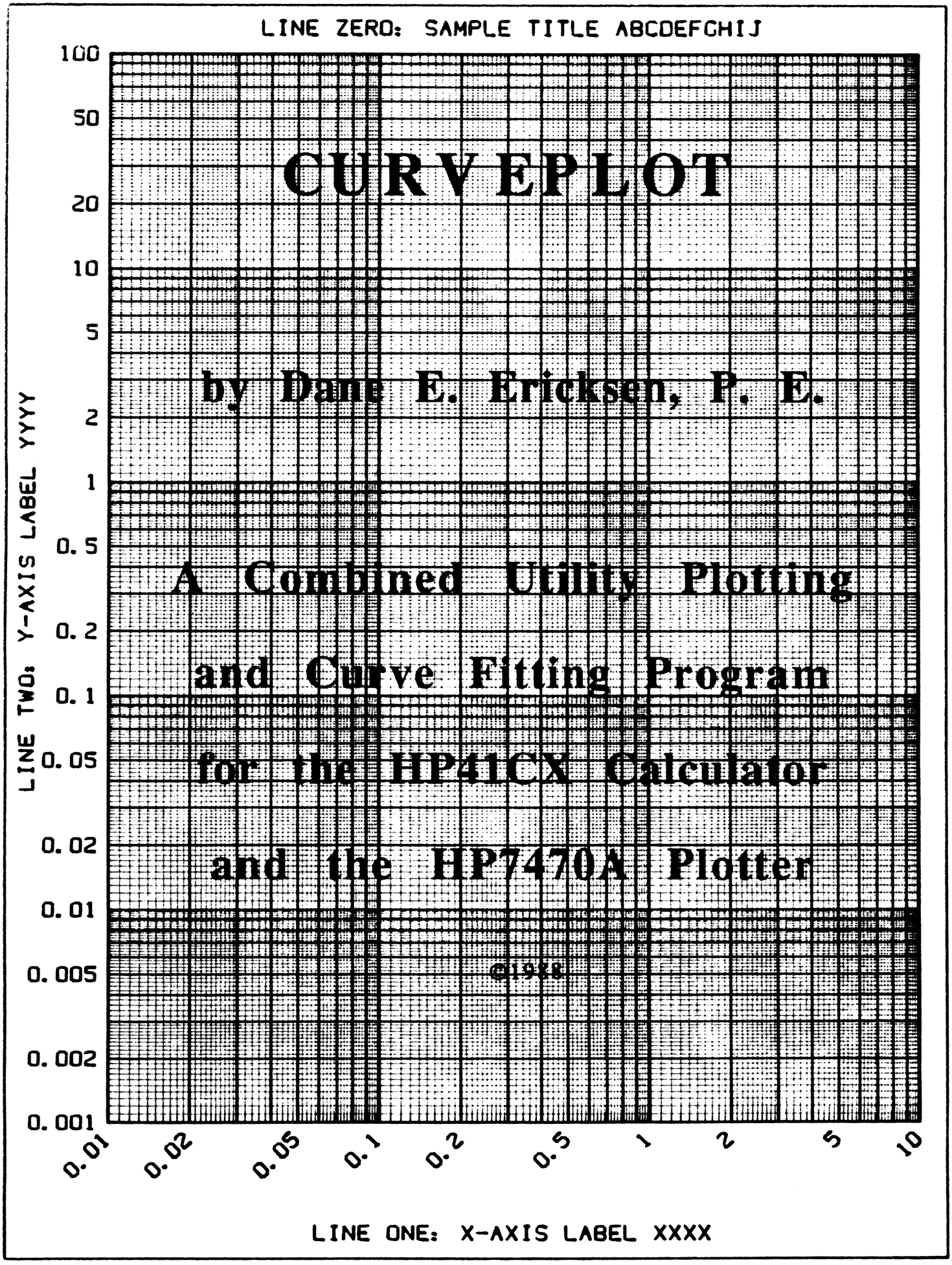
LINE ZERO: SAMPLE TITLE ABCDEFGHIJ
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
LINE TWO: Y-AXIS LABEL YYYY
CURVEPLOT
by Dane E. Ericksen, P. E.
A Combined Utility Plotting
and Curve Fitting Program
for the HP41CX Calculator
and the HP7470A Plotter
©1988
0.01
0.02
0.05
0.1
0.2
0.5
1
2
5
10
LINE ONE: X-AXIS LABEL XXXX

CURVEPLOT

CURVEPLOT is a combination utility plotting program and a powerful curve fitting program for the HP7470A plotter and HP41CX calculator. This utility plotting program can support linear-log, log-linear, and log-log plots, in addition to linear-linear plots, which makes it much more versatile than the utility plotting program provided with the 82184A Plotter Module. Any number of decades can be accommodated, and the plot boundaries do not have to be integer powers of ten.

The user can elect to employ a curve fitting option which is patterned after Bill Kolb's "Curve Fitting For Programmable Calculators". An additional curve has been added, for a total of twenty curve types. The number of input points is limited only by available extended memory. All curves meeting a user-specified adjusted coefficient of determination can be automatically plotted, including the input data points. This marriage of an improved utility plotting program with Kolb's curve fitting masterpiece results in a powerful and practical engineering tool.

In addition to the multiple curve fitting program, least-squares curve fits to polynomials through the ninth order can be selected.

The following accessories are required for the HP41CX calculator: HP-IL module; two extended memory modules; 82184A plotter module; 7470A plotter with the HP-IL option; digital cassette drive; and printer.

The author wishes to thank Mr. William Kolb for granting permission to use a modified version of his multiple curve fitting program.

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March 19, 1988

NOTICE

While every effort has been made to produce an effective utility plotting and curve fitting program, the author makes no express or implied warranty with regard to the program material offered or the merchantability or the fitness of the program material for any particular purpose. The program material is made available solely on an "as is" basis, and the entire risk as to its quality and performance is with the user. Should the program material prove defective, the user (and not the author nor any other party) shall bear the entire cost of all necessary corrections and all incidental or consequential damages. The author shall not be liable for any incidental or consequential damages in connection with or arising out of the furnishing, use, or performance of the program material.

By purchasing and using this program, the buyer accepts the above conditions. Should these terms not be acceptable, the buyer may return the software and accessories within ten days for a full refund.

HPPLOT (Hewlett Packard PLOTter) is a utility plotting program for the HP7470A plotter. It will plot (X,Y) data in linear-linear, linear-log, log-linear, or log-log formats. The format is controlled by flags 03 and 04: if flag 03 is SET, the log of X is plotted instead of X; if flag 04 is SET, the log of Y is plotted instead of Y. Multiple decade plots can be accommodated, and the starting and ending values do not have to be integer powers of ten.

HPPLOT requires a utility program, U80, to be in RAM and packed. U80 contains several short subroutines also used by GRAT (a graticule drawing program), by TICK (a program which draws minor graticules, or "tick" marks), and by PLTLBL (a program which labels the plot).

HPPLOT will prompt for the name of the called function. The name cannot exceed six letters, as the name is stored in a single data register. The called function should expect to see X in the X register upon being called by HPPLOT, and to leave f(x), or Y, in the X register upon completion. The called function must respect registers 00 to 20, which are used by HPPLOT. However, it is possible for the called function to manipulate registers 00 through 20, if it is done with a full understanding of how HPPLOT uses these registers.

The called function must not alter any of the user flags (flags 00 through 10), as these flags are used by HPPLOT. If flag usage by the called function is necessary, their use should be restricted to flags 00 through 07. This will allow the called function to use the X<>F command to save the status of flags 00 through 07 to a data register that will not be disturbed. The called function can then restore these flags before returning to HPPLOT.

Prompts calling for a yes or no response interpret any non-zero entry as "yes", and a zero (or no entry) as "no". If the "DIGITIZE?" prompt is answered in the affirmative, the plot boundaries will be set by digitization. If the digitize mode is selected, a prompt for "NEW POINTS?" will be made. An affirmative answer results in the actual setting of the digitized points. A "no" answer will cause any existing digitized points to be used. On the first digitize mode selection, the "NEW POINTS?" prompt must be answered "yes"; subsequent plots can then re-use these digitized points, if desired. The last digitized points will be retained by the plotter as long as it

is left on. Appropriate prompts to insert and remove a digitizing sight are made.

If a "no" answer is made to the "DIGITIZE?" prompt, a default plot boundary of 216 mm by 164 mm will be used. If the "FRAME?" prompt is answered in the affirmative, a prompt for pen selection will be made, and the plot boundaries will be framed.

Flag 00 determines whether a vertically-oriented or a horizontally-oriented plot is drawn. If flag 00 is CLEAR, a vertically-oriented plot, with the X-axis along the 164mm dimension and the Y-axis along the 216mm dimension, will be drawn. If flag 00 is SET, a horizontally-oriented plot will be drawn with the X-axis on the long dimension and the Y-axis on the short dimension. See Example I.

Flag 08 activates VIEW X's for each X and calculated f(x) value. This can be convenient if a printed tabulation is desired. See program examples.

If flag 01 is SET, HPPLOT will automatically call GRAT, GRAT will automatically call TICK, and TICK will automatically call PLTLBL; that is, a complete graph will be drawn and labeled. Additionally, if flag 01 is SET, GRAT, TICK, and PLTLBL will not prompt for pen selection; GRAT and PLTLBL will use pen 1, and TICK will use pen 2. Finally, if flag 01 is SET, GRAT will not prompt for the maximum fix to be used when labeling axes. The term "maximum fix" refers to the maximum number of significant figures which will be used when labeling the axes. GRAT has logic which only labels significant digits-- e.g., 1.00 will be labeled as "1"; 1.01300 will be labeled as "1.013"; 1.10 will be labeled as "1.1". However, if an axis value is 1/3, or 0.3333333..., the maximum fix subroutine in GRAT will limit the number of figures to that specified by the user. The default value is 3.

For the linear X case, incrementing X is straightforward: the user-specified X increment is simply added to the current X value. However, for the log X case, a more sophisticated incrementing method is required. HPPLOT automatically increments X in a 1.0, 1.2, 1.4,... 2.6, 2.8, 3.0, 3.5, 4.0, 4.5...9.0, 9.5 times 10 to the n fashion. HPPLOT automatically determines and increments n.

If the user requests that a graticule be drawn, in response to the "XEQ GRAT?" prompt, or automatically, if flag 01 is SET, HPPLOT will call GRAT from extended memory, overwriting HPPLOT. GRAT, in turn, prompts whether ticks should be drawn, if flag 01 is CLEAR.

If flag 01 is SET, GRAT will automatically call TICK from extended memory. If TICK is not requested, GRAT will then prompt "LABEL?". A "yes" response will cause PLTLBL to be called and executed; a "no" response will cause HPPLOT to be restored to RAM, overwriting GRAT. Upon completion of TICK, TICK calls PLTLBL if flag 01 is SET or if a "yes" response is given to the "LABEL?" prompt. A "no" response causes HPPLOT to be called instead of PLTLBL. This overwrites TICK, leaving HPPLOT once again in RAM.

This technique is necessary because of memory limitations. It is imperative that U80 and the called function be in RAM, ahead of HPPLOT, and packed. HPPLOT must not be packed (otherwise it would not be overwritten when GRAT is called). Of course, prior to running HPPLOT, HPPLOT, GRAT, TICK, and PLTLBL must be placed into extended memory, so they will be available when called. Program PLTPRP will do this; see Examples I, II, III, and V.

Program PLTLBL creates a size 022 ASCII file in extended memory called LABELS. Line 0 of the text file will be printed as the plot title. Line 1 of the text file will be printed as the X-axis label. Line 2 of the text file will be printed as the Y-axis label. PLTLBL will automatically center-justify each label. If flag 01 is SET, PLTLBL will not prompt "EDIT FILE?" if there is an existing LABELS file in extended memory. Instead, the text from lines 0, 1, and 2 of the LABELS file will be used. For this reason, do not set flag 01 if there is an existing LABELS file in extended memory, unless you want the labels in that file to be used.

If a "yes" response is made to the "EDIT FILE?" prompt, or if no LABELS file exists, PLTLBL will enter the text editor mode. The title, X-axis, and Y-axis labels can then be created. The user is referred to the text editor chapter in the HP41CX manual for instructions on use of the text editor mode.

PLTLBL has several options for drawing X's at user-specified points and printing additional text at user-specified points, as follows:

LABEL B: Prints additional user-specified text at a user-specified digitized location. Prompts for pen selection, for whether flag 17 should be SET or CLEARED, and for the user to manually move the pen to the desired location to start the user-specified labels are made. Flag 17 controls the pen movement when the text in the alpha register has been printed. If flag 17 is CLEAR, the pen moves to a

position one line below the starting point of the line just printed. If flag 17 is SET, the pen stops at the first character space following the alpha text just printed; this allows a single line of more than the 24-character alpha register maximum.

LABEL b: Similar to LABEL B, but bypasses the "PEN?" and "SET FLAG 17?" prompts.

LABEL C: Draws a "X" symbol at a user-specified (X,Y) point (X and Y are in user units). Upon entering the LABEL C subrountine, a prompt for pen selection will be made; thereafter, only "X, ENTR, Y" prompts will be made for where to plot the next "X" symbol.

LABEL D: Similar to LABEL B, but the location of the label starting point is determined by entering the (X,Y) location rather than by manually moving the pen to the desired point.

LABEL d: Similar to LABEL D, except no "PEN?" and "SET FLAG 17?" prompts are made.

LABEL E: Used to exit the LABEL B, LABEL b, LABEL C, LABEL D, and LABEL d subroutines. Secures the pen and stops program execution. Re-starting program execution will cause HPPLOT to be called from extended memory, overwriting PLTLBL. Note that it is first necessary to manually exit alpha mode before calling LABEL E when in the LABEL B, b, D, and d subroutines.

If the called function is program MCFC (Multiple Curve Fit, part C), or program POLY (POLYnomial), flag 06 is automatically SET. For the MCFC case, special incrementing routines are then used to plot all curve types found in an extended memory file called CRVDAT. CRVDAT is created by program MCFB and can be altered by EDTDAT. Programs MCFA and MCFB need only be loaded and run when the coefficients for a least-squares curve fit are to be determined. Once these coefficients have been determined, MCFB can be cleared from RAM, and only the much shorter evaluation program, MCFC, is needed in RAM. See the program documentation for MCFA/MCFB/MCFC/EDTDAT for a full explanation.

If the called function is POLY, the polynomial coefficients will be obtained from extended memory files POLYn, where n is an integer between 1 and 9. POLY1 contains the coefficients for a first order polynomial; POLY2 contains the coefficients for a second order polynomial; and so on. The POLYn data

files are created by program POLYN. Like programs MCFA and MCFB, POLYN need only be loaded and run when the polynomial coefficients for a least-squares curve fit are to be determined. See example V.

If flag 05 is SET, and if the called function is MCFC or POLY, HPPLOT will plot the percent error of each calculated Y value with respect to the given Y value. The (X,Y) pairs are obtained from the XYDAT file in extended memory. Programs MCFA and POLYN each create an XYDAT data file containing all (X,Y) pairs entered. Any previous XYDAT data file is purged.

Flag 05 can only be set manually, by the user, but may be cleared either manually or automatically by HPPLOT. Because it is only appropriate to set flag 05 if the called function is MCFC or POLY, HPPLOT will automatically clear flag 05 if the called function is not MCFC or POLY.

When two or more curves fit the data very well, plotting f(x) may result in such similar curves that it is difficult to distinguish one curve from another. Plotting the percent errors makes the best curve much easier to spot. See the program examples.

Flag 09 controls whether a prompt for pen selection is made between curves. Flag 09 is only of interest for the MCFC and POLY cases.

For the MCFC and POLY cases, a "PLOT POINTS?" prompt will be made by HPPLOT if flag 05 is CLEAR. A "yes" response will result in plotting "X" symbols for each (X,Y) input pair. The (X,Y) pairs are taken from the XYDAT file in extended memory. This is a convenient method of plotting all of the input (X,Y) pairs used for curve fitting, and provides a vivid means of comparing the curve fit to the original data. See the program examples. The size of the "X" symbol is independent of the user-specified scale.

HPPLOT/GRAT/TICK/PLTLBL/U80 FLAGS

MANUALLY CONTROLLED FLAGS

FLAG 00 If CLEAR, a vertically-oriented plot will be drawn; if SET, a horizontally-oriented plot will be drawn

FLAG 01 If SET, causes automatic execution of GRAT, TICK, and PLTLBL using default pen selections of pen 1 for GRAT and PLTLBL, and pen 2 for TICK

FLAG 02 if SET, causes short (1%) minor graticules (tick marks) instead of full-length minor graticules

FLAG 03 if SET, the log of X is plotted instead of X

FLAG 04 if SET, the log of Y is plotted instead of Y

FLAG 05 if SET, the percent error of f(x) is plotted instead of f(x); only significant for the MCFC and POLY cases (but see below, also)

FLAG 08 If SET, activates printout of X and Y values

FLAG 09 if SET, causes pen and line type prompts between curves; only significant for MCFC and POLY cases

AUTOMATICALLY CONTROLLED FLAGS

FLAG 05 automatically cleared (but not SET) if called function is not MCFC or POLY

FLAG 06 SET if called function is MCFC or POLY

FLAG 07 "scratch" flag: used in second LABEL 00 and LABEL 15 in HPPLOT; used in U82; used in LABEL 61 of TICK; and in LABELS 88 and 95 of PLTLBL

FLAG 10 if SET, suppresses "PEN?" prompt

FLAG 26 if CLEAR in program HPPLOT, indicates plot bounds set by digitizing

if SET in program GRAT, indicates label should be printed

HPPLOT/GRAT/TICK/U80 REGISTER ASSIGNMENTS

R00	current X
R01	X minimum
R02	X maximum
R03	X increment (linear case)
R04	Y minimum
R05	Y maximum
R06	FUNCTION NAME (alpha data)
R07	X graticule increment (linear case), or X log counter (logarithmic case)
R08	X decade counter
R09	number of X-axis minor graticules
R10	current X graticule
R11	Y value for where to print X-axis labels
R12	Y graticule increment (linear case), or Y log counter (logarirhmic case)
R13	Y decade counter
R14	number of Y-axis minor graticules
R15	current Y graticule
R16	X value for where to print Y-axis labels
R17	scratch
R18	previous current X
R19	FIX counter
R20	curve number/program pointer for MCFC case; loop counter for POLY case

```
 01◆LBL "HPP
LOT"
 02◆LBL A
 03 AUTOIO
 04 "HP7470A
"
 05 FINDID
 06 SELECT
 07 CF 06
 08 CF 07
 09 CF 10
 10 CF 17
 11 SF 27
 12 BEEP
 13 "SET FLA
GS"
 14 PROMPT
 15 SF 21
 16 FIX 5
 17 CLA
 18 CF 23
 19 "FUNCTIO
N?"
 20 AON
 21 PROMPT
 22 FC? 23
 23 CLA
 24 FC? 23
 25 ARCL 06
 26 ASTO 06
 27 AOFF
 28 RCL 01
 29 "X MIN?"
 30 PROMPT
 31 STO 01
 32 RCL 02
 33 "X MAX?"
 34 PROMPT
 35 STO 02
 36 FS? 03
 37 GTO 00
 38 RCL 03
 39 "DELTA X
?"
 40 PROMPT
 41 STO 03
 42 RCL 07
 43 "GRAT DL
TA X?"
 44 PROMPT
 45 STO 07
 46 RCL 09
 47 "NMBR TI
CKS?"
 48 PROMPT
 49 STO 09
 50◆LBL 00
 51 RCL 04
 52 "Y MIN?"
 53 PROMPT
 54 STO 04
 55 RCL 05
 56 "Y MAX?"
 57 PROMPT
 58 STO 05
 59 FS? 04
 60 GTO 00
 61 RCL 12
 62 "GRAT DL
TA Y?"
 63 PROMPT
 64 STO 12
 65 RCL 14
 66 "NMBR TI
CKS?"
 67 PROMPT
 68 STO 14
 69◆LBL 00
 70 CLX
 71 "FRAME?"
 72 PROMPT
 73 X≠0?
 74 SF 07
 75 SF 26
 76 CLX
 77 "DIGITIZ
E?"
 78 PROMPT
 79 X≠0?
 80 CF 26
 81 FS? 26
 82 GTO 00
 83 CLX
 84 "NEW POI
NTS?"
 85 PROMPT
 86 X=0?
 87 GTO 01
 88 XEQ 16
 89 TONE 7
 90 "INSERT
SIGHT"
 91 PROMPT
 92 2
 93 PEN
 94 PENDN
 95 LOCATD
 96 PENUP
 97 0
 98 PEN
 99 TONE 7
100 CLA
101 "RMVE SI
GHT"
102 PROMPT
103 GTO 01
104◆LBL 00
105 XEQ 18
106 FS? 07
107 XEQ "U80
"
108 FS? 07
109 FRAME
110 RATIO
111 1 E2
112 *
113 113
114 -
115 5
116 /
117 FS? 00
118 GTO 00
119 3.7
120 *
121 ENTER↑
122 ENTER↑
123 113
124 +
125 3
126 ENTER↑
127 89
128◆LBL 00
129 FC? 00
130 GTO 00
131 4
132 *
133 ENTER↑
134 ENTER↑
135 113
136 +
137 9
138 ENTER↑
139 95
140◆LBL 00
141 LOCATE
142◆LBL 01
143 RCL 01
144 1
145 -
146 STO 18
147 XEQ 20
148 "MCFC"
149 ASTO X
```

```
150 X=Y?
151 SF 06
152 "POLY"
153 ASTO X
154 X=Y?
155 SF 06
156 FC? 06
157 CF 05
158 FS? 00
159 GTO 00
160 RCL 04
161 FS? 04
162 LOG
163 STO 11
164 RCL 05
165 FS? 04
166 LOG
167 RCL 02
168 FS? 03
169 LOG
170 RCL 01
171 FS? 03
172 LOG
173 STO 16
174 SCALE
175 -
176 95
177 /
178 ST- 16
179 RDN
180 -
181 95
182 /
183 ST+ 11
184◆LBL 00
185 FC? 00
186 GTO 00
187 RCL 01
188 FS? 03
189 LOG
190 STO 16
191 RCL 02
192 FS? 03
193 LOG
194 RCL 04
195 FS? 04
196 LOG
197 STO 11
198 RCL 05
199 FS? 04
200 LOG
201 SCALE
202 -
203 50
204 /
205 ST+ 11
206 RDN
207 -
208 95
209 /
210 ST+ 16
211◆LBL 00
212 FC? 26
213 XEQ "U80
"
214 FS?C 07
215 FRAME
216 PENUP
217 CF 10
218 XEQ "U80
"
219 FS? 06
220 XEQ 25
221 SF 26
222◆LBL 15
223 FS? 05
224 GTO 00
225 FC? 03
226 GTO 32
227 RCL 01
228 XEQ "U81
"
229 ENTER↑
230 FIX 1
231 RND
232 FIX 4
233 X<Y?
234 SF 07
235 FS? 07
236 .1
237 FS?C 07
238 +
239 10
240 *
241 STO 07
242 30
243 X<>Y
244 X<Y?
245 SF 07
246 FS? 07
247 XEQ 37
248 FC?C 07
249 XEQ 38
250 RCL 01
251 XEQ "U82
"
252 STO 08
253◆LBL 32
254 RCL 01
255 STO 00
256◆LBL 40
257 FS? 05
258 GTO 00
259 RCL 18
260 RCL 00
261 X=Y?
262 GTO 42
263 STO 18
264 FS? 08
265 VIEW X
266◆LBL 00
267 XEQ IND
06
268 FS? 08
269 VIEW X
270 SF 25
271 FS? 04
272 LOG
273 FC?C 25
274 GTO 50
275 SF 25
276 RCL 00
277 FS? 03
278 LOG
279 FC?C 25
280 GTO 50
281 FC? 00
282 X<>Y
283 PLOT
284◆LBL 42
285 FS? 05
286 GTO 00
287 FS? 03
288 XEQ 56
289 FS? 03
290 GTO 00
291 RCL 03
292 ST+ 00
293◆LBL 00
294 RCL 02
295 RCL 00
296 FS? 05
297 GTO 00
298 X<=Y?
299 GTO 40
```

```
300◆LBL 00
301 FC? 05
302 GTO 00
303 X<Y?
304 GTO 40
305◆LBL 00
306 RCL 02
307 RCL 18
308 X=Y?
309 GTO 60
310 X<>Y
311 STO 00
312 GTO 40
313◆LBL 50
314 PENUP
315 GTO 42
316◆LBL 56
317 RCL 07
318 INT
319 30
320 X=Y?
321 XEQ 58
322 RCL 07
323 INT
324 RCL 08
325 XEQ "U84
"
326 STO 00
327 ISG 07
328 RTN
329 ISG 08
330 STO X
331 10.10002
332 STO 07
333 GTO 56
334◆LBL 58
335 30.10005
336 STO 07
337 RTN
338◆LBL 16
339 0
340 ENTER↑
341 257.5
342 ENTER↑
343 0
344 ENTER↑
345 191.25
346 LIMIT
347 RTN
348◆LBL 18
349 4
350 ENTER↑
351 256
352 ENTER↑
353 0
354 ENTER↑
355 190
356 LIMIT
357 RTN
358◆LBL 20
359 CLA
360 ARCL 06
361 ASTO Y
362 RTN
363◆LBL 25
364 FC? 05
365 XEQ 81
366 XEQ 20
367 "MCFC"
368 ASTO X
369 X=Y?
370 GTO 62
371 GTO 73
372◆LBL 37
373 RCL 07
374 2
375 /
376 FIX 0
377 RND
378 FIX 5
379 2
380 *
381 .10002
382 +
383 STO 07
384 RTN
385◆LBL 38
386 RCL 07
387 5
388 /
389 FIX 0
390 RND
391 FIX 5
392 5
393 *
394 .10005
395 +
396 STO 07
397 RTN
398◆LBL 60
399 XEQ 20
400 "MCFC"
401 ASTO X
402 X=Y?
403 XEQ 61
404 XEQ 20
405 "POLY"
406 ASTO X
407 X=Y?
408 XEQ 75
409 0
410 PEN
411 FS? 01
412 GTO 00
413 CLX
414 "XEQ GRA
T?"
415 PROMPT
416 X≠0?
417 GTO 00
418 "DONE"
419 AVIEW
420 GTO E
421◆LBL 00
422 "GRAT"
423 GETP
424 GTO E
425◆LBL 61
426 XEQ 77
427 "CRVDAT"
428 RCLPTA
429 20.023
430 SF 25
431 GETRX
432 FC?C 25
433 RTN
434 XEQ 64
435 GTO 15
436◆LBL 62
437 0
438 "CRVDAT"
439 SEEKPTA
440 20.023
441 GETRX
442 RCL 20
443◆LBL 64
444 ADV
445 FIX 0
446 CF 29
447 SF 12
448 "CURVE "
449 ARCL 20
```

```
450 AVIEW
451 CF 12
452 SF 29
453 FIX 9
454 FS? 05
455 XEQ 80
456 RTN
457◆LBL 73
458 .009
459 STO 20
460◆LBL 74
461 XEQ 78
462 FC?C 25
463 GTO 74
464 ASTO 21
465 XEQ 76
466 RTN
467◆LBL 75
468 XEQ 77
469 XEQ 78
470 FC?C 25
471 RTN
472 ASTO 21
473 XEQ 76
474 GTO 15
475◆LBL 76
476 ADV
477 FIX 0
478 CF 29
479 SF 12
480 "ORDER="
481 ARCL 20
482 AVIEW
483 CF 12
484 SF 29
485 FIX 9
486 FS? 05
487 XEQ 80
488 RTN
489◆LBL 77
490 FS? 09
491 CF 10
492 FS? 09
493 XEQ "U80
"
494 PENUP
495 RTN
496◆LBL 78
497 ISG 20
498 GTO 00
499 GTO 97
500◆LBL 00
501 FIX 0
502 CF 29
503 "POLY"
504 ARCL 20
505 SF 29
506 FIX 9
507 0
508 SF 25
509 SEEKPTA
510 RTN
511◆LBL 80
512 "XYDAT"
513 0
514 SEEKPTA
515 RTN
516◆LBL 81
517 PENUP
518 CLX
519 "PLOT PT
S?"
520 PROMPT
521 X=0?
522 RTN
523 XEQ 80
524 3
525 CSIZE
526 FC? 00
527 0
528 FS? 00
529 -90
530 LDIR
531 "SMX"
532 OUTA
533◆LBL 82
534 SF 25
535 GETX
536 FC?C 25
537 GTO 83
538 GETX
539 FC? 08
540 GTO 00
541 VIEW Y
542 VIEW X
543 ADV
544◆LBL 00
545 FC? 00
546 X<>Y
547 XEQ "U83
"
548 MOVE
549 GTO 82
550◆LBL 83
551 "SM"
552 OUTA
553 PENUP
554 FS? 09
555 CF 10
556 FS? 09
557 XEQ "U80
"
558 RTN
559◆LBL 97
560 "NO POLY
 FILE"
561 AVIEW
562◆LBL E
563 0
564 PEN
565 CLA
566 ADV
567 STOP
568 GTO "HPP
LOT"
569 END
```

