[R/S]	ADJ DE=
27	Display adjusted elevations. Goto step 26 to continue.		[R/S]	ELEV(k+1)=
28	Input number of decimal places results should be displayed to.	a	[R/S]	ΣHD=?
29	Input total horizontal distance	ΣHD	[R/S]	ERROR=?
30	Input error of closure			BEG ELEV=?
31	Input beginning elevation	ELEV 1	[R/S]	DSP ADJ DE?

USER INSTRUCTIONS
(continued)

P	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
2	Choose to display or not display adjusted difference in elevation	YorN	[R/S]	ADJUST
3	Continue		[R/S]	HD K-(K+1)=?
4	Input horizontal distance from point K to point (K+1).	HD	[R/S]	DE K-(K+1)=?
5	Input difference in elevation from point K to point (K+1).	DE	[R/S]	ADJ DE=
6	Display Elevation of point (K+1) to continue, goto step 33.		[R/S]	ELEV (K+1)=
	Note: Entries in the display column may vary, depending on the input in steps 8a-8d, and steps 25 and 32.			
	*Size requirement for 'ADJ' (when data not in) is 011. In the 'STADIA' program, the size requirement is computed. If the register allocation is insufficient, the size requirement is displayed. (# registers required = 2n+13) n= # of points For point K to point (K+1) HD register address = 2K+11 DE register address = 2K+12			

02796C PROGRAM LISTING

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
01	LBL"STADIA		
	XEQ 15		initialize
	DEG		
	SF 25		
	"NO. PTS=?		
	PROMPT		
	2		
	*		
	12		
10	+		
	"SET SIZE		
	FIX 0		
	CF 29		
	STO IND X		Test size
	1		
	+		
	ARCL X		
	FC?C 25		If size not large
	AVIEW		enough, aview.
20	0		
	STO 04		
	STO 05		
	STO 06		
	STO 07		
	STO 09		
	XEQ 12		
	"K=?		
	PROMPT		Input stadia
	STO 00		interval factor.
30	"C=?		
	PROMPT		Input stadia
	STO 01		constant
	"DSP Y		
	1		
	XEQ 16		
	DSP HD		
	2		
	XEQ 16		
	DSP DE		
40	3		
	XEQ 16		
	DSP ELEV		
	4		
	XEQ 16		
	XEQ 17		
	STO 11		
	LBL 02		
	1		
	ST+ 09		
50	"INT=?		
51	PROMPT		Input stadia interval
	STO 02		
	CF 22		
	"VERT<=?		input vertical angle, if = 0, no input required.
	PROMPT		
	FC?C 22		
	0		
	HR		
	STO 03		
60	1		sin in y-reg. cos in x-reg.
	P-R		
	*		
	RCL 02		
	*		
	RCL 00		
	*		
	"V=		
	ARCL X		
	FS? 01		
70	AVIEW		
	RCL 03		
	COS		
	X↑2		
	RCL 02		
	*		
	RCL 00		
	*		
	RCL 01		
	+		
80	ST+ 04		
	RCL 09		Calculate register address for HD and store.
	2		
	*		
	11		
	+		
	X<>Y		
	STO IND Y		
	X<>Y		
	RDN		
90	"HD=		
	ARCL X		
	FS? 02		
	AVIEW		
	X<>Y		
	CF 22		
	"HI=?		If new HI, save if not, use old HI
	PROMPT		
	FS? 22		
	STO 07		
100	FC?C 22		

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02796C

PROGRAM LISTING

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
101	RCL 07		
	+		
	"ROD=?		If R=HI, no input needed
	PROMPT		
	FC?C 22		
	RCL 07		
	-		
	ST+ 05		
	RCL 09		
110	2		calculate register address for DE and store.
	*		
	12		
	+		
	X<>Y		
	STO IND Y		
	ST+ 11		
	"DE=		
	ARCL X		
	FS?03		
120	AVIEW		
	"ELEV		
	RCL 09		
	1		
	+		
	FIX 0		
	CF 29		
	ARCL X		
	"F=		
	SF 29		
130	FIX IND 10		
	ARCL 11		
	FS?04		
	AVIEW		
	GTO 02		
	LBL"ADJ		Adjustment program Initialization
	XEQ 15		
	"DATA IN		
	0		
	XEQ 16		
140	FC? 00		
	XEQ 12		
	FS? 00		
	GTO 11		
	ΣHD=?		If data not in, prompt for total horizontal distance and total difference in elevation
	PROMPT		
	STO 04		
	"ERROR=?		
	PROMPT		
	STO 05		
150	GTO 05		

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
151	LBL 11		
	ΣHD=		
	ARCL 04		
	AVIEW		
	ΣDE=		
	ARCL 05		
	AVIEW		
	LBL 05		
	"OPEN		
160	4		
	FS? 00		
	XEQ 16		
	FC? 00		
	XEQ 17		
	FC? 04		If traverse open and data in, prompt for ending elevation.
	GTO 06		
	FC? 00		
	GTO 06		
	"END ELEV=?		
170	RCL 06		
	PROMPT		
	X<>Y		
	-		
	RCL 05		
	X<>Y		
	-		
	STO 05		
	LBL 06		
	FC? 00		If data not in, skip display of error.
180	GTO 04		
	"ERROR=		
	ARCL 05		
	AVIEW		
	LBL 04		
	-1		
	ST* 05		
	2		
	STO 07		
	"DSP ADJ DE		
190	2		
	XEQ 16		
	"ADJUST		Adjustment routine begins.
	AVIEW		
	12		
	STO 09		
	LBL 07		
	FIX 0		
	CF 29		
	1		Increase counter by one.
200	ST+ 09		