PROGRAM GRAT

The GRATicule program will draw and label the major axis graticules, in support of HPPLOT. If executed manually, GRAT prompts for a pen selection and the maximum fix to be used when labeling axes. GRAT calls the utility routines in U80, and shares these utilities with HPPLOT, TICK, and PLTLBL.

Flag 26 is internally set and cleared by GRAT, and indicates whether a given graticule should be labeled. For the linear case, all graticules are labeled; for the log case, only graticules in a 1, 2, 5 sequence are labeled (plus the starting and ending graticules, if they are not a 1, 2, or 5).

If flag 01 is SET, GRAT will use pen 1 and upon completion will automatically call TICK from extended memory, overwriting itself. If flag 01 is CLEAR, GRAT will prompt for "PEN?" and "MAX FIX?" selections, and after all graticules have been drawn and labeled, GRAT will prompt "XEQ TICK?". A non-zero entry is interpreted as "yes"; a zero or no entry is interpreted as "no". If "no", GRAT will then prompt "LABEL?". A "yes" response will cause PLTLBL to be called from extended memory, overwriting GRAT. A "no" response will cause HPPLOT to be called from extended memory, overwriting GRAT.

```
 01◆LBL "GRA
T"
 02 CF 06
 03 DEG
 04 FIX 5
 05 RCL 01
 06 1
 07 -
 08 STO 18
 09 1
 10 LTYPE
 11 FS? 01
 12 PEN
 13 .002
 14 STO 19
 15 FS? 01
 16 GTO 30
 17 CF 10
 18 XEQ "U80
"
 19 3
 20 "MAX FIX
?"
 21 PROMPT
 22 1
 23 -
 24 1 E3
 25 /
 26 STO 19
 27◆LBL 30
 28 SF 26
 29 CF 29
 30 FC? 03
 31 GTO 31
 32 RCL 01
 33 XEQ "U81
"
 34 FIX 0
 35 RND
 36 FIX 5
 37 10
 38 *
 39 .1001
 40 +
 41 STO 07
 42 RCL 01
 43 XEQ "U82
"
 44 STO 08
 45◆LBL 31
 46 FC? 00
 47 -45
 48 FS? 00
 49 0
 50 LDIR
 51 FC? 00
 52 8
 53 FS? 00
 54 6
 55 LORG
 56 RCL 01
 57 STO 10
 58◆LBL 32
 59 RCL 18
 60 RCL 10
 61 X=Y?
 62 GTO 33
 63 FS? 03
 64 XEQ 42
 65 FC? 03
 66 SF 26
 67 FS? 03
 68 LOG
 69 FS?C 26
 70 XEQ 43
 71 FC? 00
 72 XAXIS
 73 FS? 00
 74 YAXIS
 75◆LBL 33
 76 FS? 03
 77 XEQ 40
 78 FS? 03
 79 GTO 34
 80 RCL 07
 81 ST+ 10
 82◆LBL 34
 83 RCL 02
 84 RCL 10
 85 X<=Y?
 86 GTO 32
 87 X<>Y
 88 STO 10
 89 RCL 18
 90 X<>Y
 91 X=Y?
 92 GTO 35
 93 FS? 03
 94 LOG
 95 XEQ 43
 96◆LBL 35
 97 FC? 00
 98 -90
 99 FS? 00
100 0
101 LDIR
102 8
103 LORG
104 SF 26
105 FC? 04
106 GTO 36
107 RCL 04
108 XEQ "U81
"
109 FIX 0
110 RND
111 FIX 5
112 10
113 *
114 .1001
115 +
116 STO 12
117 RCL 04
118 XEQ "U82
"
119 STO 13
120◆LBL 36
121 RCL 04
122 1
123 -
124 STO 18
125 RCL 04
126 STO 15
127◆LBL 37
128 RCL 18
129 RCL 15
130 X=Y?
131 GTO 38
132 FS? 04
133 XEQ 42
134 FC? 04
135 SF 26
136 FS? 04
137 LOG
138 FS?C 26
139 XEQ 44
140 FC? 00
141 YAXIS
142 FS? 00
143 XAXIS
144◆LBL 38
145 FS? 04
146 XEQ 41
147 FS? 04
148 GTO 39
149 RCL 12
```

```
150 ST+ 15
151◆LBL 39
152 RCL 05
153 RCL 15
154 X<=Y?
155 GTO 37
156 X<>Y
157 STO 15
158 RCL 18
159 X<>Y
160 X=Y?
161 GTO 49
162 FS? 04
163 LOG
164 XEQ 44
165 GTO 49
166◆LBL 40
167 RCL 07
168 INT
169 RCL 08
170 XEQ "U84
"
171 STO 10
172 ISG 07
173 RTN
174 ISG 08
175 STO X
176 10.1001
177 STO 07
178 GTO 40
179◆LBL 41
180 RCL 12
181 INT
182 RCL 13
183 XEQ "U84
"
184 STO 15
185 ISG 12
186 RTN
187 ISG 13
188 STO X
189 10.1001
190 STO 12
191 GTO 41
192◆LBL 42
193 ENTER↑
194 LOG
195 FRC
196 ABS
197 FIX 5
198 RND
199 0
200 X=Y?
201 SF 26
202 RDN
203 .30103
204 X=Y?
205 SF 26
206 RDN
207 .69897
208 X=Y?
209 SF 26
210 RDN
211 RDN
212 RTN
213◆LBL 43
214 STO 17
215 RCL 11
216 FS? 00
217 X<>Y
218 MOVE
219 RCL 10
220 XEQ 45
221 RCL 17
222 RTN
223◆LBL 44
224 STO 17
225 RCL 16
226 FC? 00
227 X<>Y
228 MOVE
229 RCL 15
230 XEQ 45
231 RCL 17
232 RTN
233◆LBL 45
234 STO 18
235 RCL 19
236 FRC
237 STO 19
238 RDN
239 ABS
240◆LBL 46
241 FRC
242 X=0?
243 GTO 48
244 ISG 19
245 GTO 47
246 GTO 48
247◆LBL 47
248 10
249 *
250 GTO 46
251◆LBL 48
252 FIX IND
19
253 CLA
254 ARCL 18
255 LABEL
256 FIX 5
257 RTN
258◆LBL 49
259 SF 26
260 CLA
261 0
262 PEN
263 FS? 01
264 GTO 50
265 "XEQ TIC
K?"
266 PROMPT
267 X≠0?
268 GTO 50
269 "LABEL?"
270 PROMPT
271 X≠0?
272 "PLTLBL"
273 X=0?
274 "HPPLOT"
275 GETP
276 GTO 49
277◆LBL 50
278 "TICK"
279 GETP
280 GTO 49
281 .END.
```

PROGRAM TICK

The TICK program will draw ticks, or minor graticules, in support of HPPLOT. If executed manually (flag 01 CLEAR) it will prompt for a pen selection. If executed automatically (flag 01 SET) pen 2 will be used. TICK calls the utility routines in U80, and shares these utilities with HPPLOT, GRAT, and PLTLBL.

If flag 02 is CLEAR, full length ticks will be drawn; if flag 02 is SET, short (1%) ticks will be drawn. Flag 02 is set or cleared manually by the user.

The following CLIPUU's are performed if flag 02 is SET:

First CLIPUU, for X-axis ticks

$$T = (\log)\ Xminimum$$
$$Z = (\log)\ Xmaximum$$
$$Y = (\log)\ Yminimum$$
$$X = \frac{(\log)Ymax - (\log)Ymin}{100} + (\log)Ymin$$

Second CLIPUU, for Y-axis ticks

$$T = (\log)\ Xminimum$$
$$Z = \frac{(\log)Xmax - (\log)Xmin}{(100)(Ratio)} + (\log)Xmin$$
$$Y = (\log)\ Yminimum$$
$$X = (\log)\ Ymaximum$$

Third CLIPUU, restores plotting area

$$T = (\log)\ Xminimum$$
$$Z = (\log)\ Xmaximum$$
$$Y = (\log)\ Yminimum$$
$$Z = (\log)\ Ymaximum$$

The (log) notation indicates that the log of Xmin and Xmax is taken if flag 03 is SET, and that the log of Ymin and Ymax is taken if flag 04 is SET.

Do not abandon TICK before completion if short ticks have been selected. The CLIPUU status may not be restored.

```
 01◆LBL "TIC
K"
 02 CF 07
 03 FIX 5
 04 1
 05 LTYPE
 06 2
 07 FS? 01
 08 PEN
 09 CF 10
 10 FC? 01
 11 XEQ "U80
"
 12 FC? 02
 13 GTO 51
 14 XEQ 90
 15◆LBL 51
 16 FC? 03
 17 GTO 52
 18 RCL 01
 19 XEQ "U81
"
 20 FIX 2
 21 RND
 22 FIX 5
 23 10
 24 *
 25 STO 07
 26 XEQ 61
 27 STO 07
 28 RCL 01
 29 XEQ "U82
"
 30 STO 08
 31◆LBL 52
 32 RCL 01
 33 STO 10
 34 GTO 54
 35◆LBL 53
 36 RCL 10
 37 FS? 03
 38 LOG
 39 FC? 00
 40 XAXIS
 41 FS? 00
 42 YAXIS
 43◆LBL 54
 44 FS? 03
 45 XEQ 64
 46 FS? 03
 47 GTO 55
 48 RCL 07
 49 RCL 09
 50 /
 51 ST+ 10
 52◆LBL 55
 53 RCL 02
 54 RCL 10
 55 X<=Y?
 56 GTO 53
 57 FC? 02
 58 GTO 56
 59 XEQ 91
 60◆LBL 56
 61 FC? 04
 62 GTO 57
 63 RCL 04
 64 XEQ "U81
"
 65 FIX 2
 66 RND
 67 FIX 5
 68 10
 69 *
 70 STO 12
 71 XEQ 61
 72 STO 12
 73 RCL 04
 74 XEQ "U82
"
 75 STO 13
 76◆LBL 57
 77 RCL 04
 78 STO 15
 79 GTO 59
 80◆LBL 58
 81 RCL 15
 82 FS? 04
 83 LOG
 84 FC? 00
 85 YAXIS
 86 FS? 00
 87 XAXIS
 88◆LBL 59
 89 FS? 04
 90 XEQ 66
 91 FS? 04
 92 GTO 60
 93 RCL 12
 94 RCL 14
 95 /
 96 ST+ 15
 97◆LBL 60
 98 RCL 05
 99 RCL 15
100 X<=Y?
101 GTO 58
102 GTO 68
103◆LBL 61
104 30
105 X<>Y
106 X<Y?
107 SF 07
108 FS? 07
109 XEQ 62
110 FC?C 07
111 XEQ 63
112 RTN
113◆LBL 62
114 2
115 /
116 FIX 0
117 RND
118 FIX 5
119 2
120 *
121 .10001
122 +
123 RTN
124◆LBL 63
125 5
126 /
127 FIX 0
128 RND
129 FIX 5
130 5
131 *
132 .10002
133 +
134 RTN
135◆LBL 64
136 RCL 07
137 INT
138 30
139 X=Y?
140 XEQ 65
141 RCL 07
142 INT
143 RCL 08
144 10↑X
145 *
146 10
147 /
148 STO 10
149 ISG 07
```

```
150 RTN
151 ISG 08
152 STO X
153 10.10001
154 STO 07
155 GTO 64
156◆LBL 65
157 30.10002
158 STO 07
159 RTN
160◆LBL 66
161 RCL 12
162 INT
163 30
164 X=Y?
165 XEQ 67
166 RCL 12
167 INT
168 RCL 13
169 10↑X
170 *
171 10
172 /
173 STO 15
174 ISG 12
175 RTN
176 ISG 13
177 STO X
178 10.10001
179 STO 12
180 GTO 66
181◆LBL 67
182 30.10002
183 STO 12
184 RTN
185◆LBL 68
186 FC? 02
187 GTO 69
188 RCL 01
189 FS? 03
190 LOG
191 RCL 02
192 FS? 03
193 LOG
194 RCL 04
195 FS? 04
196 LOG
197 RCL 05
198 FS? 04
199 LOG
200 FC? 00
201 RDN
202 FC? 00
203 RDN
204 CLIPUU
205◆LBL 69
206 0
207 PEN
208 FS? 01
209 GTO 00
210 "LABEL?"
211 PROMPT
212 X≠0?
213 GTO 00
214 "HPPLOT"
215 GETP
216 GTO 69
217◆LBL 00
218 "PLTLBL"
219 GETP
220 GTO 69
221◆LBL 90
222 RCL 05
223 FS? 04
224 LOG
225 RCL 04
226 FS? 04
227 LOG
228 -
229 1 E2
230 /
231 FC? 00
232 RATIO
233 FC? 00
234 /
235 RCL 04
236 FS? 04
237 LOG
238 +
239 RCL 01
240 FS? 03
241 LOG
242 RCL 02
243 FS? 03
244 LOG
245 RCL 04
246 FS? 04
247 LOG
248 FS? 00
249 RDN
250 FS? 00
251 RDN
252 RDN
253 CLIPUU
254 RTN
255◆LBL 91
256 RCL 02
257 FS? 03
258 LOG
259 RCL 01
260 FS? 03
261 LOG
262 -
263 1 E2
264 /
265 FS? 00
266 RATIO
267 FS? 00
268 /
269 RCL 01
270 FS? 03
271 LOG
272 +
273 RCL 04
274 FS? 04
275 LOG
276 RCL 05
277 FS? 04
278 LOG
279 RCL 01
280 FS? 03
281 LOG
282 RDN
283 FC? 00
284 RDN
285 FC? 00
286 RDN
287 CLIPUU
288 RTN
289 END
```

Programs U80, U81, U82, U83, and U84 are global label common utility subroutines used by HPPLOT, GRAT, TICK, and PLTLBL.

```
01◆LBL "U80
"
02 FS? 10
03 RTN
04 FC? 06
05 GTO 00
06 FC? 09
07 GTO 00
08 ADV
09 ADV
10 ADV
11◆LBL 00
12 TONE 7
13 0
14 PEN
15 RDN
16 CF 22
17 1
18 "PEN?"
19 PROMPT
20 PEN
21 RDN
22 FS?C 22
23 RDN
24 FC? 06
25 GTO 00
26 1
27 "LINE TY
PE?"
28 PROMPT
29 LTYPE
30 RDN
31 FS?C 22
32 RDN
33◆LBL 00
34 SF 10
35 RTN
36◆LBL "U81
"
37 LOG
38 FRC
39 1
40 X<>Y
41 X<0?
42 +
43 10↑X
44 RTN
```

```
45◆LBL "U82
"
46 CF 07
47 LOG
48 ENTER↑
49 FRC
50 X=0?
51 GTO 83
52 RDN
53 X<0?
54 SF 07
55 INT
56 -1
57 X<>Y
58 FS?C 07
59 +
60 RTN
61◆LBL 83
62 RDN
63 INT
64 RTN
```

```
65◆LBL "U83
"
66 FS? 00
67 GTO 00
68 SF 25
69 FS? 03
70 LOG
71 FC? 25
72 GTO 02
73 X<>Y
74 FS? 04
75 LOG
76 FC?C 25
77 GTO 02
78◆LBL 00
79 FC? 00
80 RTN
81 SF 25
82 FS? 04
83 LOG
84 FC? 25
85 GTO 02
86 X<>Y
87 FS? 03
88 LOG
89 FC?C 25
90 GTO 02
91 RTN
92◆LBL 02
93 PENUP
94 RTN
```

```
95◆LBL "U84
"
96 10↑X
97 *
98 10
99 /
100 RTN
101 END
```

PROGRAM PLTLBL

Program PLTLBL (PLoT LaBel) will label the plot title, X-axis, and Y-axis. PLTLBL also offers the opportunity to print text or an "X" symbol at user-specified locations. PLTLBL will normally be executed after HPPLOT, GRAT, and TICK have been run. PLTLBL calls utility routines in U80, and shares these routines with HPPLOT, GRAT, and TICK.

If flag 01 is CLEAR, PLTLBL will prompt "EDIT FILE?". A "yes" response will cause PLTLBL to create an ASCII file in extended memory of size 022 called "LABELS". As a precaution against inadvertent overwriting of an existing LABELS file, PLTLBL will print "EXISTING FILE" and prompt "PURGE?" if a LABELS file already exists. A "yes" response will cause the file to be purged, and a new, empty LABELS file to be created. A "no" repsonse will allow the existing LABELS file to be edited.

If flag 01 is SET, and if a LABELS file exists, PLTLBL will bypass the "EDIT FILE?", "RVW TITLES?", and "OK?" prompts. Lines 00, 01, and 02 of the LABELS file will be printed as the plot title, X-axis label, and Y-axis label, respectively. Pen 01 will be used. If a LABELS file does not exist, PLTLBL will instead create a LABELS file and stop in the text editor mode, even though flag 01, the HPPLOT "auto execution" flag, is SET.

The reader is referred to the appropriate chapter in the HP41CX manual for instructions on how to use the text editor. Once three lines of text have been created, the user must manually exit the text editor mode. Program execution will then continue with a "RVW TITLES?" prompt. A "yes" response will cause the LABELS file to be printed for review, prior to actual labeling on the completed graph. If the text is satisfactory, a "yes" response should be made to the "OK?" prompt. PLTLBL will then label the plot. A "no" response will cause a return to the text editor mode.

PLTLBL includes logic which center-justifies each line of text. Because a line of text may exceed the 24-character alpha register maximum, PLTLBL first determines the text length while each line of text is still in extended memory. This can require several seconds, so a display of the determination is shown to let the user known that program execution is proceding normally.

After the plot has been labeled, PLTLBL will jump to LABEL E, which secures the pen, prints "DONE", and stops program execution. At this point, local labels B, b, C, D, or d can be selected, or the R/S key can be pressed. Pressing the R/S key will cause HPPLOT to be called from extended memory, overwriting PLTLBL.

The functions of labels B, b, C, D, and d have already been discussed in the HPPLOT program instructions and will not be repeated here. See the program examples as well.

```
 01◆LBL "PLT
LBL"
 02 3
 03 CSIZE
 04 DEG
 05 SF 21
 06 SETGU
 07 1
 08 LORG
 09 FS? 01
 10 GTO 20
 11 CLX
 12 "EDIT FI
LE?"
 13 PROMPT
 14 X=0?
 15 GTO 02
 16◆LBL 01
 17 "LABELS"
 18 22
 19 SF 25
 20 CRFLAS
 21 FS?C 25
 22 GTO 00
 23 BEEP
 24 CLX
 25 "EXISTIN
G FILE"
 26 AVIEW
 27 "PURGE?"
 28 PROMPT
 29 X=0?
 30 GTO 00
 31 "LABELS"
 32 PURFL
 33 GTO 01
 34◆LBL 00
 35 "LABELS"
 36 0
 37 SEEKPT
 38 AON
 39 ED
 40◆LBL 02
 41 AOFF
 42 "LABELS"
 43 0
 44 SEEKPTA
 45 CLX
 46 "RVW TIT
LES?"
 47 PROMPT
 48 X=0?
 49 GTO 20
 50 XEQ 10
 51 CLX
 52 "OK?"
 53 PROMPT
 54 X≠0?
 55 GTO 20
 56 GTO 01
 57◆LBL 10
 58 0
 59 SEEKPT
 60◆LBL 15
 61 CLA
 62◆LBL 18
 63 SF 25
 64 ARCLREC
 65 FC?C 25
 66 RTN
 67 FC? 55
 68 AVIEW
 69 FS? 55
 70 PRA
 71 CLA
 72 FS? 17
 73 GTO 18
 74 GTO 15
 75◆LBL 20
 76 FC? 01
 77 GTO 00
 78 0
 79 "LABELS"
 80 SF 25
 81 SEEKPTA
 82 FC?C 25
 83 GTO 01
 84 1
 85 PEN
 86◆LBL 00
 87 FS? 01
 88 GTO 00
 89 CF 10
 90 XEQ "U80
"
 91◆LBL 00
 92 FS? 00
 93 GTO 50
 94 -90
 95 LDIR
 96 0
 97 XEQ 80
 98 CHS
 99 46
100 -
101 CHS
102 129.5
103 MOVE
104 CLA
105◆LBL 22
106 ARCLREC
107 LABEL
108 CLA
109 FS? 17
110 GTO 22
111 CLA
112 1
113 XEQ 80
114 CHS
115 46
116 -
117 CHS
118 2
119 MOVE
120 CLA
121◆LBL 24
122 ARCLREC
123 LABEL
124 CLA
125 FS? 17
126 GTO 24
127 0
128 LDIR
129 2
130 XEQ 80
131 71.03
132 -
133 CHS
134 97
135 X<>Y
136 MOVE
137 CLA
138◆LBL 26
139 ARCLREC
140 LABEL
141 CLA
142 FS? 17
143 GTO 26
144 GTO E
145◆LBL 50
146 0
147 LDIR
148 XEQ 80
149 72.12
```

```
150 -
151 CHS
152 97
153 X<>Y
154 MOVE
155 CLA
156◆LBL 52
157 ARCLREC
158 LABEL
159 CLA
160 FS? 17
161 GTO 52
162 CLA
163 1
164 XEQ 80
165 72.12
166 -
167 CHS
168 2
169 X<>Y
170 MOVE
171◆LBL 54
172 ARCLREC
173 LABEL
174 CLA
175 FS? 17
176 GTO 54
177 CLA
178 90
179 LDIR
180 2
181 XEQ 80
182 52
183 -
184 CHS
185 3
186 MOVE
187◆LBL 56
188 ARCLREC
189 LABEL
190 CLA
191 FS? 17
192 GTO 56
193 GTO E
194◆LBL 80
195 CF 21
196 ENTER↑
197 SEEKPT
198◆LBL 84
199 SF 25
200 SEEKPT
201 FC?C 25
202 GTO 85
203 1 E-3
204 +
205 FIX 3
206 VIEW X
207 GTO 84
208◆LBL 85
209 FRC
210 1 E3
211 *
212 X<>Y
213 SEEKPT
214 X<>Y
215 FIX 0
216 VIEW X
217 FIX 3
218 SF 21
219 2
220 /
221 1.575
222 *
223 RTN
224◆LBL B
225 XEQ 88
226◆LBL b
227 XEQ 95
228 TONE 9
229 DGTIZE
230 MOVE
231◆LBL 86
232 CLA
233 AON
234 PROMPT
235 AOFF
236 LABEL
237 GTO 86
238◆LBL C
239 PENUP
240 CF 17
241 "SMX"
242 OUTA
243 FC? 00
244 0
245 FS? 00
246 -90
247 LDIR
248 CF 10
249 XEQ "U80
"
250◆LBL 81
251 XEQ 89
252 XEQ "U83
"
253 MOVE
254 GTO 81
255◆LBL D
256 XEQ 88
257◆LBL d
258 XEQ 95
259 XEQ 89
260 XEQ "U83
"
261 MOVE
262◆LBL 87
263 CLA
264 AON
265 PROMPT
266 AOFF
267 LABEL
268 GTO 87
269◆LBL 88
270 PENUP
271 CF 10
272 XEQ "U80
"
273 CF 07
274 CF 17
275 CLX
276 "SET FLA
G 17?"
277 PROMPT
278 X≠0?
279 SF 07
280 RTN
281◆LBL 89
282 TONE 7
283 "X, ENTR
, Y"
284 PROMPT
285 FC? 00
286 X<>Y
287 RTN
288◆LBL 95
289 SETUU
290 CF 17
291 "SM"
292 OUTA
293 FS? 07
294 SF 17
295 FC? 00
296 -90
297 FS? 00
298 0
299 LDIR
```

```
300 RTN
301◆LBL E
302 XEQ 95
303 0
304 PEN
305 CF 07
306 CF 17
307 BEEP
308 "DONE"
309 AVIEW
310 STOP
311 "HPPLOT"
312 GETP
313 GTO E
314 END
```

PLTPRP PROGRAM

Program PLTPRP (PLoTter PRePare) is a utility program used to configure the HP41CX for plotting.

If there is a CRVDAT file in extended memory, PLTPRP will leave programs U80 and MCFC in RAM and packed, and program HPPLOT in RAM, but not packed. Also, programs HPPLOT, GRAT, TICK, and PLTLBL will be left in extended memory. Size will be set to 024, user flags 00 through 10 will be CLEAR, and all registers will be set to zero. Flags 21 (printer enable) and 27 (user mode) will be SET, and Flag 11 (auto execute) will be CLEAR.

If there is a POLYn file in extended memory, PLTPRP will leave programs U80 and POLY in RAM and packed, and program HPPLOT in RAM, but not packed. Also, programs HPPLOT, GRAT, TICK, and PLTLBL will be left in extended memory. Size will be set to 023, user flags 00 through 10 will be CLEAR, and all registers will be set to zero. Flags 21 and 27 will be SET, and Flag 11 will be CLEAR.

If there are neither a CRVDAT or POLYn files in extended memory, PLTPRP will leave program U80 in RAM and packed, and programs HPPLOT, GRAT, TICK, and PLTLBL will be left in extended memory. Size will be set to 021, user flags 00 through 10 will be CLEAR, and all registers will be set to zero. Flags 21 and 27 will be SET, and Flag 11 will be CLEAR. The user can then enter the called function by any convenient method, PACK the called function, and re-SIZE to a larger SIZE, if required by the called function. HPPLOT can then be called from extended memory, but not packed.

Program PLTPRP uses a series of three readall commands to configure the calculator, including extended memory. This technique is used to allow the PLTPRP shell program to be overwritten upon completion.

Progam PLTPRP is only three steps long:

```
 01◆LBL "PLT
PRP"
 02 "PLTPRP1
"
 03 READA
 04 END
```

The PLTPRP1 readall command causes the calculator to be configured as follows:

```
                    CAT 1
LBL'GRAT
END          576 BYTES
LBL'TICK
END          540 BYTES
LBL'PLTLBL
END          695 BYTES
LBL'PREP1
END          45 BYTES
.END.        06 BYTES
```

Since the auto execution flag was set and the calculator was positioned to line 001 of program PREP1, execution automatically begins at line 001 of PREP1 upon completion of the PLTPRP1 readall. PREP1 causes GRAT, TICK, and PLTLBL to be stored in extended memory. Next, the second readall is executed, with PLTPRP2 in alpha:

```
 01◆LBL "PRE
P1"
 02 "GRAT"
 03 SAVEP
 04 "TICK"
 05 SAVEP
 06 "PLTLBL"
 07 SAVEP
 08 "PLTPRP2
"
 09 READA
 10 END
```

Again, since the auto execution flag was SET and the calculator was at line 001 of program PREP2, execution begins at that point upon completion of the PLTPRP2 readall command. PLTPRP2 leaves the calculator with the following configuration:

```
                    CAT 1
LBL'HPPLOT
END          1260 BYTES
LBL'PREP2
END          97 BYTES
.END.        08 BYTES
```

Program PREP2 causes HPPLOT to be saved to extended memory. PREP2 next tests to see which of three readalls, PLTPRP3, PLTPRP4, or PLTPRP5, should be used for the third, and final, readall. PLTPRP3 configues for the MCFC case, PLTPRP4 configures for the POLY case, and PLTPRP5 configures for all other cases.

```
 01◆LBL "PRE
P2"
 02 "HPPLOT"
 03 SAVEP
 04 SF 25
 05 "CRVDAT"
 06 FLSIZE
 07 FC?C 25
 08 GTO 00
 09 "PLTPRP3
"
 10 READA
 11◆LBL 00
 12 1.009
 13 CF 29
 14 FIX 0
 15◆LBL 01
 16 "POLY"
 17 ARCL X
 18 SF 25
 19 FLSIZE
 20 FS?C 25
 21 GTO 02
 22 ISG X
 23 GTO 01
 24 "PLTPRP5
"
 25 READA
 26◆LBL 02
 27 "PLTPRP4
"
 28 READA
 29 END
```

The PLTPRP3 readall leaves the calculator with the U80 and MCFC in RAM and packed, and HPPLOT in RAM but not packed. The HP41CX will be initialized for plotting (i.e., plotter buffer registers will have been created), USER mode will be SET, and SIZE will be set to 024.

```
                CAT 1
LBL'U80
LBL'U81                                    CAT 4
LBL'U82                          CRVDAT  D004
LBL'U83                          GRAT    P083
LBL'U84                          TICK    P078
END         188 BYTES            PLTLBL  P100
LBL'MCFC                         HPPLOT  P181
END         289 BYTES                 144.0000000    ***
LBL'HPPLOT
.END.       1266 BYTES
```

The PLTPRP4 readall leaves the calculator with U80 and POLY in RAM and packed, and HPPLOT in RAM but not packed. The HP41CX will be initialized for plotting, USER mode will be SET, and SIZE will be set to 023.

```
                CAT 1
LBL'U80
LBL'U81                                    CAT 4
LBL'U82                          POLY3   D005
LBL'U83                          GRAT    P083
LBL'U84                          TICK    P078
END         188 BYTES            PLTLBL  P100
LBL'POLY                         HPPLOT  P181
END         121 BYTES                 143.0000000    ***
LBL'HPPLOT
.END.       1266 BYTES
```

The PLTPRP5 read all leaves the calculator with U80 in RAM and packed, and HPPLOT in RAM but not packed. The HP41CX will be initialized for plotting, USER mode will be SET, and SIZE will be set to 021.

```
                CAT 1
LBL'U80
LBL'U81                                    CAT 4
LBL'U82                          GRAT    P083
LBL'U83                          TICK    P078
LBL'U84                          PLTLBL  P100
END         188 BYTES            HPPLOT  P181
.END.       08 BYTES                  150.0000000    ***
```

Note that all of the shell programs have been overwritten, and extended memory is configured as required.

CAUTION NUMBER ONE: PLTPRP uses the presence of a CRVDAT file or a POLYn file in extended memory as an indication that the called function is MCFC or POLY. If a CRVDAT or POLYn file(s) have been created from earlier runs, either first PURGE the obsolete files, or, if the files may be of interest later, save the files to mass storage before PURGING. (PLTPRP will be automatically executed at the end of MCFB, if a "no" response is given to the "XEQ EDTDAT?" prompt. PLTPRP will be automatically executed at the end of POLYN, if a "yes" response is given to the XEQ PLTPRP? prompt.)

CAUTION NUMBER TWO: Because all conditions of the calculator are duplicated by the readall command, the HP41CX must be set up exactly as it was when the information was stored-- including plug-in extensions and peripherals. Therefore, insure that the HP41CX has an 82184A plotter module, an 82160A HP-IL module, and two 82181A extended memory modules installed.

PROGRAM MCFA

Program MCFA (Multiple Curve Fit, Part A) is patterned after William M. Kolb's masterpiece, "Curve Fitting for Programmable Calculators"*. Users interested in a thorough treatment of regression analysis are urged to read this text. MCFA is the data entry portion; it automatically PSIZE's to size 069 and clears all registers.

MCFA will create a data file in extended memory, called XYDAT, of size 2n, where n is the number of (X,Y) pairs entered. Of course, sufficient room must be available in extended memory. MCFA PURGES ANY PREVIOUS XYDAT DATA FILE. If the percent errors of the curve fits to the original (X,Y) data is desired, the X values should be entered in ascending order.

A minimum of three data points is required for curves 1, 2, 4, 5, 9, 10, 11, 15, 16, and 20. A minimum of four data points is required for curves 3, 6, 7, 8, 12, 13, 17, 18, and 19. This requirement is due to the use of (n-2) and (n-3), respectively, in the denominator of the equation for the adjusted RR.

LABEL A is used to start the program. LABEL a can be used to correct the current (X,Y) pair. Only the current (X,Y) pair is correctable; if an input error is subsequently discovered, MCFA must be re-started and all data re-entered. This is because of difficulties in purging the incorrect (X,Y) data once entered into the XYDAT file. In practice, this is not a problem, because the program echos back the (X,Y) pair just entered, so it is easy to spot an error while the erroneous (X,Y) pair is still the current (X,Y) pair.

LABEL E is used to terminate data entry. LABEL E will automatically call program MCFB from a digital cassette drive, overwriting MCFA. For this reason, MCFA must be the last program in RAM and must not be packed. If a digital cassette drive is not attached, a "NO DRIVE" error will occur; MCFB can then be alternatively entered using any method convenient to the user.

*Published by IMTEC, P.O. Box 1402, Bowie, MD. 20716. "Curve Fitting For Programmable Calculators" is available from EduCALC, 27953 Cabot Road, Laguna Niguel, CA 92677; telephone (800) 633 2252, ext.343. The price is $13.95, plus tax and shipping.

MCFA/MCFB REGISTER ASSIGNMENTS

R00	curve number (1 through 20)
R01	X value
R02	Y, or f(X), value
R03	scratch register
R04	scratch register
R05	scratch register
R06	scratch register
R07	scratch register
R08	scratch register
R09	scratch register
R10	adjusted coefficient of determination ("RR")
R11	scratch register
R12	scratch register
R13	scratch register
R14	SIGMA X**3/2
R15	SIGMA (X**1/2)(Y)
R16	SIGMA X
R17	SIGMA X squared
R18	SIGMA Y
R19	SIGMA Y squared
R20	SIGMA XY
R21	n
R22	SIGMA 1/X
R23	SIGMA 1/(X squared)
R24	SIGMA 1/Y
R25	SIGMA 1/(Y squared)
R26	SIGMA 1/XY
R27	n
R28	SIGMA Ln X
R29	SIGMA (Ln X) squared
R30	SIGMA (Ln Y)
R31	SIGMA (Ln Y) squared
R32	SIGMA (Ln X)(Ln Y)
R33	n
R34	SIGMA X/Y
R35	SIGMA Y/X
R36	SIGMA (X squared)(Y)
R37	SIGMA (X squared)/(Y)
R38	SIGMA (Y)/(X squared)
R39	SIGMA (X cubed)
R40	SIGMA 1/(X cubed)
R41	SIGMA X**4
R42	SIGMA 1/(X**4)
R43	SIGMA (Ln X)/X
R44	SIGMA (X)(Ln Y)
R45	SIGMA (Ln Y)/X
R46	SIGMA (X)(Ln X)
R47	SIGMA ((X)(Ln X)) squared
R48	SIGMA (X)(Ln X)(Ln Y)
R49	SIGMA (Y)(Ln X)
R50	SIGMA (Ln X)/Y
R51	SIGMA ((Ln X)/X) squared
R52	SIGMA (X squared)(Ln Y)

R53 SIGMA (Ln X) cubed
R54 SIGMA (LN X)**4
R55 SIGMA ((Ln X) squared)(Ln Y)
R56 SIGMA ((Ln X)(Ln Y))/X
R57 SIGMA SQRT X
R58 curve pointer
R59 scratch register
R60 scratch register
R61 scratch register
R62 scratch register
R63 scratch register
R64 scratch register
R65 scratch register
R66 scratch register
R67 scratch register
R68 user-specified minimum RR

Note: Because the summation registers include terms with both X and Y in the denominator, MCFA will substitute an arbitrarily small number, 0.000000009, for any zero inputs.

FLAGS

FLAG 02 SET if any X input is negative

FLAG 03 SET is any Y input is negative

```
 01◆LBL "MCF
A"
 02◆LBL A
 03 CF 02
 04 CF 03
 05 SF 27
 06 FIX 9
 07 69
 08 PSIZE
 09 CLA
 10 "XYDAT"
 11 SF 25
 12 PURFL
 13 CF 25
 14 6
 15 CRFLD
 16 ADV
 17 ADV
 18 ADV
 19 ADV
 20 ADV
 21 CLRG
 22◆LBL 15
 23 CF 21
 24 "X, ENTR
, Y, R/S"
 25 PROMPT
 26 SF 21
 27 ADV
 28 X<0?
 29 SF 03
 30 X=0?
 31 XEQ 89
 32 STO 02
 33 X<>Y
 34 X<0?
 35 SF 02
 36 X=0?
 37 XEQ 89
 38 STO 01
 39 SF 25
 40 SAVEX
 41 FC?C 25
 42 XEQ 16
 43 ΣREG 16
 44 Σ+
 45 LASTX
 46 /
 47 ST+ 35
 48 1/X
 49 ST+ 34
 50 RCL 01
 51 *
 52 ST+ 37
 53 1/X
 54 ST+ 38
 55 RCL 02
 56 SAVEX
 57 RCL 01
 58 X↑2
 59 *
 60 ST+ 36
 61 LASTX
 62 X↑2
 63 ST+ 41
 64 1/X
 65 ST+ 42
 66 RCL 01
 67 *
 68 ST+ 40
 69 1/X
 70 ST+ 39
 71 RCL 02
 72 1/X
 73 RCL 01
 74 1/X
 75 ΣREG 22
 76 Σ+
 77 XEQ 88
 78 Σ+
 79 LASTX
 80 RCL 01
 81 *
 82 ST+ 46
 83 *
 84 ST+ 48
 85 LASTX
 86 X↑2
 87 ST+ 47
 88 RCL 03
 89 RCL 01
 90 /
 91 ST+ 43
 92 X↑2
 93 ST+ 51
 94 LASTX
 95 RCL 04
 96 *
 97 ST+ 56
 98 LASTX
 99 RCL 01
100 *
101 ST+ 44
102 LASTX
103 *
104 ST+ 52
105 RCL 04
106 LASTX
107 /
108 ST+ 45
109 RCL 02
110 RCL 03
111 *
112 ST+ 49
113 LASTX
114 RCL 02
115 /
116 ST+ 50
117 RCL 04
118 RCL 03
119 X↑2
120 *
121 ST+ 55
122 LASTX
123 X↑2
124 ST+ 54
125 LASTX
126 RCL 03
127 *
128 ST+ 53
129 FS? 02
130 GTO 00
131 RCL 01
132 SQRT
133 ST+ 57
134 LASTX
135 *
136 ST+ 14
137 RCL 02
138 RCL 01
139 SQRT
140 *
141 ST+ 15
142◆LBL 00
143 SF 21
144 "X"
145 FIX 0
146 CF 29
147 ARCL 21
148 "⊢="
149 FIX 5
```

```
150 ARCL 01
151 AVIEW
152 CLA
153 "Y"
154 FIX 0
155 ARCL 21
156 FIX 5
157 "⊢="
158 ARCL 02
159 AVIEW
160 SF 29
161 GTO 15
162◆LBL 16
163 CLA
164 "XYDAT"
165 FLSIZE
166 2
167 +
168 SF 25
169 RESZFL
170 FC?C 25
171 GTO 18
172 RDN
173 SAVEX
174 RTN
175◆LBL 18
176 RDN
177 TONE 9
178 TONE 9
179 TONE 9
180 "NO ROOM
"
181 PROMPT
182 GTO 16
183◆LBL a
184 CLA
185 "XYDAT"
186 RCLPTA
187 2
188 -
189 SEEKPT
190 RCL 01
191 RCL 02
192 X=0?
193 XEQ 89
194 STO 02
195 X<>Y
196 X=0?
197 XEQ 89
198 STO 01
199 ΣREG 16
200 Σ-
201 LASTX
202 /
203 ST- 35
204 1/X
205 ST- 34
206 RCL 01
207 *
208 ST- 37
209 1/X
210 ST- 38
211 RCL 02
212 RCL 01
213 X↑2
214 *
215 ST- 36
216 LASTX
217 X↑2
218 ST- 41
219 1/X
220 ST- 42
221 RCL 01
222 *
223 ST- 40
224 1/X
225 ST- 39
226 RCL 02
227 1/X
228 RCL 01
229 1/X
230 ΣREG 22
231 Σ-
232 XEQ 88
233 Σ-
234 LASTX
235 RCL 01
236 *
237 ST- 46
238 *
239 ST- 48
240 LASTX
241 X↑2
242 ST- 47
243 RCL 03
244 RCL 01
245 /
246 ST- 43
247 X↑2
248 ST- 51
249 LASTX
250 RCL 04
251 *
252 ST- 56
253 LASTX
254 RCL 01
255 *
256 ST- 44
257 LASTX
258 *
259 ST- 52
260 RCL 04
261 LASTX
262 /
263 ST- 45
264 RCL 02
265 RCL 03
266 *
267 ST- 49
268 LASTX
269 RCL 02
270 /
271 ST- 50
272 RCL 04
273 RCL 03
274 X↑2
275 *
276 ST- 55
277 LASTX
278 X↑2
279 ST- 54
280 LASTX
281 RCL 03
282 *
283 ST- 53
284 FS? 02
285 GTO 15
286 RCL 01
287 SQRT
288 ST- 57
289 LASTX
290 *
291 ST- 14
292 RCL 01
293 SQRT
294 RCL 02
295 *
296 ST- 15
297 SF 21
298 SF 12
299 ADV
```

```
300 "POINT D
LTD"
301 AVIEW
302 CF 12
303 ADV
304 GTO 15
305◆LBL 88
306 ΣREG 28
307 FS? 03
308 GTO 00
309 RCL 02
310 LN
311 STO 04
312◆LBL 00
313 FS? 02
314 RTN
315 RCL 01
316 LN
317 STO 03
318 RTN
319◆LBL 89
320 CLX
321 9 E-9
322 RTN
323◆LBL E
324 SF 21
325 ADV
326 ADV
327 ADV
328 ADV
329 ADV
330 "MCFB"
331 READP
332 GTO E
333 END
```

PROGRAM MCFB

Program MCFB (Multiple Curve Fit, Part B) is patterned after William M. Kolb's masterpiece, "Curve Fitting for Programmable Calculators". MCFB is the data analysis portion, and calculates the curve coefficients and the adjusted coefficient of determination ("RR") for up to twenty curves. MCFB assumes that MCFA has been run, and utilizes the 69 data registers created by MCFA. The "RR" symbol for the coefficient of determination comes from the relationship R squared = RR = coefficient of determination, where R is the correlation coefficient.

MCFB can be run any number of times as long as the data registers created by MCFA are not manually altered. Re-running MCFB could be desireable if the specified RR was so high as to result in no curves meeting the criteria; MCFB could then be re-run, with a lower RR specified.

LABEL A is used to start MCFB. The program prompts for the minimum adjusted coefficient of determination that is acceptable. Only curves with RR's equal to or greater than this value will be printed and stored in the CRVDAT file. If all twenty curves are desired, the RR should be set equal to zero.

The RR bounds are zero to one; a curve with perfect correlation will have an RR = 1, IF THE POPULATION IS NORMALLY DISTRIBUTED. If this is not the case, the interpretation of the coefficient of determination will be very uncertain. For this reason, curves with RR's very close to one may still not model the input data accurately. A plot of the curve fit against the given data is a prudent and graphic means of insuring that the curve fit is reasonable.

The program will next prompt "AUTO SELECT?". A non-zero entry is interpreted as "yes"; a zero or no entry is interpreted as "no". If a "yes" answer is given, the program will curve fit all curve types consistent with flags 02 and 03. Flag 02 is set by MCFA if any of the X input values are negative; Flag 03 is set if any of the Y input values are negative. The following combinations are possible:

INPUTS	FLAGS	CURVES
X ≥ 0	FC 02	1 through 20
Y ≥ 0	FC 03	
X ≥ 0	FC 02	1 through 8 and
Y < 0	FS 03	15 through 17
X < 0	FS 02	1 through 8
Y (doesn't matter)		

Flag 00 is SET if the calculated adjusted coefficient of determination ("RR") is less than the user-specified RR. Flag 01 is SET if manual curve selection is specified (a zero or no entry to the "AUTO SELECT?" prompt). Flag 04 is SET if the "c" coefficient should be printed. Flag 07 is SET if the manual curve selection mode is requested (a zero or no response to the "AUTO SELECT?" prompt).