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02796C PROGRAM LISTING

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
201	ᵀHD		If data in, use stored value, if not, prompt for value of HD.
	FC?00		
	XEQ 08		
	FS?00		
	RCL IND 09		
	RCL 04		
	/		
	RCL 05		
	*		
210	1		
	ST+ 09		
	RDN		
	ᵀDE		
	FS?00		If data in, use stored value, if not, prompt for value of DE.
	GTO 09		
	XEQ 08		
	X<>Y		
	RDN		
	GTO 10		
220	LBL 09		
	RCL IND 09		
	LBL 10		
	+		
	SF 29		
	FIX IND 10		
	ᵀADJ DE=		
	ARCL X		
	FS? 02		
	AVIEW		
230	CF 29		
	FIX 0		
	ST+ 06		
	ᵀELEV		
	FS?00		
	GTO 14		
	ARCL 07		
	GTO 13		
	LBL 14		
	RCL 09		
240	10		Calculate number of point.
	—		
	2		
	/		
	ARCL X		
	LBL 13		
	ᵀP=		
	SF 29		
	FIX IND 10		
	ARCL 06		
250	AVIEW		

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
251	1		
	ST+ 07		
	GTO 07		
	LBL 08		
	RCL 07		Subroutine for HD and DE prompts.
	1		
	—		
	ARCL X		
	ᵀP-		
260	ARCL 07		
	ᵀP=?		
	PROMPT		
	RTN		
	LBL 12		
	ᵀFIX 1,2?		Subroutine to prompt for fix notation.
	PROMPT		
	STO 10		
	FIX IND 10		
	SF 29		
270	RTN		
	LBL 15		
	SF 21		Initialization
	CF 00		
	CF 01		
	CF 02		
	CF 03		
	CF 04		
	RTN		
	LBL 16		
280	STO 08		
	ᵀP?		
	AON		
	PROMPT		
	AOFF		
	ASTO X		
	ᵀY		
	ASTO Y		
	X=Y?		
	SF IND 08		
290	RTN		
	LBL 17		
	BEG ELEV=?		Prompt for beginning elevation.
	PROMPT		
	STO 06		
	END		
00			

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REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

'STADIA'

00 Stadia interval factor
01 Stadia constant
02 Current stadia interval
03 Current vertical angle
04 Total horizontal distance
05 Total difference in elevation
06 Beginning elevation
07 Current height of instrument
08 Indirect flag setting
09 Counter for HD and DE storage (indirect)
10 Indirect display control
11 Current elevation

'ADJ'

04 Total horizontal distance
05 Total difference in elevation
06 Current elevation
07 Counter for HD and DE prompts
08 Indirect flag setting
09 Counter for HD and DE recall (indirect)
10 Indirect display control

Odd numbered registers ≥ 13 for HD's
Even numbered registers ≥ 14 for DE's

STATUS

SIZE 2n+13		TOT. REG. 104+2n		USER MODE	
ENG		FIX	SCI	ON	OFF
DEG	✓	RAD	GRAD		

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
		'STADIA'	
01	C	Display V	Not display V
02	C	Display HD	Not display HD
03	C	Display DE	Not display DE
04	C	Display ELEV	
21	S	Printer Enabled	Printer Disabled
25	S	Size large enough	Size not large enough
29	C	Digit seperaters present	Digit seperators omitted
22	C	Numeric entry	No numeric entry
		'ADJ'	
00	C	Data in	Data not in
02	C	Display adj. DE's	Not display
04	C	Traverse open	Traverse closed
21	S	Printer Enabled	Printer Disabled

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

STADIA ADJUSTMENT
PROGRAM NUMBER: 02796

ROW 1: LINES 1-2

ROW 2: LINES 3-5

ROW 3: LINES 6-11

ROW 4: LINES 11-17

ROW 5: LINES 18-27

ROW 6: LINES 27-33

ROW 7: LINES 33-36

ROW 8: LINES 36-39

ROW 9: LINES 40-42

ROW 10: LINES 43-50

ROW 11: LINES 50-54

ROW 12: LINES 54-62

STADIA ADJUSTMENT
PROGRAM NUMBER: 02796

ROW 13: LINES 63-71

ROW 14: LINES 72-83

ROW 15: LINES 84-91

ROW 16: LINES 91-97

ROW 17: LINES 98-103

ROW 18: LINES 104-113

ROW 19: LINES 114-119

ROW 20: LINES 120-126

ROW 21: LINES 126-132

ROW 22: LINES 132-136

ROW 23: LINES 136-139

ROW 24: LINES 140-144

STADIA ADJUSTMENT
PROGRAM NUMBER: 02796

ROW 25: LINES 144-148

ROW 26: LINES 149-155

ROW 27: LINES 155-159

ROW 28: LINES 160-165

ROW 29: LINES 166-169

ROW 30: LINES 169-178

ROW 31: LINES 179-182

ROW 32: LINES 183-189

ROW 33: LINES 189-192

ROW 34: LINES 192-198

ROW 35: LINES 199-204

ROW 36: LINES 204-213

STADIA ADJUSTMENT
PROGRAM NUMBER: 02796

ROW 37: LINES 213-219

ROW 38: LINES 220-226

ROW 39: LINES 226-231

ROW 40: LINES 232-236

ROW 41: LINES 236-245

ROW 42: LINES 246-252

ROW 43: LINES 253-260

ROW 44: LINES 261-265

ROW 45: LINES 265-272

ROW 46: LINES 272-279

ROW 47: LINES 279-287

ROW 48: LINES 287-292

STADIA ADJUSTMENT
PROGRAM NUMBER: 02796

ROW 49: LINES 292-295