MCFB will only attempt to curve fit to curves consistent with the input data. If the user elects to manually specify which curves should be attempted, only curve numbers consistent with the input data will be accepted.

MCFB will create a file in extended memory called CRVDAT. ANY PREVIOUS CRVDAT FILE IS PURGED. The data file consists of four registers for each curve fitted. The first register contains the curve number (1 through 20) as the integer portion, and the adjusted coefficient of determination divided by ten as the fractional portion. The next three registers contain coefficients a, b, and c. Of course, there must be sufficient room in extended memory for this data file. If all twenty curves are fitted, the data file length will be 80 registers.

If there is insufficient room in extended memory to automatically re-size the CRVDAT file by four registers, program execution will branch to LABEL 49 and stop. Program(s) can then be purged from extended memory to make room for the expanding CRVDAT file. As long as the stack is not disturbed, MCFB can then be continued by pressing the R/S key, without any loss of data.

If the automatic curve selection mode has been selected, MCFB will automatically execute LABEL E after calculating all possible curves. If the manual curve select mode has been selected, use LABEL E to manually exit the "CURVE?" prompt loop, after all desired curve types have been selected. Only integers from 1 to 20 must be entered in response to the CURVE? prompt.

LABEL E advances the printout and prompts "XEQ EDTDAT?" Three choices are now possible: LABEL A can be used to re-run MCFB, presumably with a lower RR; or a non-zero entry can be made (a non-zero entry is interpreted as a "yes") to call program EDTDAT from a digital cassette drive, overwriting MCFB; or a zero or no entry can be made (which will be interpreted as a "no" response), in which case shell program PLTPRP will be called from a digital cassette drive,

overwriting MCFB. Program PLTPRP will call programs U80, MCFC, GRAT, TICK, PLTLBL, and HPPLOT from the digital cassette drive. Programs U80, MCFC, and HPPLOT will be placed in RAM. U80 and MCFC will have ENDs attached, but program HPPLOT will not. PLTPRP will also place HPPLOT, GRAT, TICK, and PLTLBL into extended memory.

MCFB FLAGS

FLAG 00 SET if the calculated adjusted coefficient of determination ("RR") is less than the user-specified minimum RR

FLAG 01 initially SET; cleared after doing first loop through of automatic curve selection routine

FLAG 02 SET if any X input was negative

FLAG 03 SET if any Y input was negative

FLAG 04 SET for those curves with three coefficients (causes the "c" coefficient to be printed)

FLAG 07 SET if manual curve selection requested

CURVE TYPES

CURVE NUMBER	TYPE	GENERAL EQUATION
1	Linear	$Y = a + bX$
2	Reciprocal	$Y = 1/(a + bX)$
3	Linear-Hyperbolic	$Y = a + bX + c/X$
4	Hyperbola	$Y = a + b/X$
5	Reciprocal Hyperbola	$Y = X/(aX + b)$
6	2nd Order Hyperbola	$Y = a + b/X + c/X^2$
7	Parabola	$Y = a + bX + cX^2$
8	Cauchy Distribution	$Y = 1/[a(X + b)^2 + c]$
9	Power	$Y = aX^b$
10	Super Geometric	$Y = aX^{(bX)}$
11	Modified Geometric	$Y = aX^{(b/X)}$
12	Hoerl Function	$Y = a(b^X)X^c$
13	Modified Hoerl	$Y = a(b^{1/X})X^c$
14	Log-Normal	$Y = ae^{(b - \ln X)^2/c}$
15	Logarithmic	$Y = a + b \ln X$
16	Reciprocal Log	$Y = 1/(a + b \ln X)$
17	Coax Function	$Y = a + b\sqrt{X} + cX$
18	Modified Power	$Y = ab^X$
19	Root	$Y = ab^{1/X}$
20	Normal Distribution	$Y = ae^{(X - b)^2/c}$

```
 01◆LBL "MCF
B"
 02◆LBL A
 03 ADV
 04 ADV
 05 ADV
 06 ADV
 07 ADV
 08 CF 00
 09 SF 01
 10 CF 04
 11 CF 07
 12 SF 24
 13 CF 25
 14 CLX
 15 "AUTO SE
LECT?"
 16 PROMPT
 17 X=0?
 18 SF 07
 19 RCL 68
 20 "MIN RR?
"
 21 PROMPT
 22 STO 68
 23 ADV
 24 FS? 07
 25 CF 01
 26 CLA
 27 "CRVDAT"
 28 SF 25
 29 PURFL
 30 CF 25
 31 4
 32 CRFLD
 33 1.02
 34 STO 58
 35 GTO 32
 36◆LBL 01
 37 SF 04
 38 XEQ 24
 39 XEQ 25
 40 RCL 20
 41 XEQ 21
 42 "Y=a+bX"
 43 RTN
 44◆LBL 02
 45 SF 04
 46 XEQ 23
 47 XEQ 26
 48 RCL 34
 49 XEQ 21
 50 "Y=1/(a+
bX)"
 51 RTN
 52◆LBL 03
 53 XEQ 24
 54 XEQ 25
 55 RCL 22
 56 STO 64
 57 RCL 23
 58 STO 65
 59 RCL 20
 60 RCL 21
 61 RCL 35
 62 XEQ 22
 63 "Y=a+bX+
c/X"
 64 RTN
 65◆LBL 04
 66 SF 04
 67 XEQ 27
 68 XEQ 25
 69 RCL 35
 70 XEQ 21
 71 "Y=a+b/X
"
 72 RTN
 73◆LBL 05
 74 SF 04
 75 XEQ 27
 76 XEQ 26
 77 RCL 26
 78 XEQ 21
 79 "Y=X/(aX
+b)"
 80 RTN
 81◆LBL 06
 82 XEQ 27
 83 XEQ 25
 84 RCL 23
 85 STO 64
 86 RCL 42
 87 STO 65
 88 RCL 35
 89 RCL 40
 90 RCL 38
 91 XEQ 22
 92 "Y=a+b/X
+c/X↑2"
 93 RTN
 94◆LBL 07
 95 XEQ 24
 96 XEQ 25
 97 XEQ 28
 98 RCL 20
 99 RCL 39
100 RCL 36
101 XEQ 22
102 "Y=a+bX+
cX↑2"
103 RTN
104◆LBL 08
105 XEQ 24
106 XEQ 26
107 XEQ 28
108 RCL 34
109 RCL 39
110 RCL 37
111 XEQ 22
112 RCL 11
113 RCL 12
114 X↑2
115 RCL 13
116 STO 01
117 ST+ X
118 ST/ 02
119 ST+ X
120 /
121 -
122 STO 03
123 "Y=1/[c+
a(X+b)↑2"
124 "⊢]"
125 RTN
126◆LBL 09
127 SF 04
128 XEQ 29
129 XEQ 30
130 RCL 32
131 XEQ 21
132 RCL 11
133 E↑X
134 STO 01
135 "Y=aX↑b"
136 RTN
137◆LBL 10
138 SF 04
139 RCL 46
140 STO 59
141 RCL 47
142 STO 60
143 XEQ 30
144 RCL 48
145 XEQ 21
146 RCL 11
147 E↑X
148 STO 01
149 "Y=aX↑(b
X)"
```

```
150 RTN
151◆LBL 11
152 SF 04
153 RCL 43
154 STO 59
155 RCL 51
156 STO 60
157 XEQ 30
158 RCL 56
159 XEQ 21
160 RCL 11
161 E↑X
162 STO 01
163 "Y=aX↑(b
/X)"
164 RTN
165◆LBL 12
166 XEQ 24
167 XEQ 30
168 XEQ 31
169 RCL 44
170 RCL 46
171 RCL 32
172 XEQ 22
173 RCL 11
174 E↑X
175 STO 01
176 RCL 12
177 E↑X
178 STO 02
179 "Y=a(b↑X
)(X↑c)"
180 RTN
181◆LBL 13
182 XEQ 27
183 XEQ 30
184 XEQ 31
185 RCL 45
186 RCL 43
187 RCL 32
188 XEQ 22
189 RCL 11
190 E↑X
191 STO 01
192 RCL 12
193 E↑X
194 STO 02
195 "Y=a(b↑1
/X)(X↑c)"
196 RTN
197◆LBL 14
198 XEQ 29
199 XEQ 30
200 RCL 29
201 STO 64
202 RCL 54
203 STO 65
204 RCL 32
205 RCL 53
206 RCL 55
207 XEQ 22
208 RCL 11
209 RCL 12
210 X↑2
211 RCL 13
212 ST+ X
213 CHS
214 ST/ 02
215 ST+ X
216 /
217 +
218 E↑X
219 STO 01
220 RCL 13
221 1/X
222 STO 03
223 "Y=aEXP[
(1/c)(b-"
224 "⊢LNX)↑2
]"
225 RTN
226◆LBL 15
227 SF 04
228 XEQ 29
229 XEQ 25
230 RCL 49
231 XEQ 21
232 "Y=a+bLN
X"
233 RTN
234◆LBL 16
235 SF 04
236 XEQ 29
237 XEQ 26
238 RCL 50
239 XEQ 21
240 "Y=1/(a+
bLNX)"
241 RTN
242◆LBL 17
243 RCL 57
244 STO 59
245 RCL 16
246 STO 60
247 XEQ 25
248 RCL 16
249 STO 64
250 RCL 17
251 STO 65
252 RCL 15
253 RCL 14
254 RCL 20
255 XEQ 22
256 "Y=a+bSQ
RT(X)+cX"
257 RTN
258◆LBL 18
259 SF 04
260 XEQ 24
261 XEQ 30
262 RCL 44
263 XEQ 21
264 RCL 11
265 E↑X
266 STO 01
267 RCL 12
268 E↑X
269 STO 02
270 "Y=ab↑X"
271 RTN
272◆LBL 19
273 SF 04
274 XEQ 27
275 XEQ 30
276 RCL 45
277 XEQ 21
278 RCL 11
279 E↑X
280 STO 01
281 RCL 12
282 E↑X
283 STO 02
284 "Y=ab↑(1
/X)"
285 RTN
286◆LBL 20
287 XEQ 24
288 XEQ 30
289 XEQ 28
290 RCL 44
291 RCL 39
292 RCL 52
293 XEQ 22
294 RCL 11
295 RCL 12
296 X↑2
297 RCL 13
298 ST+ X
299 CHS
```

```
300 ST/ 02
301 ST+ X
302 /
303 +
304 E↑X
305 STO 01
306 RCL 13
307 1/X
308 STO 03
309 "Y=aEXP[
(1/c)(X-"
310 "-b)↑2]"
311 RTN
312◆LBL 21
313 STO 63
314 RCL 60
315 RCL 21
316 *
317 RCL 59
318 X↑2
319 -
320 STO 05
321 RCL 60
322 RCL 61
323 *
324 RCL 59
325 RCL 63
326 *
327 -
328 RCL 05
329 /
330 STO 11
331 STO 01
332 RCL 63
333 RCL 21
334 *
335 RCL 59
336 RCL 61
337 *
338 -
339 RCL 05
340 /
341 STO 12
342 STO 02
343 0
344 STO 03
345 STO 13
346 2
347 GTO 23
348◆LBL 22
349 STO 67
350 RDN
351 STO 66
352 RDN
353 STO 63
354 RCL 60
355 RCL 21
356 *
357 RCL 59
358 X↑2
359 -
360 STO 05
361 RCL 21
362 RCL 67
363 *
364 RCL 61
365 RCL 64
366 *
367 -
368 STO 06
369 RCL 21
370 RCL 66
371 *
372 RCL 59
373 RCL 64
374 *
375 -
376 STO 07
377 RCL 63
378 RCL 21
379 *
380 RCL 59
381 RCL 61
382 *
383 -
384 STO 08
385 RCL 21
386 RCL 65
387 *
388 RCL 64
389 X↑2
390 -
391 STO 09
392 RCL 05
393 RCL 06
394 *
395 RCL 07
396 RCL 08
397 *
398 -
399 RCL 05
400 RCL 09
401 *
402 RCL 07
403 X↑2
404 -
405 /
406 STO 13
407 STO 03
408 RCL 08
409 RCL 07
410 RCL 13
411 *
412 -
413 RCL 05
414 /
415 STO 12
416 STO 02
417 RCL 61
418 RCL 12
419 RCL 59
420 *
421 -
422 RCL 13
423 RCL 64
424 *
425 -
426 RCL 21
427 /
428 STO 11
429 STO 01
430 3
431◆LBL 23
432 RCL 11
433 RCL 61
434 *
435 RCL 12
436 RCL 63
437 *
438 +
439 RCL 13
440 RCL 67
441 *
442 +
443 RCL 61
444 X↑2
445 RCL 21
446 /
447 -
448 RCL 62
449 LASTX
```

```
450 -
451 /
452 1
453 -
454 LASTX
455 RCL 21
456 -
457 *
458 X<>Y
459 RCL 21
460 -
461 /
462 1
463 +
464 X<0?
465 0
466 1
467 X<>Y
468 X>Y?
469 X<>Y
470 STO 10
471 RTN
472◆LBL 24
473 RCL 16
474 STO 59
475 RCL 17
476 STO 60
477 RTN
478◆LBL 25
479 RCL 18
480 STO 61
481 RCL 19
482 STO 62
483 RTN
484◆LBL 26
485 RCL 24
486 STO 61
487 RCL 25
488 STO 62
489 RTN
490◆LBL 27
491 RCL 22
492 STO 59
493 RCL 23
494 STO 60
495 RTN
496◆LBL 28
497 RCL 17
498 STO 64
499 RCL 41
500 STO 65
501 RTN
502◆LBL 29
503 RCL 28
504 STO 59
505 RCL 29
506 STO 60
507 RTN
508◆LBL 30
509 RCL 30
510 STO 61
511 RCL 31
512 STO 62
513 RTN
514◆LBL 31
515 RCL 28
516 STO 64
517 RCL 29
518 STO 65
519 RTN
520◆LBL 32
521 RCL 58
522 INT
523 STO 00
524 FS? 07
525 XEQ 35
526 SF 21
527 FIX 0
528 SF 12
529 CF 29
530 "CURVE "
531 ARCL 00
532 AVIEW
533 CF 12
534 SF 29
535 FIX 9
536 XEQ IND
00
537 RCL 68
538 RCL 10
539 X<Y?
540 SF 00
541 FS? 00
542 GTO 33
543 FS? 55
544 SCI 9
545 FC? 55
546 SCI 4
547 XEQ 34
548 "a= "
549 ARCL 01
550 XEQ 34
551 "b= "
552 ARCL 02
553 XEQ 34
554 FS?C 04
555 GTO 00
556 "c= "
557 ARCL 03
558 XEQ 34
559◆LBL 00
560 RCL 10
561 FIX 3
562 "RR= "
563 ARCL X
564 XEQ 34
565 ADV
566 10
567 /
568 ST+ 00
569 .003
570 SF 25
571 SAVERX
572 FC?C 25
573 XEQ 48
574◆LBL 33
575 FC?C 00
576 GTO 00
577 FIX 3
578 "RR< "
579 ARCL 68
580 XEQ 34
581 ADV
582 CF 04
583◆LBL 00
584 FS? 07
585 GTO 32
586 XEQ 40
587 ISG 58
588 GTO 32
589 GTO E
590◆LBL 34
591 FC? 55
592 AVIEW
593 FS? 55
594 PRA
595 RTN
596◆LBL 35
597 RCL 00
598 "CURVE?"
599 PROMPT
```

```
600 STO 00
601 8
602 X<>Y
603 X<=Y?
604 RTN
605 FS? 02
606 GTO 39
607 FC? 03
608 RTN
609 15
610 X<>Y
611 X=Y?
612 RTN
613 16
614 X<>Y
615 X=Y?
616 RTN
617 17
618 X<>Y
619 X=Y?
620 RTN
621◆LBL 39
622 TONE 7
623 CF 21
624 "INVLD C
RVE"
625 AVIEW
626 SF 21
627 GTO 35
628◆LBL 40
629 7
630 RCL 00
631 INT
632 X<=Y?
633 RTN
634 FC?C 01
635 RTN
636 FS? 02
637 GTO 47
638 FS? 03
639 GTO 45
640 RTN
641◆LBL 45
642 14.017
643 STO 58
644 RTN
645◆LBL 47
646 8.008
647 STO 58
648 RTN
649◆LBL 48
650 CLA
651 "CRVDAT"
652 FLSIZE
653 4
654 +
655 SF 25
656 RESZFL
657 FC?C 25
658 GTO 49
659 RDN
660 SAVERX
661 RTN
662◆LBL 49
663 RDN
664 TONE 9
665 TONE 9
666 TONE 9
667 "NO ROOM
"
668 PROMPT
669 GTO 48
670◆LBL E
671 CF 24
672 ADV
673 ADV
674 ADV
675 ADV
676 ADV
677 ADV
678 CLX
679 "XEQ EDT
DAT?"
680 PROMPT
681 X≠0?
682 GTO 00
683 "PLTPRP"
684 READP
685 GTO E
686◆LBL 00
687 "EDTDAT"
688 READP
689 GTO E
690 END
```

PROGRAM EDTDAT

Program EDTDAT (EDiTDATa) can be used to edit the CRVDAT file created by MCFB. EDTDAT can delete or change the sequence of any of the curves in the CRVDAT file.

EDTDAT requires a size equal to the CRVDAT file size plus one-- this could be as great as SIZE 081. EDTDAT will load all of the CRVDAT data in RAM. It will then ask for each curve number to be placed back into a modified CRVDAT file. The curves can be entered in any order.

EDTDAT will normally be used to reduce the size of the CRVDAT file to only those curves (or curve) found to adequately model the input data.

After all desired curves have been entered into the new CRVDAT file, execute LABEL E to exit the loop. LABEL E will automatically re-size to SIZE 024.

```
 01◆LBL "EDT
DAT"
 02 CF 25
 03 FIX 9
 04 CLA
 05 "CRVDAT"
 06 0
 07 SEEKPTA
 08 FLSIZE
 09 1
 10 +
 11 SIZE?
 12 X<>Y
 13 X>Y?
 14 PSIZE
 15 1
 16 -
 17 1 E3
 18 /
 19 1
 20 +
 21 GETRX
 22 4 E-5
 23 +
 24 STO 00
 25 PURFL
 26 4
 27 CRFLD
 28◆LBL 02
 29 TONE 7
 30 "CURVE?"
 31 PROMPT
 32◆LBL 03
 33 RCL IND
00
 34 INT
 35 X<>Y
 36 X=Y?
 37 GTO 10
 38 ISG 00
 39 GTO 03
 40 TONE 9
 41 CF 21
 42 "NOT FOU
ND"
 43 AVIEW
 44 SF 21
 45◆LBL 04
 46 RCL 00
 47 FRC
 48 1
 49 +
50 STO 00
51 GTO 02
52◆LBL 10
53 RCL 00
54 INT
55 ENTER↑
56 ENTER↑
57 3
58 +
59 1 E3
60 /
61 +
62 SF 25
63 SAVERX
64 FC?C 25
65 XEQ 20
66 GTO 04
67◆LBL 20
68 CLA
69 "CRVDAT"
70 FLSIZE
71 4
72 +
73 RESZFL
74 RDN
75 SAVERX
76 RTN
77◆LBL E
78 24
79 PSIZE
80 CLX
81 CLA
82 STOP
83 GTO E
84 .END.
```

PROGRAM MCFC

Program MCFC (Multiple Curve Fit, Part C) is patterned after William Kolb's masterpiece, "Curve Fitting for Programmable Calculators". MCFC is the equation evaluating portion, and assumes that a CRVDAT data file exists in extended memory.

MCFC uses the curve number (the integer portion of every fourth register of the CRVDAT file) as a curve pointer. The pointer is the curve number plus 60. This corresponds to LABELS 61 through 80 in MCFC.

MCFC obtains the curve number and coefficients a, b, and c (where applicable) from the CRVDAT file, and places this data in RAM, using registers 20 through 23. The "a" coefficient is placed in register 21, the "b" coefficient in register 22, and the "c" coefficient in register 23. LABELS 61 through 80 then use registers 21 through 23 to evaluate each curve.

Program HPPLOT will automatically step through the CRVDAT file until all curves in that file have been plotted. If flag 05 is SET, MCFC obtains its X value from the XYDAT file rather than from the incrementing routines in HPPLOT, and calculates the percent error of f(x) instead of f(x).

When calculating the percent error of f(X), MCFC will skip any (X,Y) pairs where Y is equal to zero or 0.000000009, as the percent error is undefined when Y is equal to zero.

MCFC REGISTER ASSIGNMENTS

R00 through R19: reserved for programs HPPLOT, GRAT, TICK, and PLTLBL

R20 curve number and program pointer
R21 a
R22 b
R23 c

Flag 00 through flag 10: reserved for programs HPPLOT, GRAT, TICK, and PLTLBL

```
 01◆LBL "MCF
C"
 02 FIX 9
 03 FS? 05
 04 GTO 20
 05◆LBL 90
 06 RCL 20
 07 INT
 08 60
 09 +
 10 X<>Y
 11 ENTER↑
 12 SF 25
 13 XEQ IND
Z
 14 FC?C 25
 15 PENUP
 16 RCL 00
 17 X<>Y
 18 RTN
 19◆LBL 20
 20 CF 07
 21 SF 25
 22 GETX
 23 FC?C 25
 24 GTO 23
 25 STO 00
 26 FS? 08
 27 VIEW X
 28 XEQ 25
 29 FS?C 07
 30 GTO 20
 31 RTN
 32◆LBL 23
 33 RCL 02
 34 STO 00
 35 STO 18
 36 PENUP
 37 RTN
 38◆LBL 25
 39 XEQ 90
 40 GETX
 41 9 E-9
 42 X=Y?
 43 SF 07
 44 RDN
 45 X=0?
 46 SF 07
 47 -
 48 LASTX
 49 /
 50 1 E2
 51 *
 52 RTN
 53◆LBL 75
 54 LN
 55◆LBL 61
 56 RCL 22
 57 *
 58 RCL 21
 59 +
 60 RTN
 61◆LBL 62
 62 XEQ 61
 63 1/X
 64 RTN
 65◆LBL 63
 66 RCL 23
 67 X<>Y
 68 /
 69 RCL 22
 70 LASTX
 71 *
 72 +
 73 RCL 21
 74 +
 75 RTN
 76◆LBL 64
 77 RCL 22
 78 X<>Y
 79 /
 80 RCL 21
 81 +
 82 RTN
 83◆LBL 65
 84 XEQ 64
 85 1/X
 86 RTN
 87◆LBL 66
 88 1/X
 89 ENTER↑
 90 ENTER↑
 91◆LBL 67
 92 RCL 23
 93 *
 94 RCL 22
 95 +
 96 *
 97 RCL 21
 98 +
 99 RTN
100◆LBL 68
101 RCL 22
102 +
103 X↑2
104 RCL 21
105 *
106 RCL 23
107 +
108 1/X
109 RTN
110◆LBL 69
111 RCL 22
112 Y↑X
113 RCL 21
114 *
115 RTN
116◆LBL 79
117 1/X
118◆LBL 78
119 RCL 22
120 X<>Y
121 Y↑X
122 RCL 21
123 *
124 RTN
125◆LBL 77
126 SQRT
127 RCL 22
128 *
129 X<>Y
130 RCL 23
131 *
132 +
133 RCL 21
134 +
135 RTN
136◆LBL 71
137 1/X
138◆LBL 70
139 RCL 22
140 *
141 Y↑X
142 RCL 21
143 *
144 RTN
145◆LBL 72
146 RCL 22
147 X<>Y
148 Y↑X
149 X<>Y
```

```
150 RCL 23
151 Y↑X
152 *
153 RCL 21
154 *
155 RTN
156◆LBL 73
157 RCL 23
158 Y↑X
159 RCL 22
160 RCL Z
161 1/X
162 Y↑X
163 *
164 RCL 21
165 *
166 RTN
167◆LBL 74
168 LN
169◆LBL 80
170 RCL 22
171 -
172 X↑2
173 RCL 23
174 /
175 E↑X
176 RCL 21
177 *
178 RTN
179◆LBL 76
180 XEQ 75
181 1/X
182 RTN
183 END
```

After a specific curve has been selected as a satisfactory curve fit, LABELS 61 through 80 can be used to derive an evaluation subroutine to evaluate just the selected curve type. For example, if a parabola is selected as the best fit, a curve-specific subroutine can be derived from LABEL 67, as follows:

```
LBL "PARAB"
ENTR
c coefficient
*
b coefficient
+
*
a coefficient
RTN
```

PROGRAM POLYN

Program POLYN (POLYNomial) performs a least-squares curve fit to user-specified (X,Y) data points. Polynomials of orders one through nine can be accommodated, although truncation errors may affect the accuracy of polynomials above fifth order. POLYN is based on an improved version of "Polynomial Curve Fitting, Second Through Ninth Order", by John C. Elison (HP User's Library program number 01415C). The program has been modified to allow X to be any value, rather than only increasing integers. Modifications have also been made to make the program more user-friendly: the program automatically PSIZEs for the each polynomial order, and automatically creates data files in extended memory which are compatible with HPPLOT.

The number of (X,Y) input pairs must be equal to or greater than the polynomial order plus one. For a ninth order polynomial, a SIZE 155 will be required.

POLYN is used to enter the input points and to calculate the polynomial coefficients. POLYN creates a data file in extended memory, called XYDAT, which contains all of the input pairs. POLYN also creates up to nine data files in extended memory, one for each order selected. The data files are named POLYn, where n is an integer corresponding to the polynomial order; for example, POLY4 would be the data file for a fourth-order polynomial curve fit. The size of each POLYn data file is (n + 2).

The POLYn file format is as follows:

```
R00 = Bn
R01 = Bn-1
R02 = Bn-2
    .
    .
    .
Rn-2 = B3
Rn-1 = B2
Rn   = B1
Rn+1 = B0
Rn+2 = RR (coefficient of determination)

where

Y = (Bn)(X**n) + (Bn-1)(X**n-1) + (Bn-2)(X**n-2) ...
    + (B2)(X**2) + (B1)(X) + B0

(The symbol "**" indicates exponentiation.)
```

Use LABEL A to start data entry. LABEL A will PSIZE to SIZE 043 and clear all registers. Use LABEL a to correct a current (X,Y) pair. Use LABEL E when all (X,Y) pairs have been entered. LABEL E will prompt for the lowest and highest order polynomials to be fitted. The default values are first order through fifth order. For other orders, key in the lowest order desired, ENTER, key in the highest order desired, and R/S. The coefficients and RR for each order polynomial will be printed.

POLYN will prompt "XEQ PLTPRP?" after all coefficients have been printed. A "yes" response will cause shell program PLTPRP to be called from digital cassette drive and executed. PLTPRP will place U80 and POLY in RAM and PACK these programs. HPPLOT will be placed in RAM but not PACKED. HPPLOT, GRAT, TICK, and PLTLBL will be placed into extended memory. SIZE will be set to 023.

Readers interested in a discussion of the theory for calculation of the polynomial coefficients should order Mr. Elison's program from the User's Library or its sucessor institution.

POLYN and POLY REGISTERS

POLYN registers:

R00: used, RR (initial use, final use)
R01: used, B0
R02: used, B1
R03: used, B2
R04: used, B3
R05: used, B4
R06: used, B5
R07: used, B6
R08: used, B7
R09: used, B8
R10: used, B9
R11: used
R12: (n min + 1).((n max + 1)/1000),
where n = polynomial order
R13: Sigma Y squared
R14: number of (X,Y) pairs
R15: Sigma X
R16: Sigma X squared
R17: Sigma X cubed
R18: Sigma X**4
R19: Sigma X**5
R20: Sigma X**6
R21: Sigma X**7
R22: Sigma X**8
R23: Sigma X**9
R24: Sigma X**10
R25: Sigma X**11
R26: Sigma X**12
R27: Sigma X**13
R28: Sigma X**14
R29: Sigma X**15
R30: Sigma X**16
R31: Sigma X**17
R32: Sigma X**18
R33: Sigma Y
R34: Sigma XY
R35: Sigma (X**2)(Y)
R36: Sigma (X**3)(Y)
R37: Sigma (X**4)(Y)
R38: Sigma (X**5)(Y)
R39: Sigma (X**6)(Y)
R40: Sigma (X**7)(Y)
R41: Sigma (X**8)(Y)
R42: Sigma (X**9)(Y)

R43 through R(44 + n**2 + 3n): used for matrices

POLY registers:

R21: data file name (POLY1, POLY2, etc.)
R22: polynomial order, n

```
 01◆LBL "POL
YN"
 02◆LBL A
 03 SF 21
 04 "INITIAL
IZING"
 05 AVIEW
 06 ADV
 07 43
 08 PSIZE
 09 CLRG
 10 ΣREG 11
 11 "XYDAT"
 12 SF 25
 13 PURFL
 14 CF 25
 15 4
 16 CRFLD
 17 CF 29
 18 FIX 0
 19 1.009
 20◆LBL 77
 21 "POLY"
 22 ARCL X
 23 SF 25
 24 PURFL
 25 CF 25
 26 CLA
 27 ISG X
 28 GTO 77
 29 SF 29
 30 FIX 5
 31◆LBL 78
 32 XEQ 03
 33 ISG 14
 34◆LBL 01
 35 *
 36 ST+ IND
03
 37 ISG 03
 38 GTO 01
 39 XEQ 06
 40◆LBL 02
 41 ST+ IND
03
 42 *
 43 ISG 03
 44 GTO 02
 45 CF 29
 46 FIX 0
 47 "X"
 48 ARCL 14
 49 "⊢="
 50 SF 29
 51 FIX 5
 52 ARCL 01
 53 AVIEW
 54 CF 29
 55 FIX 0
 56 "Y"
 57 ARCL 14
 58 "⊢="
 59 SF 29
 60 FIX 5
 61 ARCL 02
 62 AVIEW
 63 ADV
 64 GTO 78
 65◆LBL 03
 66 TONE 7
 67 FIX 0
 68 CF 29
 69 RCL 14
 70 1
 71 +
 72 "X"
 73 ARCL X
 74 "⊢, Y"
 75 ARCL X
 76 "⊢?"
 77 RDN
 78 PROMPT
 79 SF 29
 80 FIX 9
 81◆LBL 00
 82 STO 02
 83 STO 04
 84 X<>Y
 85 STO 01
 86 SF 25
 87 SAVEX
 88 FC?C 25
 89 XEQ 05
 90 X<>Y
 91 SAVEX
 92 X↑2
 93 ST+ 13
 94 15.032
 95 STO 03
 96 RCL 01
 97 ENTER↑
 98 ENTER↑
 99 ENTER↑
100 1
101 RTN
102◆LBL 05
103 "XYDAT"
104 FLSIZE
105 2
106 +
107 RESZFL
108 RDN
109 SAVEX
110 RTN
111◆LBL 06
112 RDN
113 .01
114 ST+ 03
115 X<> 04
116 RTN
117◆LBL a
118 "XYDAT"
119 RCLPTA
120 2
121 -
122 SEEKPT
123 CF 29
124 SF 12
125 FIX 0
126 "X"
127 ARCL 14
128 "⊢, Y"
129 ARCL 14
130 "⊢ DLTD"
131 AVIEW
132 ADV
133 CF 12
134 SF 29
135 FIX 5
136 RCL 02
137 STO 04
138 X↑2
139 ST- 13
140 15.032
141 STO 03
142 RCL 01
143 ENTER↑
144 ENTER↑
145 ENTER↑
146 1
147◆LBL 08
148 *
149 ST- IND
03
```

```
150 ISG 03
151 GTO 08
152 XEQ 06
153◆LBL 09
154 ST- IND
03
155 *
156 ISG 03
157 GTO 09
158 DSE 14
159 DEG
160 GTO 78
161◆LBL E
162 1
163 ENTER↑
164 5
165 "MIN, ↑,
 MAX?"
166 PROMPT
167 1
168 +
169 1 E3
170 /
171 +
172 1
173 +
174 STO 12
175◆LBL 15
176 RCL 12
177 INT
178 1
179 -
180 STO 10
181 1
182 +
183 1 E3
184 /
185 STO 08
186 STO 11
187 1 E2
188 /
189 STO 05
190 STO 02
191 1 E-5
192 +
193 STO 01
194 STO 04
195 STO 09
196 43
197 ST+ 01
198 ST+ 02
199 STO 03
200 ST+ 05
201 1 E3
202 /
203 ST+ 04
204 RCL 10
205 RCL 08
206 *
207 ST- 03
208 +
209 ST+ 05
210 ST+ 01
211 RCL 08
212 +
213 ST+ 02
214 2 E-3
215 ST- 01
216 42
217 RCL 12
218 INT
219 STO 00
220 ST+ 02
221 X↑2
222 +
223 ST+ 09
224 ST+ 04
225 ST+ 00
226 1 E3
227 /
228 ST+ 00
229 1
230 ST+ 08
231 ST+ 11
232 +
233 ST+ 03
234 RCL 00
235 +
236 INT
237 SIZE?
238 X<>Y
239 X>Y?
240 PSIZE
241 X>Y?
242 CF 29
243 FIX 0
244 "SIZE="
245 ARCL X
246 X>Y?
247 AVIEW
248 X>Y?
249 ADV
250 CF 21
251 "WORKING
"
252 AVIEW
253 SF 21
254 SF 29
255 FIX 5
256 STO IND
00
257 "POLY"
258 CF 29
259 FIX 0
260 RCL 12
261 INT
262 DSE X
263 ARCL X
264 SF 29
265 SCI 5
266 SF 25
267 PURFL
268 CF 25
269 RCL 00
270 ENTER↑
271 INT
272 X<>Y
273 FRC
274 1 E3
275 *
276 -
277 1
278 +
279 CRFLD
280 33
281 RCL 10
282 +
283 RCL 00
284◆LBL 17
285 RCL IND
Y
286 STO IND
Y
287 RDN
288 DSE Y
289 DSE X
290 GTO 17
291 RCL 05
292 12.012
293 RCL 08
294 2
295 *
296 +
297◆LBL 18
298 RCL IND
X
299 STO IND
Z
```

```
300 RDN
301 ISG X
302 GTO 19
303 GTO 20
304◆LBL 19
305 ISG Y
306 GTO 18
307 1.001
308 ST+ 05
309 RCL 05
310 RCL Z
311 RCL 10
312 -
313 GTO 18
314◆LBL 20
315 RCL 02
316 STO 05
317 1.1
318 +
319 STO 06
320◆LBL 22
321 RCL 05
322 RCL 06
323 RCL IND
03
324 X=0?
325 GTO 24
326 RCL IND
01
327 /
328 STO 07
329 RDN
330◆LBL 23
331 RCL IND
Y
332 RCL 07
333 *
334 ST- IND
Y
335 RDN
336 ISG X
337 ISG Y
338 GTO 23
339◆LBL 24
340 1
341 ST+ 06
342 ISG 03
343 GTO 22
344 ISG 08
345 RCL 08
346 ST+ 03
347 1.001
348 RCL 12
349 INT
350 +
351 ST+ 02
352 ISG 01
353 GTO 20
354 RCL 00
355 STO 06
356 1.01
357 -
358 STO 07
359 RCL 09
360 INT
361 1
362 -
363 STO Y
364 RCL 10
365 -
366 1 E3
367 /
368 +
369 STO 08
370◆LBL 25
371 RCL 07
372◆LBL 26
373 RCL IND
08
374 X=0?
375 GTO 27
376 RCL IND
04
377 /
378 RCL IND
06
379 *
380 ST- IND
Y
381◆LBL 27
382 RDN
383 DSE X
384 DSE 08
385 GTO 26
386 ISG 11
387 RCL 11
388 ST- 08
389 DSE 07
390 DSE 06
391 DSE 04
392 GTO 25
393 RCL 00
394◆LBL 28
395 RCL IND
09
396 ST/ IND
Y
397 RDN
398 DSE 09
399 DSE X
400 GTO 28
401 32
402 RCL 12
403 INT
404 STO 11
405 +
406 RCL 33
407 X↑2
408 RCL 14
409 /
410 CHS
411◆LBL 30
412 RCL IND
00
413 STO IND
11
414 SAVEX
415 RCL 11
416 RDN
417 DSE T
418 CLA
419 "B"
420 CF 29
421 FIX 0
422 ARCL T
423 "⊢="
424 SCI 3
425 SF 29
426 ARCL X
427 AVIEW
428 RCL IND
Z
429 *
430 +
431 DSE Y
432 DSE 11
433 DEG
434 DSE 00
435 GTO 30
436 RCL 13
437 RCL 33
438 X↑2
439 RCL 14
440 /
441 -
442 /
443 STO 00
444 SAVEX
445 FIX 5
446 "RR="
447 ARCL X
448 AVIEW
449 ADV
```

```
450 ADV
451 ISG 12
452 GTO 15
453◆LBL 90
454 ADV
455 ADV
456 ADV
457 ADV
458 CLX
459 BEEP
460 "XEQ PLT
PRP?"
461 PROMPT
462 X≠0?
463 GTO 00
464 STOP
465 GTO 90
466◆LBL 00
467 "PLTPRP"
468 READP
469 GTO 90
470 END
```

PROGRAM POLY

Program POLY is designed to work as a called program for HPPLOT and is used to evaluate a polynomial. POLY contains special incrementing routines to make it compatible with HPPLOT.

Program POLY uses the POLYn file(s) created by POLYN. F(x) is evaluated using the following method:

```
f(x) = X(X(X... (X(X(XBn + Bn-1) + Bn-2)
       + Bn-3)... + B2) + B1) + B0
```

For example, for a fourth-order polynomial,

```
f(x) = X(X(X(XB4 + B3) + B2) + B1) + B0
```

POLY requires SIZE 023, and uses registers 00, 02, 18, 21, and 22. POLY's use of registers 00 through 20 is compatible with HPPLOT's use of these registers.

```
 01◆LBL "POL
Y"
 02 FS? 05
 03 GTO 05
 04◆LBL 00
 05 ENTER↑
 06 ENTER↑
 07 ENTER↑
 08 0
 09 CLA
 10 ARCL 21
 11 SEEKPTA
 12 RDN
 13 XEQ 09
 14 ENTER↑
 15 GETX
 16 *
 17◆LBL 01
 18 DSE 22
 19 GTO 02
 20 GTO 03
 21◆LBL 02
 22 GETX
 23 +
 24 *
 25 GTO 01
 26◆LBL 03
 27 GETX
 28 +
 29 XEQ 09
 30 RTN
 31◆LBL 05
 32 "XYDAT"
 33 RCLPTA
 34 SF 25
 35 GETX
 36 FC?C 25
 37 GTO 07
 38 STO 00
 39 FS? 08
 40 VIEW X
 41 XEQ 08
 42 RTN
 43◆LBL 07
 44 RCL 02
 45 STO 00
 46 STO 18
 47 PENUP
 48 RTN
 49◆LBL 08
 50 XEQ 00
 51 "XYDAT"
 52 RCLPTA
 53 RDN
 54 GETX
 55 -
 56 LASTX
 57 /
 58 1 E2
 59 *
 60 RTN
 61◆LBL 09
 62 FLSIZE
 63 2
 64 -
 65 STO 22
 66 RDN
 67 RTN
 68 END
```

EXAMPLE 1

Example I demonstrates the basic HPPLOT, GRAT, TICK, and PLTLBL programs, without implementing the curve fitting capabilities of MCFC or POLY.

A Hoerl function (Y=a(b**X)(X**c), where "**" indicates exponentiation) was used to model the attenuation of Times Fiber type TX565 0.565" coaxial cable. This function was plotted in the linear-linear, linear-log, log-linear, and log-log modes. For the linear-linear plot, flag 08 was SET, so a printout of the calculated values was generated. For the other three plots, flag 08 was CLEAR, and no printout was generated.

Flag 02 was SET for the linear-log case, so short tick marks were drawn. Flag 01 was CLEAR for the log-linear example, so prompts for "XEQ GRAT?", "PEN?", "MAX FIX?", "XEQ TICK?", and "LABEL?" were made.

LABEL C of PLTLBL was used in each case to plot the manufacturer's published attenuation data. LABEL C was activated after HPPLOT, GRAT, TICK, and the automatic labeling portion of PLTLBL had been run.

STEP BY STEP INSTRUCTIONS FOR EXAMPLE I

1. Connect a HP41CX calculator with two extended memory modules, an 82184A plotter module, and an HP-IL module to a digital cassette drive, a printer, and the 7470A plotter.

2. Load utility program PLTPRP from the digital cassette drive and execute. PLTPRP will configure the HP41CX as follows:

```
PLTPRP
                READADP
                  RUN
                CAT 1                          CAT 4
                                       GRAT    P083
LBL'U80                                TICK    P078
LBL'U81                                PLTLBL  P100
LBL'U82                                HPPLOT  P181
LBL'U83                                     150.0000000    ***
LBL'U84
END         188 BYTES
.END.       08 BYTES
```

3. Load program HOERL from the digital cassette drive and PACK.

```
HOERL
                READP
               GTO ..
PACKING
```

4. Get program HPPLOT from extended memory, using the GETP command:

```
HPPLOT
                GETP
```

5. The HP41CX configuration should now be as follows:

```
          CAT 1
LBL'U80
LBL'U81
LBL'U82
LBL'U83
LBL'U84
END          188 BYTES
LBL'HOERL
END          54 BYTES
LBL'HPPLOT
.END.        1263 BYTES
```

```
                    CAT 4
GRAT    P083
TICK    P078
PLTLBL  P100
HPPLOT  P181
     150.0000000    ***
```

6. Run HPPLOT. LABEL A can be used to start HPPLOT. HPPLOT will automatically call GRAT, TICK, and PLTLBL from extended memory if flag 01 is SET, or if a "yes" response is made to the "XEQ GRAT?" prompt. See detailed examples.

7. Use LABELS C and B of PLTLBL to manually place "X" symbols and additional text on the completed graph.

Program listing for the called function "HOERL":

```
 01◆LBL "HOE
RL"
 02 ENTER↑
 03 X=0?
 04 RTN
 05 1.000135
259
 06 X<>Y
 07 Y↑X
 08 X<>Y
 09 4.850058
 E-1
 10 Y↑X
 11 *
 12 6.818418
 E-2
 13 *
 14 END
```

```
                XEQ A        Use LABEL A of HPPLOT to start the plotting
SET FLAGS                    process
                CF 00
                SF 01        FC00: vertically-oriented plot
                CF 02        FS01: auto execution of GRAT/TICK/PLTLBL
                CF 03        FC02: full-length minor graticules
                CF 04        FC03: linear X
                SF 08        FC04: linear Y
                  RUN        FS08: print tabulation of (X,Y) values
FUNCTION?
HOERL             RUN
X MIN?
        0.00000   RUN
X MAX?
      700.00000   RUN
DELTA X?
        5.00000   RUN
GRAT DLTA X?
      100.00000   RUN
NMBR TICKS?
        5.00000   RUN
Y MIN?
        0.00000   RUN
Y MAX?
        2.00000   RUN
GRAT DLTA Y?
         .50000   RUN
NMBR TICKS?
        5.00000   RUN        Any non-zero entry interpreted as "yes"
FRAME?                       hitting "R/S" interpreted as "no"
        3.00000   RUN
DIGITIZE?                    This prompt selects the pen for framing the
                  RUN        plot; the "R/S" results in the default pen
PEN?                         1 selection
                  RUN
PEN?                         This prompt selects the pen for plotting
                  RUN
                0.00000      first X value
                0.00000      first f(X), or Y, value
                5.00000      next X value
                0.14893      next Y value
               10.00000
                0.20858
               15.00000
                0.25408
               20.00000
                0.29232
               25.00000
                0.32596
               30.00000
                0.35633
               35.00000
                0.38426
               40.00000
                0.41024
               45.00000
                0.43465
               50.00000
                0.45775
```

```
                55.00000
                 0.47973
                60.00000
                 0.50075
                65.00000
                 0.52092

Intermediate values
not shown for brevity

               670.00000
                 1.75267
               675.00000
                 1.76019
               680.00000
                 1.76770
               685.00000
                 1.77519
               690.00000
                 1.78267
               695.00000
                 1.79014
               700.00000
                 1.79759
```

GRAT has been automatically called from extended memory, overwriting HPPLOT. GRAT has drawn and labeled the major graticules. TICK was next automatically called from extended memory, overwriting GRAT. TICK drew the minor graticules. PLTLBL was then automatically called from extended memory, overwriting TICK. Because no LABELS file was found, PLTLBL defaulted to the text editor mode. The text editor was used to create text lines 00, 01, and 02. Program execution was resumed by exiting the text editor mode and seeing the "RVW TITLES?" prompt. A "yes" response caused printing of the three text lines for review. A "yes" response to the "OK?" prompt then caused PLTLBL to label the plot. After labeling the title, X-axis, and Y-axis, execution jumps to LABEL E, which secures the pen and prints "DONE". LABEL C is now used to manually plot "X" symbols representing the manufacturer's published attenuation versus frequency data.

```
RVW TITLES?
          3.00000    RUN
HOERL FUNCTION CURVE FIT
  TIMES FIBER TX565 CABL
E
FREQUENCY, MHZ
ATTENUATION, dB/100 FT
OK?
          3.00000    RUN
DONE
                   XEQ C
PEN?
                      RUN
X, ENTR, Y
             5.000 ENTER↑
              .150    RUN
X, ENTR, Y
            30.000 ENTER↑
              .350    RUN
```

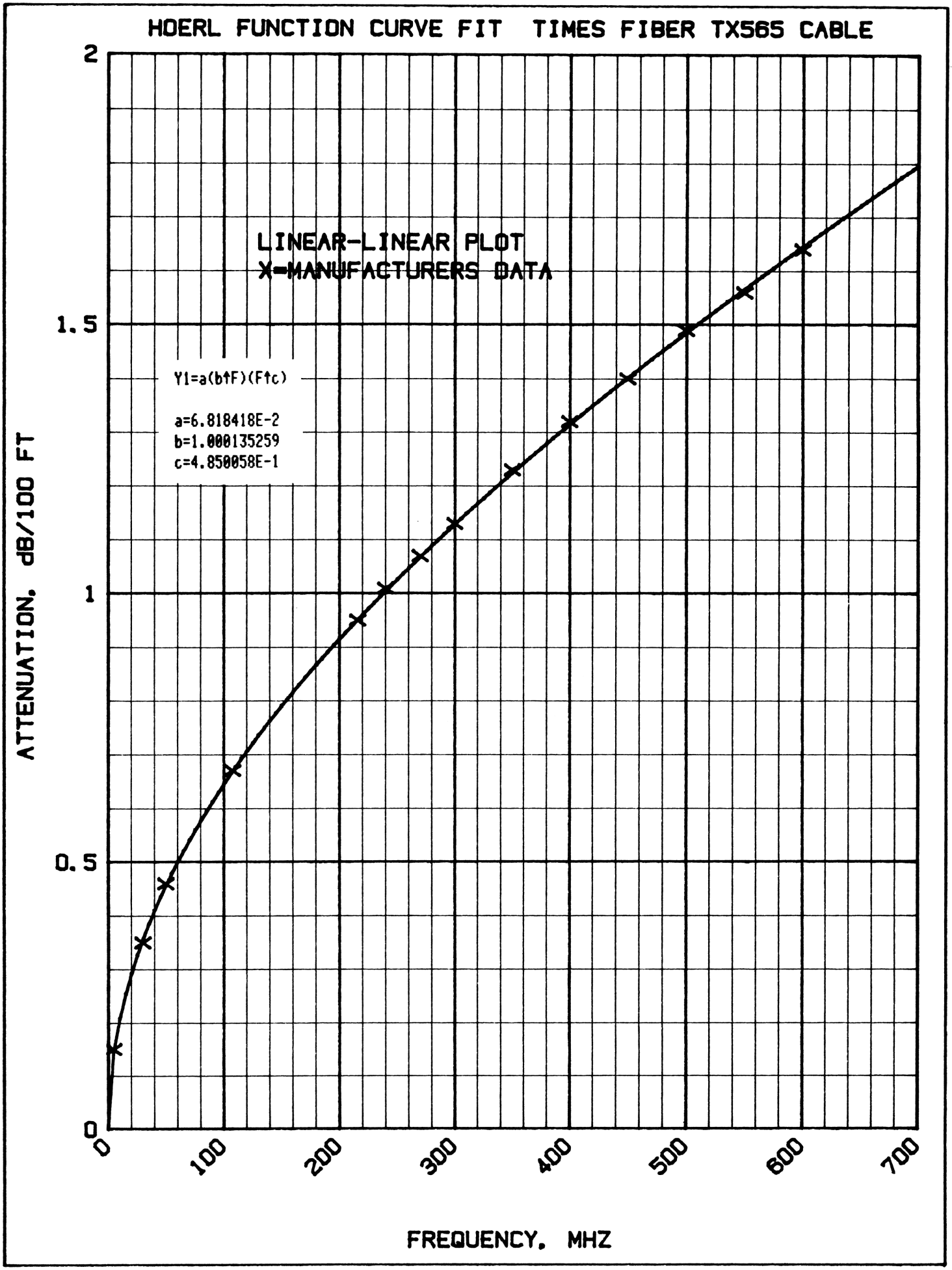
Default pen 1 selected

First X,Y pair

Second X,Y pair

```
X, ENTR, Y
          50.000 ENTER↑
            .460    RUN
X, ENTR, Y
         108.000 ENTER↑
            .670    RUN
X, ENTR, Y
         216.000 ENTER↑
            .950    RUN
X, ENTR, Y
         240.000 ENTER↑
           1.010    RUN
X, ENTR, Y
         270.000 ENTER↑
           1.070    RUN
X, ENTR, Y
         300.000 ENTER↑
           1.130    RUN
X, ENTR, Y
         350.000 ENTER↑
           1.230    RUN
X, ENTR, Y
         400.000 ENTER↑
           1.320    RUN
X, ENTR, Y
         450.000 ENTER↑
           1.400    RUN
X, ENTR, Y
         500.000 ENTER↑
           1.490    RUN
X, ENTR, Y
         550.000 ENTER↑
           1.560    RUN
X, ENTR, Y
         600.000 ENTER↑
           1.640    RUN
X, ENTR, Y
                  XEQ B
PEN?
                    RUN
SET FLAG 17?
                    RUN

LINEAR-LINEAR PLOT  RUN

X=MANUFACTURERS DATA RUN

                  XEQ E
DONE
```

Last X,Y pair. LABEL B is now called to print additional labels at user-specified locations. The default pen 1 was again selected, and the "R/S" response to the "SET FLAG 17?" prompt is interpreted as a "no". LABEL B prompts for the user to manually move the pen to the desired starting point, using the plotter's controls. Pressing the plotter's ENTER key causes the digitized point to be accepted and allows program operation to continue. Two lines of additional text are then entered (note that ALPHA mode is automatically set). To exit LABEL B, manually switch out of ALPHA mode and execute LABEL E. This once again secures the pen, prints "DONE", and stops program execution.


HOERL FUNCTION CURVE FIT TIMES FIBER TX565 CABLE
LINEAR-LINEAR PLOT
X=MANUFACTURERS DATA
Y1=a(btF)(Ftc)
a=6.818418E-2
b=1.000135259
c=4.850058E-1
ATTENUATION, dB/100 FT
FREQUENCY, MHZ
0
0.5
1
1.5
2
0
100
200
300
400
500
600
700

CURVEPLOT

```
                    RUN
SET FLAGS
                  SF 00
                  SF 01
                  SF 02
                  CF 03
                  SF 04
                  CF 08
                    RUN
FUNCTION?
HOERL               RUN
X MIN?
         0.00000    RUN
X MAX?
       700.00000    RUN
DELTA X?
         5.00000    RUN
GRAT DLTA X?
       100.00000    RUN
NMBR TICKS?
         5.00000    RUN
Y MIN?
          .10000    RUN
Y MAX?
         2.00000    RUN
FRAME?
         3.00000    RUN
DIGITIZE?
                    RUN
PEN?
                    RUN
PEN?
                    RUN
DONE
```

Re-plot function in linear-log mode. Hitting the R/S key causes PLTLBL to call HPPLOT from extended memory, overwriting PLTLBL.

FS00: horizontally-oriented plot requested
FS01: auto execution of GRAT/TICK/PLTLBL
FS02: short minor graticules
FC03: linear X
FS04: logarithmic Y
FC08: no X,Y tabulations

Note that there are no prompts for "GRAT DELTA Y?" and "NMBR TICKS?" if logarithmic mode selected for Y.

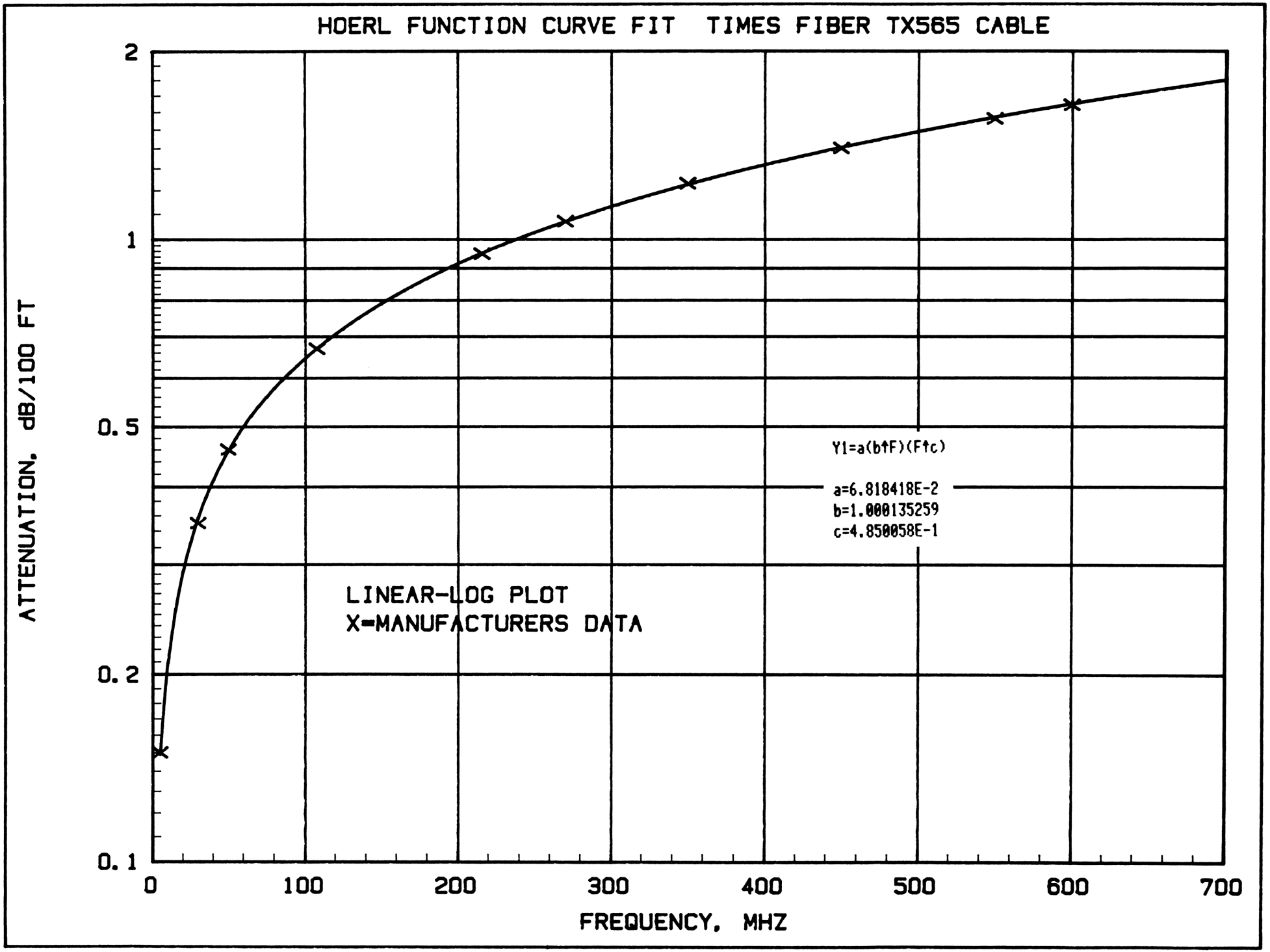
Default pen 1 selected for framing
Default pen 1 selected for plotting

The function has been plotted; GRAT has automatically been called and executed; TICK has automatically been called and executed; and PLTLBL has been automatically called and executed. Since an existing LABELS text file was found, program execution did not terminate until a complete graph had been drawn. Now use LABEL C to once again plot the input points.

```
                  XEQ C
PEN?
                    RUN
X, ENTR, Y
           5.000 ENTER↑
            .150    RUN
X, ENTR, Y
          30.000 ENTER↑
            .350    RUN
X, ENTR, Y
          50.000 ENTER↑
            .460    RUN
X, ENTR, Y
         108.000 ENTER↑
            .670    RUN
X, ENTR, Y
         216.000 ENTER↑
            .950    RUN
X, ENTR, Y
         270.000 ENTER↑
           1.070    RUN
```

```
X, ENTR, Y
          350.000 ENTER↑
            1.230    RUN
X, ENTR, Y
          450.000 ENTER↑
            1.400    RUN
X, ENTR, Y
          550.000 ENTER↑
            1.560    RUN
X, ENTR, Y
          600.000 ENTER↑
            1.640    RUN
X, ENTR, Y
                  XEQ B
PEN?
                    RUN
SET FLAG 17?
                    RUN

LINEAR-LOG PLOT     RUN

X=MANUFACTURERS DATA RUN

                  XEQ E
DONE
```

Use LABEL B to print additional text at a starting point determined by the user. To exit the loop, manually switch out of ALPHA mode and execute LABEL E.



CURVEPLOT EXAMPLE 1 PAGE 68

```
                    RUN
SET FLAGS
                  CF 00
                  CF 01
                  CF 02
                  SF 03
                  CF 04
                  CF 08
                    RUN
FUNCTION?
HOERL               RUN
X MIN?
         5.00000    RUN
X MAX?
       700.00000    RUN
Y MIN?
         0.00000    RUN
Y MAX?
         2.00000    RUN
GRAT DLTA Y?
          .50000    RUN
NMBR TICKS?
         5.00000    RUN
FRAME?
         3.00000    RUN
DIGITIZE?
                    RUN
PEN?
                    RUN
PEN?
                    RUN
XEQ GRAT?
         3.00000    RUN
PEN?
                    RUN
MAX FIX?
                    RUN
XEQ TICK?
         3.00000    RUN
PEN?
         2.00000    RUN
LABEL?
         3.00000    RUN
EDIT FILE?
                    RUN
RVW TITLES?
         3.00000    RUN
HOERL FUNCTION CURVE FIT
  TIMES FIBER TX565 CABL
E
FREQUENCY, MHZ
ATTENUATION, dB/100 FT
OK?
         3.00000    RUN
PEN?
                    RUN
DONE
```

Re-plot the function in log-linear mode. Hit "R/S" to cause PLTLBL to restore HPPLOT to RAM.

FC00: vertically-oriented plot
FC01: no auto execution of GRAT/TICK/PLTLBL
FC02: full-length minor graticules
FS03: logarithmic X
FC04: linear Y
FC08: no X,Y tabulations

Note that there are no prompts for "DELTA X?", "GRAT DLTA X?", or "NMBR TICKS?" for the logarithmic X case.

Since flag 01 is CLEAR, HPPLOT prompts "XEQ GRAT?". Any non-zero response is interpreted as "yes".

GRAT now prompts for a pen selection, since flag 01 is CLEAR. The default pen 1 is selected by hitting "R/S".

GRAT next prompts "MAX FIX?", since flag 01 is CLEAR. The default MAX FIX of 3 is selected by hitting "R/S".

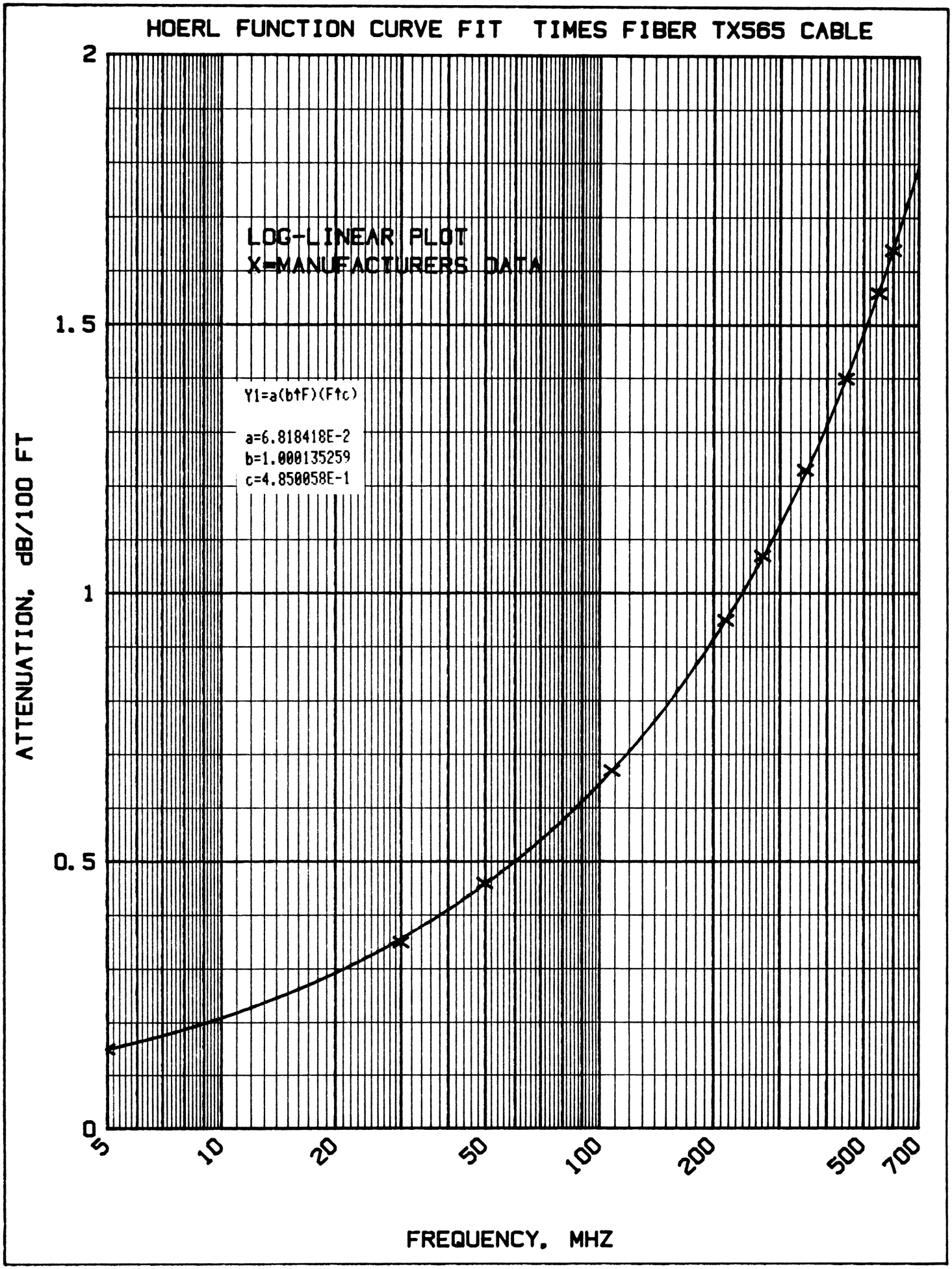
Since flag 01 is CLEAR, GRAT prompts whether TICK should be executed. Any non-zero response is interpreted as "yes".

TICK has called PLTLBL, overwriting itself. PLTLBL now prompts "EDIT FILE?", since flag 01 is CLEAR. A "no" response is made. PLTLBL next prompts "RVW TITLES?" A "yes" response is made, causing a print out of the LABELS text. A "yes" response to the "OK?" prompt allows actual labeling. Since flag 01 is CLEAR, PLTLBL first prompts for a pen selection rather than automatically using pen 1.

```
                XEQ C
PEN?
                  RUN
X, ENTR, Y
          5.000 ENTER↑
           .150   RUN
X, ENTR, Y
         30.000 ENTER↑
           .350   RUN
X, ENTR, Y
         50.000 ENTER↑
           .460   RUN
X, ENTR, Y
        100.000 ENTER↑
           .670   RUN
X, ENTR, Y
        216.000 ENTER↑
           .950   RUN
X, ENTR, Y
        270.000 ENTER↑
          1.070   RUN
X, ENTR, Y
        350.000 ENTER↑
          1.230   RUN
X, ENTR, Y
        450.000 ENTER↑
          1.400   RUN
X, ENTR, Y
        550.000 ENTER↑
          1.560   RUN
X, ENTR, Y
        600.000 ENTER↑
          1.640   RUN
X, ENTR, Y
                XEQ B
PEN?
                  RUN
SET FLAG 17?
                  RUN

LOG-LINEAR PLOT   RUN

X=MANUFACTURERS DATA RUN

                XEQ E
DONE
```

LABEL C of PLTLBL is now used to plot "X" symbols at the manufacturer's data points

LABEL E is used to exit the loop and park the pen in its stall


HOERL FUNCTION CURVE FIT TIMES FIBER TX565 CABLE
LOG-LINEAR PLOT
X=MANUFACTURERS DATA
Y1=a(btF)(Ftc)
a=6.818418E-2
b=1.000135259
c=4.850058E-1
ATTENUATION, dB/100 FT
2
1.5
1
0.5
0
5
10
20
50
100
200
500
700
FREQUENCY, MHZ

```
                    RUN
SET FLAGS
                  SF 00
                  SF 01
                  CF 02
                  SF 03
                  SF 04
                  CF 08
                    RUN
FUNCTION?
HOERL               RUN
X MIN?
          5.00000   RUN
X MAX?
        700.00000   RUN
Y MIN?
           .10000   RUN
Y MAX?
          2.00000   RUN
FRAME?
          3.00000   RUN
DIGITIZE?
                    RUN
PEN?
                    RUN
PEN?
                    RUN
DONE
                  XEQ C
PEN?
                    RUN
X, ENTR, Y
            5.000 ENTER↑
             .150   RUN
X, ENTR, Y
           30.000 ENTER↑
             .350   RUN
X, ENTR, Y
           50.000 ENTER↑
             .460   RUN
X, ENTR, Y
          108.000 ENTER↑
             .670   RUN
X, ENTR, Y
          216.000 ENTER↑
             .950   RUN
X, ENTR, Y
          270.000 ENTER↑
            1.070   RUN
X, ENTR, Y
          350.000 ENTER↑
            1.230   RUN
X, ENTR, Y
          450.000 ENTER↑
            1.400   RUN
```

Re-plot the function in log-log mode.

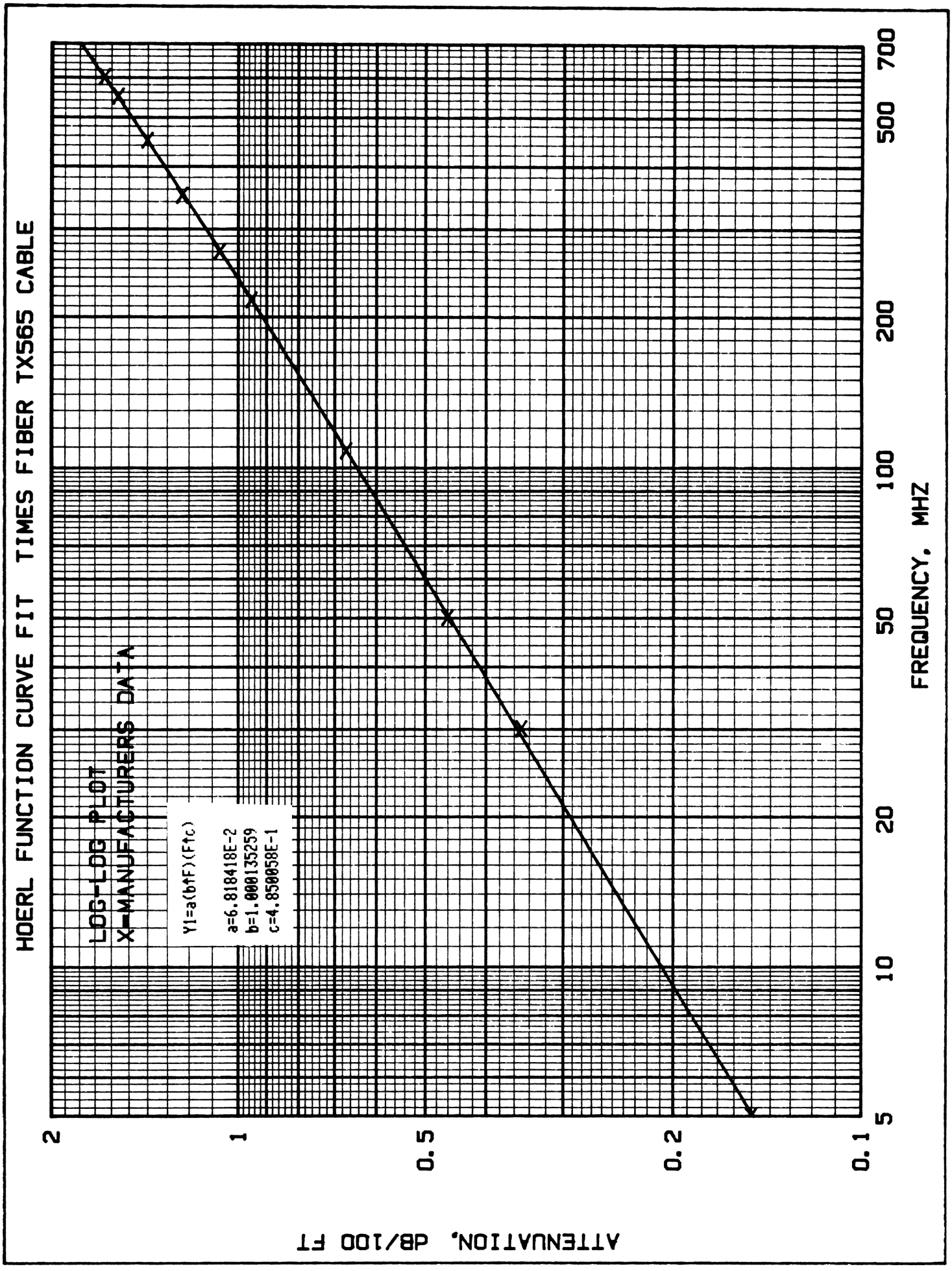
FS00: horizontally-oriented plot
FS01: auto execution of GRAT/TICK/PLTLBL
FC02: full-length minor graticules
FS03: logarithmic X
FS04: logarithmic Y
FC08: no X,Y tabulations

Note the lack of prompts for "DELTA X?", "GRAT DLTA X?", "NMBR TICKS?", "GRAT DLTA Y?", and "NMBR TICKS?", in the log-log mode.

The function has been plotted; GRAT has been automatically called and executed; TICK has been automatically called and executed; and PLTLBL has automatically labeled the plot. The HP41CX has printed "DONE" and program execution has stopped. Now use LABEL C to plot "X" symbols at user-specified points. Next, use LABEL B to label additional text at user-specified locations.

```
X, ENTR, Y
          550.000 ENTER↑
            1.560    RUN
X, ENTR, Y
          600.000 ENTER↑
            1.640    RUN
X, ENTR, Y
                   XEQ B
PEN?
                     RUN
SET FLAG 17?
                     RUN

LOG-LOG PLOT         RUN

X=MANUFACTURERS DATA RUN

                   XEQ E
DONE
```

Manually switch out of ALPHA mode to exit the loop. Use LABEL E to secure the pen and stop program execution.


HOERL FUNCTION CURVE FIT TIMES FIBER TX565 CABLE
LOG-LOG PLOT
X=MANUFACTURERS DATA
Y1=a(btF)(Ftc)
a=6.818418E-2
b=1.000135259
c=4.850058E-1
ATTENUATION, dB/100 FT
FREQUENCY, MHZ
2
1
0.5
0.2
0.1
5
10
20
50
100
200
500
700

EXAMPLE II

Example II demonstrates using the MCFA, MCFB, MCFC, EDTDAT, and PLTPRP programs to model the attenuation of a rigid 3 1/8 inch coaxial line, as a function of frequency. Programs HPPLOT, GRAT, TICK, and U80 were then used to plot the resulting curves.

Twenty input values were used. MCFB was initially run with RR = 0, to force all twenty curves to be fitted. All twenty curves were then plotted, for demonstration purposes. Normally, curves with low RR's would not be of interest.

Program HPPLOT was run with flag 00 SET, so a tabulation of the (X,Y) values was generated. Because flag 09 was SET, the program prompted for pen selection between curves. This allowed changing pen colors. Program EDTDAT was then used to edit the CRVDAT file to only curves with RR's of 0.99 or better (curves 3, 7, 9, 12, 13, 14, and 17).

The seven curves with RR's of 0.99 or better were again plotted. Flag 00 was CLEAR, so no tabulation of the (X,Y) values was generated. As can be seen, it is difficult to distinguish between the curves, as they all closely match the data. HPPLOT was then re-run, but with flag 05 SET. This resulted in plotting the percent errors of f(x) for the seven curves, rather than f(x). This makes it much easier to select the best fitting curve. Since flag 00 had been re-SET, a tabulation of the percent errors was printed.

STEP BY STEP INSTRUCTIONS FOR EXAMPLE II

1. Connect a HP41CX with two extended memory modules, a 82184 plotter module, and an HP-IL module, to the digital cassette drive, printer, and 7470A plotter.

2. Set SIZE to 069. Load program MCFA from digital cassette drive into RAM. Do not PACK.

3. Run MCFA. MCFA will automatically call MCFB from the digital cassette drive when data entry is terminated by executing LABEL E.

4. Run MCFB. Upon completion, MCFB will prompt XEQ EDTDAT? Respond to the prompt by entering any non-zero number if EDTDAT is desired. Respond by a zero or no entry if plotting is desired, in which case shell program PLTPRP will be called from the digital cassette drive. PLTPRP will load and pack programs U80 and MCFC into RAM. Programs GRAT, TICK, and HPPLOT will then be loaded from the digital cassette drive and placed into extended memory. Program HPPLOT will also be left in RAM, but not packed.

5. Execute HPPLOT, GRAT, TICK, and PLTLBL.

6. If using MCFC to plot curve fits, and after plotting all curves in the CRVDAT file, if it is desired to edit the CRVDAT file to remove one or more curves, call EDTDAT from the digital cassette drive. It may be necessary to temporarily delete HPPLOT and MCFC from RAM, to accomodate up to SIZE 081 required by EDTDAT.

8. After using EDTDAT to edit the CRVDAT data file, re-load program MCFC back into RAM (if necessary) and PACK. Then re-load HPPLOT into RAM, but do not PACK.

```
MCFA
              READP
              XEQ A
```

Be sure calculator is in USER mode. Use LABEL A to intialize MCFA and start the data entry process.

```
     55.25000000 ENTER↑
      .072000000    RUN

X1=55.25000
Y1=0.07200
        61.25000 ENTER↑
          .07600    RUN

X2=61.25000
Y2=0.07600
        67.25000 ENTER↑
          .08000    RUN

X3=67.25000
Y3=0.08000
```

Enter each (X,Y) pair by keying X, ENTER, Y, R/S

```
        77.25000 ENTER↑
          .08600    RUN

X4=77.25000
Y4=0.08600
        83.25000 ENTER↑
          .08900    RUN

X5=83.25000
Y5=0.08900
       175.25000 ENTER↑
          .13000    RUN

X6=175.25000
Y6=0.13000
       181.25000 ENTER↑
          .13200    RUN

X7=181.25000
Y7=0.13200
       187.25000 ENTER↑
          .13400    RUN

X8=187.25000
Y8=0.13400
       193.25000 ENTER↑
          .13600    RUN

X9=193.25000
Y9=0.13600
       193.25000 ENTER↑
          .13600    RUN

X10=193.25000
Y10=0.13600
                 XEQ a

POINT DLTD

       199.25000 ENTER↑
          .13800    RUN

X10=199.25000
Y10=0.13800
       205.25000 ENTER↑
          .14100    RUN

X11=205.25000
Y11=0.14100
       211.25000 ENTER↑
          .14300    RUN

X12=211.25000
Y12=0.14300
       471.25000 ENTER↑
          .22300    RUN

X13=471.25000
Y13=0.22300
```

Oops! The (193.25, 0.126) X,Y pair got entered twice. Use LABEL a to correct this erroneous X,Y pair.

```
       501.25000 ENTER↑
          .23300    RUN

X14=501.25000
Y14=0.23300
       549.25000 ENTER↑
          .24500    RUN

X15=549.25000
Y15=0.24500
       603.25000 ENTER↑
          .25800    RUN

X16=603.25000
Y16=0.25800
       651.25000 ENTER↑
          .27000    RUN

X17=651.25000
Y17=0.27000
       699.25000 ENTER↑
          .28200    RUN

X18=699.25000
Y18=0.28200
       753.25000 ENTER↑
          .29500    RUN

X19=753.25000
Y19=0.29500
       801.25000 ENTER↑
          .30300    RUN

X20=801.25000
Y20=0.30300
```

```
XEQ E
```

The last X,Y pair has been entered. A data file has been created in extended memory, called XYDAT, containing all of the input X,Y pairs. Use LABEL E to terminate data entry and to automatically call MCFB from a digital cassette drive.

This is the calculator configuration at the end of the data entry process:

```
                    CAT 1
LBL'MCFA
.END.       546 BYTES
                    CAT 4
XYDAT   D040
        558.00000    ***
```

```
AUTO SELECT?
        3.00000    RUN
MIN RR?
        0.00000    RUN

CURVE 1
Y=a+bX
a= 6.939097527E-2
b= 3.089312472E-4
RR= 0.988

CURVE 2
Y=1/(a+bX)
a= 1.128205762E1
b= -1.206206565E-2
RR= 0.779

CURVE 3
Y=a+bX+c/X
a= 9.792448840E-2
b= 2.684099087E-4
c= -2.408700482E0
RR= 0.999

CURVE 4
Y=a+b/X
a= 2.508498814E-1
b= -1.253303923E1
RR= 0.711

CURVE 5
Y=X/(aX+b)
a= 3.313634080E0
b= 6.321231453E2
RR= 0.966

CURVE 6
Y=a+b/X+c/X↑2
a= 3.233222928E-1
b= -4.234186202E1
c= 1.672467573E3
RR= 0.938

CURVE 7
Y=a+bX+cX↑2
a= 5.222846065E-2
b= 4.567985871E-4
c= -1.836098515E-7
RR= 0.999

CURVE 8
Y=1/[c+a(X+b)↑2]
a= 3.143521346E-5
b= -5.945231806E2
c= 3.109371100E0
RR= 0.933
```

"AUTO SELECT?" prompt of MCFB. Any non-zero response interpreted as "yes". Auto select mode causes all 20 curve types to be tested.

"MIN RR?" prompt asks for a user-specified minimum acceptable adjusted coefficient of determination. If all 20 curves are desired, set the minimum RR to zero.

CURVE #1 LINEAR

CURVE #2 RECIPROCAL

CURVE #3 LINEAR-HYPERBOLIC

CURVE #4 HYPERBOLA

CURVE #5 RECIPROCAL HYPERBOLA

CURVE #6 SECOND ORDER HYPERBOLA

CURVE #7 PARABOLA

CURVE #8 CAUCHY DISTRIBUTION

CURVE 9
Y=aX↑b
a= 8.133623018E-3
b= 5.391798549E-1
RR= 0.999

CURVE #9 POWER

CURVE 10
Y=aX↑(bX)
a= 9.070554365E-2
b= 2.613076528E-4
RR= 0.895

CURVE #10 SUPER GEOMETRIC

CURVE 11
Y=aX↑(b/X)
a= 2.968836072E-1
b= -2.211512957E1
RR= 0.908

CURVE #11 MODIFIED GEOMETRIC

CURVE 12
Y=a(b↑X)(X↑c)
a= 1.004054634E-2
b= 1.000183961E0
c= 4.893460637E-1
RR= 1.000

CURVE #12 HOERL FUNCTION

CURVE 13
Y=a(b↑1/X)(X↑c)
a= 6.067082300E-3
b= 2.668880481E3
c= 5.838595928E-1
RR= 1.000

CURVE #13 MODIFIED HOERL

CURVE 14
Y=aEXP[(1/c)(b-LNX)↑2]
a= 5.808629537E-3
b= -6.574794796E0
c= 4.439131158E1
RR= 1.000

CURVE #14 LOG-NORMAL

CURVE 15
Y=a+bLNX
a= -2.997727657E-1
b= 8.651553396E-2
RR= 0.953

CURVE #15 LOGARITHMIC

CURVE 16
Y=1/(a+bLNX)
a= 2.807267039E1
b= -3.812624693E0
RR= 0.971

CURVE #16 RECIPROCAL
LOGARITHMIC

CURVE 17
Y=a+bSQRT(X)+cX
a= 7.258629105E-3
b= 8.134759245E-3
c= 8.438498364E-5
RR= 1.000

CURVE #17 COAX FUNCTION

CURVE 18
Y=abtX
a= 8.417765593E-2
b= 1.001819250E0
RR= 0.917

CURVE #18 MODIFIED POWER

CURVE 19
Y=abt(1/X)
a= 2.600179640E-1
b= 5.624740371E-37
RR= 0.859

CURVE #19 ROOT

CURVE 20
Y=aEXP[(1/c)(X-b)t2]
a= 2.843586757E-1
b= 7.212767988E2
c= -3.505833247E5
RR= 0.983

CURVE #20 NORMAL DISTRIBUTION

XEQ EDTDAT?

RUN

SET FLAGS

The coefficients for all curves meeting the user-specified RR have now been printed. A data file has been created in extended memory, called CRVDAT, containing the curve number, adjusted RR, and coefficients a, b, and c, for each curve fitted.

```
                    CAT 1                          CAT 4
   LBL'MCFB                          XYDAT   D040
                                     CRVDAT  D080
   .END.      1491 BYTES                    476.000    ***
```

MCFB now prompts "XEQ EDTDAT?" The "R/S" response is interpreted as "no", causing program PLTPRP to be called from digital cassette drive. PLTPRP takes several minutes to run, as it calls U80, HPPLOT, GRAT, TICK, PLTLBL, and MCFC from digital cassette and places these programs in RAM and extended memory, as appropriate. The calculator configuration at the completion of PLTPRP is as follows:

```
                    CAT 1                          CAT 4
   LBL'U80                           XYDAT   D040
   LBL'U81                           CRVDAT  D080
   LBL'U82                           GRAT    P083
   LBL'U83                           TICK    P078
   LBL'U84                           PLTLBL  P100
   END        188 BYTES              HPPLOT  P181
   LBL'MCFC                                26.0000    ***
   END        289 BYTES
   LBL'HPPLOT
   .END.      1266 BYTES
```

```
                  XEQ A
SET FLAGS
                  SF 00
                  SF 01
                  CF 02
                  SF 03
                  CF 04
                  CF 05
                  SF 08
                  CF 09
                    RUN
FUNCTION?
MCFC              RUN
X MIN?
        50.00000  RUN
X MAX?
       850.00000  RUN
Y MIN?
         0.00000  RUN
Y MAX?
          .35000  RUN
GRAT DLTA Y?
          .05000  RUN
NMBR TICKS?
         5.00000  RUN
FRAME?
         3.00000  RUN
DIGITIZE?
                  RUN
PEN?
                  RUN
PEN?
         2.00000  RUN
LINE TYPE?
                  RUN
PLOT PTS?
         3.00000  RUN
              55.25000
               0.07200

              61.25000
               0.07600

              67.25000
               0.08000

              77.25000
               0.08600


Intermediate values
not shown for brevity

             753.25000
               0.29500

             801.25000
               0.30300
```

LABEL A of HPPLOT is used to start the plotting process.

FS00: horizontally-oriented plot
FS01: auto execution of GRAT/TICK/PLTLBL
FC02: full length minor graticules
FS03: logarithmic X
FC04: linear Y
FC05: plot f(x), not percent error of f(x)
FS08: print (X,Y) values
FC09: no pen prompts between curves

Specifying MCFC as the called function causes flag 06 to be SET and invokes special subroutines in HPPLOT to cause automatic plotting of "X" symbols for each point in the XYDAT file, and causes the plotting of each curve type found in the CRVDAT file.

This pen prompt selects the pen used for framing the plot.

This pen prompt selects the pen used to plot the octagon-bracketed X's

Since the called function is MCFC, HPPLOT prompts "PLOT PTS?". Any non-zero response is interpreted as "yes".

First (X,Y) pair

Second (X,Y) pair

The twenty input pairs have now been plotted, as the first "curve". An "X" symbol has been drawn for each input pair. MCFC will next proceed to plot all of the curves in the CRVDAT file.

CURVE 1

50.00000
0.084837538
55.00000000
0.086382194
60.00000000
0.087926850
65.00000000
0.089471506
70.00000000
0.091016163
75.00000000
0.092560819

Intermediate values
not shown for brevity

800.0000000
0.316535973
850.0000000
0.331982535

CURVE 2

50.00000
0.093642127
55.00000000
0.094173983
60.00000000
0.094711915
65.00000000
0.095256027
70.00000000
0.095806428
75.00000000
0.096363226

Intermediate values
not shown for brevity

800.0000000
0.612593038
850.0000000
0.971532334

CURVE 3

50.00000
0.063170974
55.00000000
0.068892479
60.00000000
0.073884075
65.00000000
0.078314202
70.00000000
0.082303175
75.00000000
0.085939225

Intermediate values
not shown for brevity

800.0000000
0.309641540
850.0000000
0.323239146

CURVE 4

50.00000
0.000189097
55.00000000
0.022976441
60.00000000
0.041965894
65.00000000
0.058033893
70.00000000
0.071806464
75.00000000
0.083742692

Intermediate values
not shown for brevity

800.0000000
0.235183582
850.0000000
0.236105129

CURVE 5

50.00000
0.062671968
55.00000000
0.067536619
60.00000000
0.072207276
65.00000000
0.076695318
70.00000000
0.081011249
75.00000000
0.085164783

Intermediate values
not shown for brevity

800.0000000
0.243677304
850.0000000
0.246468819

CURVE 6

50.00000
0.145472082
55.00000000
0.106352098
60.00000000
0.082198918
65.00000000
0.067759344
70.00000000
0.059758463
75.00000000
0.056091701

Intermediate values
not shown for brevity

800.0000000
0.273008196
850.0000000
0.275823172

CURVE 7

50.00000
0.074609365
55.00000000
0.076796963
60.00000000
0.078975380
65.00000000
0.081144617
70.00000000
0.083304673
75.00000000
0.085455549

Intermediate values
not shown for brevity

800.0000000
0.300157025
850.0000000
0.307849142

CURVE 8

50.00000
0.080449975
55.00000000
0.081568075
60.00000000
0.082706938
65.00000000
0.083866997
70.00000000
0.085048690
75.00000000
0.086252465

Intermediate values
not shown for brevity

800.0000000
0.225398409
850.0000000
0.193757244

CURVE 9

50.00000
0.067040067
55.00000000
0.070575269
60.00000000
0.073965189
65.00000000
0.077227220
70.00000000
0.080375508
75.00000000
0.083421751

Intermediate values
not shown for brevity

800.0000000
0.298931497
850.0000000
0.308864298

CURVE 10

50.00000
0.095462219
55.00000000
0.096082918
60.00000000
0.096719157
65.00000000
0.097370222
70.00000000
0.098035531
75.00000000
0.098714607

Intermediate values
not shown for brevity

800.0000000
0.366871128
850.0000000
0.405780784

CURVE 11

50.00000
0.052617157
55.00000000
0.059264975
60.00000000
0.065642553
65.00000000
0.071742036
70.00000000
0.077564610
75.00000000
0.083117011

Intermediate values
not shown for brevity

800.0000000
0.246793351
850.0000000
0.249097394

CURVE 12

50.00000
0.068728351
55.00000000
0.072076004
60.00000000
0.075280382
65.00000000
0.078359552
70.00000000
0.081328136
75.00000000
0.084198167

Intermediate values
not shown for brevity

800.0000000
0.306395034
850.0000000
0.318537069

CURVE 13

50.00000
0.069737505
55.00000000
0.072678211
60.00000000
0.075557232
65.00000000
0.078375351
70.00000000
0.081134513
75.00000000
0.083837203

Intermediate values
not shown for brevity

800.0000000
0.303570618
850.0000000
0.314325925

CURVE 14

50.00000
0.069179643
55.00000000
0.072380913
60.00000000
0.075459586
65.00000000
0.078430820
70.00000000
0.081306876
75.00000000
0.084097840

Intermediate values
not shown for brevity

800.0000000
0.304858057
850.0000000
0.316127454

CURVE 15

50.00000
0.038677993
55.00000000
0.046923805
60.00000000
0.054451640
65.00000000
0.061376578
70.00000000
0.067788069
75.00000000
0.073757024

Intermediate values
not shown for brevity

800.0000000
0.278549987
850.0000000
0.283794959

CURVE 16

50.00000
0.076001732
55.00000000
0.078160337
60.00000000
0.080240908
65.00000000
0.082255117
70.00000000
0.084212281
75.00000000
0.086119970

Intermediate values
not shown for brevity

800.0000000
0.386584789
850.0000000
0.424517457

CURVE 17

50.00000
0.068999313
55.00000000
0.072228792
60.00000000
0.075333302
65.00000000
0.078328179
70.00000000
0.081225857
75.00000000
0.084036584

Intermediate values
not shown for brevity

800.0000000
0.304852353
850.0000000
0.316152814

CURVE 18

50.00000
0.092186101
55.00000000
0.093027706
60.00000000
0.093876994
65.00000000
0.094734035
70.00000000
0.095598900
75.00000000
0.096471662

Intermediate values
not shown for brevity

800.0000000
0.360325306
850.0000000
0.394605729

CURVE 19

50.00000
0.048978491
55.00000000
0.057005178
60.00000000
0.064690185
65.00000000
0.071996705
70.00000000
0.078912840
75.00000000
0.085441996

Intermediate values
not shown for brevity

800.0000000
0.234256139
850.0000000
0.235698281

CURVE 20

50.00000
0.078642649
55.00000000
0.080157245
60.00000000
0.081689360
65.00000000
0.083238888
70.00000000
0.084805712
75.00000000
0.086389707

Intermediate values
not shown for brevity

800.0000000
0.279376170
850.0000000
0.271231652

All done plotting the twenty curve types. Since flag 01 is SET, HPPLOT automatically called GRAT from extended memory, overwriting itself. GRAT, in turn, automatically called TICK, and TICK automatically called PLTLBL. Because no LABELS text file existed in extended memory, PLTLBL created a LABELS ASCII file and entered the text editor mode. The text editor was then used to create lines 00, 01, and 02. After manually exiting the text editor mode, program execution resumed with the "RVW TITLES?" prompt.

```
                    RUN
RVW TITLES?
          3.00000   RUN
DIELECTRIC DC-375 3 1/8
IN RIGID LINE
FREQUENCY, MHZ
ATTENUATION, dB/100 FT
OK?
          3.00000   RUN
DONE
                  XEQ B
PEN?
                    RUN
SET FLAG 17?
            3.000   RUN

CURVE FIT TO ALL 20 CURV
                    RUN

ES                  RUN

                  XEQ E
DONE
```

Finding the labels acceptable, a "yes" response was given to the "OK?" prompt. PLTLBL then labeled the title, X-axis, and Y-axis.

PLTLBL prints "DONE" after labeling. LABEL B was then used to print additional text onto the plot. To exit this subroutine, manually switch out of ALPHA mode and execute LABEL E.

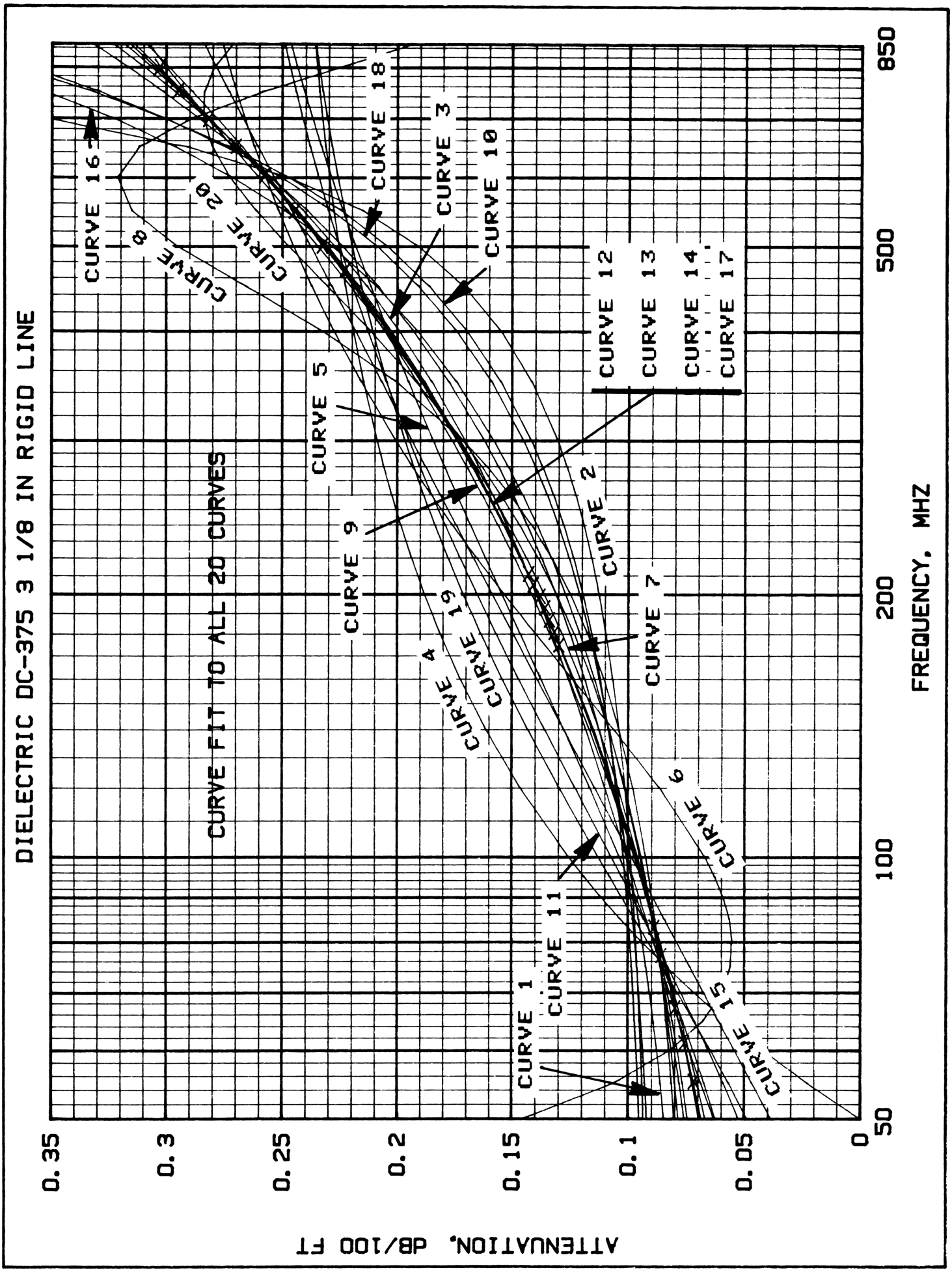
This is the calculator configuration at the completion of the 20-curve plot:

CAT 1

```
LBL'U80
LBL'U81
LBL'U82
LBL'U83
LBL'U84
END          188 BYTES
LBL'MCFC
END          289 BYTES
LBL'PLTLBL
.END.        699 BYTES
```

CAT 4

```
XYDAT    D040
CRVDAT   D080
GRAT     P083
TICK     P078
PLTLBL   P100
HPPLOT   P181
LABELS   A022
             2.000   ***
```


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
CURVE FIT TO ALL 20 CURVES
ATTENUATION, dB/100 FT
FREQUENCY, MHZ
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
50
100
200
500
850
CURVE 1
CURVE 2
CURVE 3
CURVE 4
CURVE 5
CURVE 6
CURVE 7
CURVE 8
CURVE 9
CURVE 10
CURVE 11
CURVE 12
CURVE 13
CURVE 14
CURVE 15
CURVE 16
CURVE 17
CURVE 18
CURVE 19
CURVE 20

```
EDTDAT
                READP
                  RUN
CURVE?
     3.000000000  RUN
CURVE?
     7.000000000  RUN
CURVE?
     9.000000000  RUN
CURVE?
     12.00000000  RUN
CURVE?
     13.00000000  RUN
CURVE?
     14.00000000  RUN
CURVE?
     17.00000000  RUN
CURVE?
                XEQ E
```

Now, call EDTDAT from the digital cassette drive. Clear MCFC from RAM, if necessary. Use EDTDAT to edit the CRVDAT file to only those curves with RR's of 0.99 or better.

This is the calculator configuration as the start of EDTDAT:

```
                CAT 1                          CAT 4
LBL'U80                        XYDAT   D040
LBL'U81                        CRVDAT  D080
LBL'U82                        GRAT    P083
LBL'U83                        TICK    P078
LBL'U84                        PLTLBL  P100
END         188 BYTES          HPPLOT  P181
LBL'MCFC                       LABELS  A022
END         289 BYTES                2.000    ***
LBL'EDTDAT
.END.       174 BYTES
```

Use LABEL E to exit the curve prompt loop. The calculator configuration is now as follows:

```
                CAT 1
LBL'U80                                    CAT 4
LBL'U81
LBL'U82                        XYDAT   D040
LBL'U83                        GRAT    P083
LBL'U84                        TICK    P078
END         188 BYTES          PLTLBL  P100
LBL'MCFC                       HPPLOT  P181
END         289 BYTES          LABELS  A022
LBL'EDTDAT                     CRVDAT  D028
.END.       174 BYTES               54.00000000    ***
```

Note that the CRVDAT file has been reduced from 80 registers (20 curves) to 28 registers (7 curves).

```
HPPLOT
                GETP
```

Next, restore MCFC to RAM, if necessary, and PACK; then, call HPPLOT from extended memory, but do not PACK. The calculator configuration is now as follows:

```
                CAT 1
LBL'U80                                    CAT 4
LBL'U81
LBL'U82                        XYDAT   D040
LBL'U83                        GRAT    P083
LBL'U84                        TICK    P078
END         188 BYTES          PLTLBL  P100
LBL'MCFC                       HPPLOT  P181
END         289 BYTES          LABELS  A022
LBL'HPPLOT                     CRVDAT  D028
.END.       1266 BYTES              54.00000000    ***
```

	XEQ À	Execute HPPLOT, to plot the edited CRVDAT file.
SET FLAGS		
	SF 00	FS00: horizontally-oriented plot
	SF 01	FS01: auto execution of GRAT/TICK/PLTLBL
	CF 02	FC02: full length minor graticules
	SF 03	FS03: logarithmic X
	CF 04	FC04: linear Y
	CF 05	FC05: plot f(x), not percent errors of f(x)
	CF 08	FC08: no tabulation of (X,Y) values
	SF 09	FS09: pen prompts between curves
	RUN	
FUNCTION?		
MCFC	RUN	
X MIN?		
50.00000	RUN	
X MAX?		
850.00000	RUN	
Y MIN?		
0.00000	RUN	
Y MAX?		
.35000	RUN	
GRAT DLTA Y?		
.05000	RUN	
NMBR TICKS?		
5.00000	RUN	
FRAME?		
3.00000	RUN	
DIGITIZE?		
	RUN	
PEN?		This prompt selects the pen for framing the plot
	RUN	
PEN?		Select pen for plotting the "X" symbols
	RUN	
LINE TYPE?		
	RUN	
PLOT PTS?		
3.00000	RUN	
PEN?		
2.00000	RUN	
LINE TYPE?		
	RUN	
CURVE 3		CURVE 3 LINEAR-HYPERBOLIC
PEN?		
2.000000000	RUN	
LINE TYPE?		
	RUN	
CURVE 7		CURVE 7 PARABOLA

```
PEN?
     2.000000000    RUN
LINE TYPE?
                    RUN

CURVE 9                 CURVE 9 POWER


PEN?
     2.000000000    RUN
LINE TYPE?
                    RUN

CURVE 12                CURVE 12 HOERL FUNCTION


PEN?
     2.000000000    RUN
LINE TYPE?
                    RUN

CURVE 13                CURVE 13 MODIFIED HOERL FUNCTION


PEN?
     2.000000000    RUN
LINE TYPE?
                    RUN

CURVE 14                CURVE 14 LOG-NORMAL


PEN?
     2.000000000    RUN
LINE TYPE?
                    RUN

CURVE 17                CURVE 17 COAX FUNCTION


PEN?
     2.000000000    RUN
LINE TYPE?
                    RUN
```

```
DONE
                    XEQ B
PEN?
                      RUN
SET FLAG 17?
              3.000   RUN

CURVES 3, 7, 9, 12, 13,
                      RUN

14 AND 17             RUN

                    XEQ E
DONE
```

All seven curves in the edited CRVDAT file have now been plotted; GRAT, TICK, and PLTLBL have been executed. LABEL B of PLTLBL was used to print the additional message "Curves 3, 7, 9, 12, 13, 14 and 17".

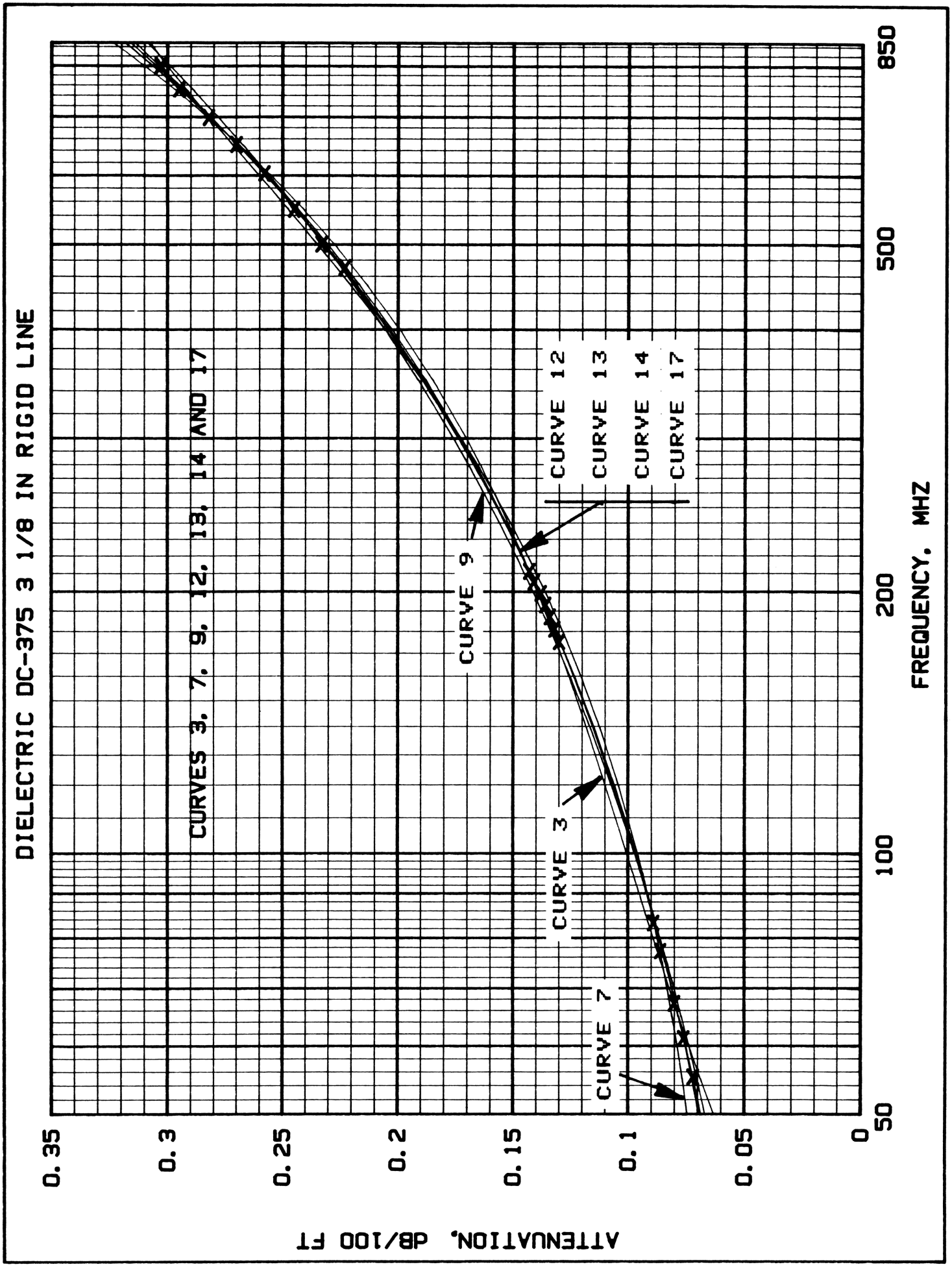
This is the calculator configuration at the end of PLTLBL:

```
                    CAT 1
LBL'U80                                  CAT 4
LBL'U81             XYDAT   D040
LBL'U82             GRAT    P083
LBL'U83             TICK    P078
LBL'U84             PLTLBL  P100
END         188 BYTES   HPPLOT  P181
LBL'MCFC            LABELS  A022
END         289 BYTES   CRVDAT  D028
LBL'PLTLBL                54.000   ***
.END.       699 BYTES
```

```
                      RUN
SET FLAGS
```

This is the calculator configuration after hitting R/S after LABEL E:

```
                    CAT 1
LBL'U80                                  CAT 4
LBL'U81             XYDAT   D040
LBL'U82             GRAT    P083
LBL'U83             TICK    P078
LBL'U84             PLTLBL  P100
END         188 BYTES   HPPLOT  P181
LBL'MCFC            LABELS  A022
END         289 BYTES   CRVDAT  D028
LBL'HPPLOT                54.000   ***
.END.      1266 BYTES
```


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
CURVES 3, 7, 9, 12, 13, 14 AND 17
CURVE 9
CURVE 12
CURVE 13
CURVE 14
CURVE 17
CURVE 3
CURVE 7
ATTENUATION, dB/100 FT
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
50
100
200
500
850
FREQUENCY, MHZ

```
                    XEQ A
SET FLAGS
                    SF 00
                    CF 01
                    CF 02
                    SF 03
                    CF 04
                    SF 05
                    SF 08
                    SF 09
                      RUN
FUNCTION?
MCFC                  RUN
X MIN?
          50.00000    RUN
X MAX?
         850.00000    RUN
Y MIN?
          -3.00000    RUN
Y MAX?
           3.00000    RUN
GRAT DLTA Y?
           1.00000    RUN
NMBR TICKS?
           5.00000    RUN
FRAME?
           3.00000    RUN
DIGITIZE?
                      RUN
PEN?
                      RUN



PEN?
                      RUN
LINE TYPE?
                      RUN
CURVE 3
             55.25000000
             -3.947573542
             61.25000000
             -1.264640592
             67.25000000
             0.197434025
             77.25000000
             1.719261733
             83.25000000
             2.625027169
             175.2500000
             0.937659231
             181.2500000
             0.973032121
             187.2500000
             0.985589403
             193.2500000
             0.978334706
```

Now, re-plot the edited CRVDAT file, but this time, plot the percent errors of each fit. This makes it much easier to see which curve best fits the data.

FS00: horizontally-oriented plot
FC01: no auto execution of GRAT/TICK/PLTLBL
FC02: full length minor graticules
FS03: logarithmic X
FC04: linear Y (NOTE: SHOULD ALWAYS BE LINEAR Y WHEN PERCENT ERRORS ARE REQUESTED)
FS05: plot percent errors of f(x)
FS08: print tabulation of % errors
FS09: pen prompts between curves

Note that the Ymin and Ymax limits have been re-set to +-3 percent!

The percent errors for each of the 20 input values are now calculated. For brevity, not all of the tabulations are shown.

CURVE 3 LINEAR-HYPERBOLIC

```
              199.2500000
              0.953860290
              205.2500000
              0.198705816
              211.2500000
              0.156607832
              471.2500000
             -1.658584260
              501.2500000
             -2.292031073
              549.2500000
             -1.647675429
              603.2500000
             -0.833374767
              651.2500000
             -0.360051482
              699.2500000
              0.058661596
              753.2500000
              0.646274000
              801.2500000
              2.304207690
              850.0000000



    PEN?
                      RUN
    LINE TYPE?
         4.000000000    RUN

    CURVE 7
              55.25000000
              6.814030611
              61.25000000
              4.629671421
              67.25000000
              2.647223250


Intermediate values
not shown for brevity


              699.2500000
             -0.046548759
              753.2500000
             -0.971383864
              801.2500000
             -0.871116469
              850.0000000



    PEN?
                      RUN
    LINE TYPE?
         5.000000000    RUN
```

CURVE 7 PARABOLA

Note use of other than default line type of 1.

```
CURVE 9                                  CURVE 9 POWER
          55.25000000
          -1.738812042
          61.25000000
          -1.589361118
          67.25000000
          -1.678404913

Intermediate values
not shown for brevity

          699.2500000
          -1.416676241
          753.2500000
          -1.904372000
          801.2500000
          -1.259654422
          850.0000000



 PEN?
                  RUN
 LINE TYPE?
      6.000000000    RUN

CURVE 12                                 CURVE 12 HOERL FUNCTION
          55.25000000
          0.332581917
          61.25000000
          0.080645079
          67.25000000
          -0.364590150

Intermediate values
not shown for brevity

          699.2500000
          -0.143082340
          753.2500000
          -0.016525153
          801.2500000
          1.221030594
          850.0000000



 PEN?
                  RUN
 LINE TYPE?
      7.000000000    RUN

CURVE 13                                 CURVE 13 MODIFIED HOERL FUNCTION
          55.25000000
          1.143927417
          61.25000000
          0.351853197
          67.25000000
          -0.469839000
```

```
Intermediate values
not shown for brevity

              699.2500000
             -0.345539504
              753.2500000
             -0.588846542
              801.2500000
              0.278150231
              850.0000000



    PEN?
                        RUN
    LINE TYPE?
         8.000000000    RUN
                                        CURVE 14 LOG-NORMAL
    CURVE  14
              55.25000000
              0.746692750
              61.25000000
              0.278875145
              67.25000000
             -0.329780163

 Intermediate values
 not shown for brevity

              699.2500000
             -0.206089823
              753.2500000
             -0.301426339
              801.2500000
              0.707110066
              850.0000000



    PEN?
         2.000000000    RUN
    LINE TYPE?
                        RUN

    CURVE  17           CURVE 17 COAX FUNCTION
              55.25000000
              0.537284097
              61.25000000
              0.120750842
              67.25000000
             -0.445618625


Intermediate values
not shown for brevity
```

```
          699.2500000
         -0.221631915
          753.2500000
         -0.310731492
          801.2500000
          0.705451650
          850.0000000



PEN?
                    RUN
LINE TYPE?
                    RUN
XEQ GRAT?
     3.000000000    RUN
PEN?
                    RUN
MAX FIX?
                    RUN
XEQ TICK?
          3.00000   RUN
PEN?
          2.00000   RUN
LABEL?
          3.00000   RUN
EDIT FILE?
          3.00000   RUN
EXISTING FILE
PURGE?
                    RUN
RVW TITLES?
          3.00000   RUN
DIELECTRIC DC-375 3 1/8
IN RIGID LINE
FREQUENCY, MHZ
PERCENT ERROR
OK?
          3.00000   RUN
PEN?
                    RUN
DONE
```

Use the "PEN?" prompt after CURVE 17 (now the last curve in the CRVDAT file) to switch to pen colors and sizes desired for GRAT (default = PEN 1), TICK (default = PEN 2), and PLTLBL (default = PEN 1).

GRAT has been called and executed.

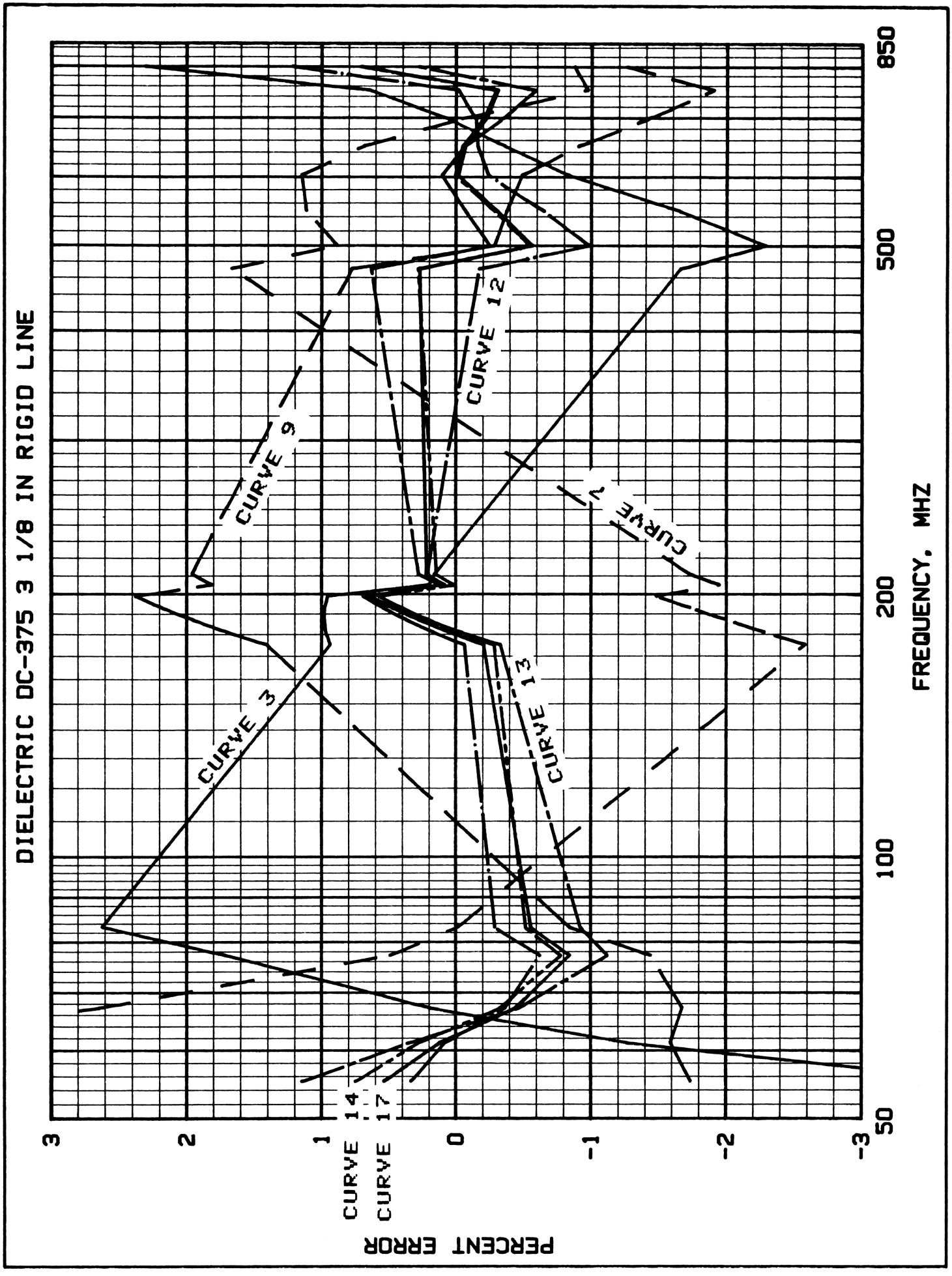
TICK has been called and executed.

The "LABEL?" prompt is asking whether PLTLBL should be called.

A "yes" response to the "EDIT FILE?" prompt allows changing line 02 from "attenuation, dB/100 ft" to "percent error".

Prompt for pen to be used, since flag 01 is CLEAR.

```
                    CAT 1
LBL'U80
LBL'U81                                          CAT 4
LBL'U82                          XYDAT   B040
LBL'U83                          GRAT    P083
LBL'U84                          TICK    P078
END          188 BYTES           PLTLBL  P100
LBL'MCFC                         HPPLOT  P181
END          289 BYTES           LABELS  A022
LBL'PLTLBL                       CRVDAT  B028
.END.        699 BYTES                 54.000   ***
```


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
CURVE 9
CURVE 12
CURVE 7
CURVE 3
CURVE 13
CURVE 14
CURVE 17
3
2
1
0
-1
-2
-3
PERCENT ERROR
50
100
200
500
850
FREQUENCY, MHZ

```
EDTDAT
                  READP
                    RUN
CURVE?
      17.00000000   RUN
CURVE?
                  XEQ E
HPPLOT
                   GETP
```

Examine the percent errors plot. Select curve 17 as the best fit. Use EDTDAT to edit the CRVDAT file so it contains just curve 17.

Use LABEL E to exit the curve prompt loop.

Restore HPPLOT to RAM

This is the calculator configuration. Note that the CRVDAT file size has been reduced to 004 (i.e., a single curve).

```
                    CAT 1
  LBL'U80
  LBL'U81                                   CAT 4
  LBL'U82                  XYDAT   D040
  LBL'U83                  GRAT    P083
  LBL'U84                  TICK    P078
  END          188 BYTES   PLTLBL  P100
  LBL'MCFC                 HPPLOT  P181
  END          289 BYTES   LABELS  A022
  LBL'HPPLOT               CRVDAT  D004
  .END.        1266 BYTES       78.00000000   ***
```

```
                  XEQ A
SET FLAGS
                  SF 00
                  CF 01
                  CF 02
                  SF 03
                  CF 04
                  CF 05
                  CF 08
                  SF 09
                    RUN
FUNCTION?
MCFC                RUN
X MIN?
         50.00000   RUN
X MAX?
        850.00000   RUN
Y MIN?
          0.00000   RUN
Y MAX?
           .35000   RUN
GRAT DLTA Y?
           .05000   RUN
NMBR TICKS?
          5.00000   RUN
FRAME?
          3.00000   RUN
DIGITIZE?
                    RUN
PEN?                              Select PEN for framing
                    RUN
```

Re-run HPPLOT for the one curve judged to best fit the data

FS00: horizontally-oriented plot
FC01: no auto execution of GRAT/TICK/PLTLBL
FC02: full length minor graticules
FS03: logarithmic X
FC04: linear Y
FC05: plot f(x), not percent errors of f(x)
FC08: no (X,Y) tabulations
FS09: pen selections between curves

```
PEN?
                    RUN
LINE TYPE?
                    RUN
PLOT PTS?
          3.00000   RUN
```

Select pen for "X" symbols

Select pen for first curve (CURVE 17)

```
PEN?
                    RUN
LINE TYPE?
                    RUN
```

CURVE 17

Select pen for next curve. Since there are no additional curves in the CRVDAT file, and since flag 01 is CLEAR, prompts for whether to execute GRAT, TICK, and PLTLBL will be made. The "yes" response to the "EDIT FILE?" prompt allows using the text editor to change line 02 back to "attenuation, dB/100 ft".

```
PEN?
                    RUN
LINE TYPE?
                    RUN
XEQ GRAT?
       3.000000000  RUN
PEN?
                    RUN
MAX FIX?
                    RUN
XEQ TICK?
          3.00000   RUN
PEN?
          2.00000   RUN
LABEL?
          3.00000   RUN
EDIT FILE?
          3.00000   RUN
EXISTING FILE
PURGE?
                    RUN
RVW TITLES?
          3.00000   RUN
DIELECTRIC DC-375 3 1/8
IN RIGID LINE
FREQUENCY, MHZ
ATTENUATION, dB/100 FT
OK?
          3.00000   RUN
PEN?
                    RUN
DONE
                  XEQ B
PEN?
                    RUN
SET FLAG 17?
            3.000   RUN

THE FINAL RESULT:   RUN

                  XEQ E
DONE
```

Use LABEL B to print additional text.

Exit the loop by manually switching out of ALPHA mode and executing LABEL E.

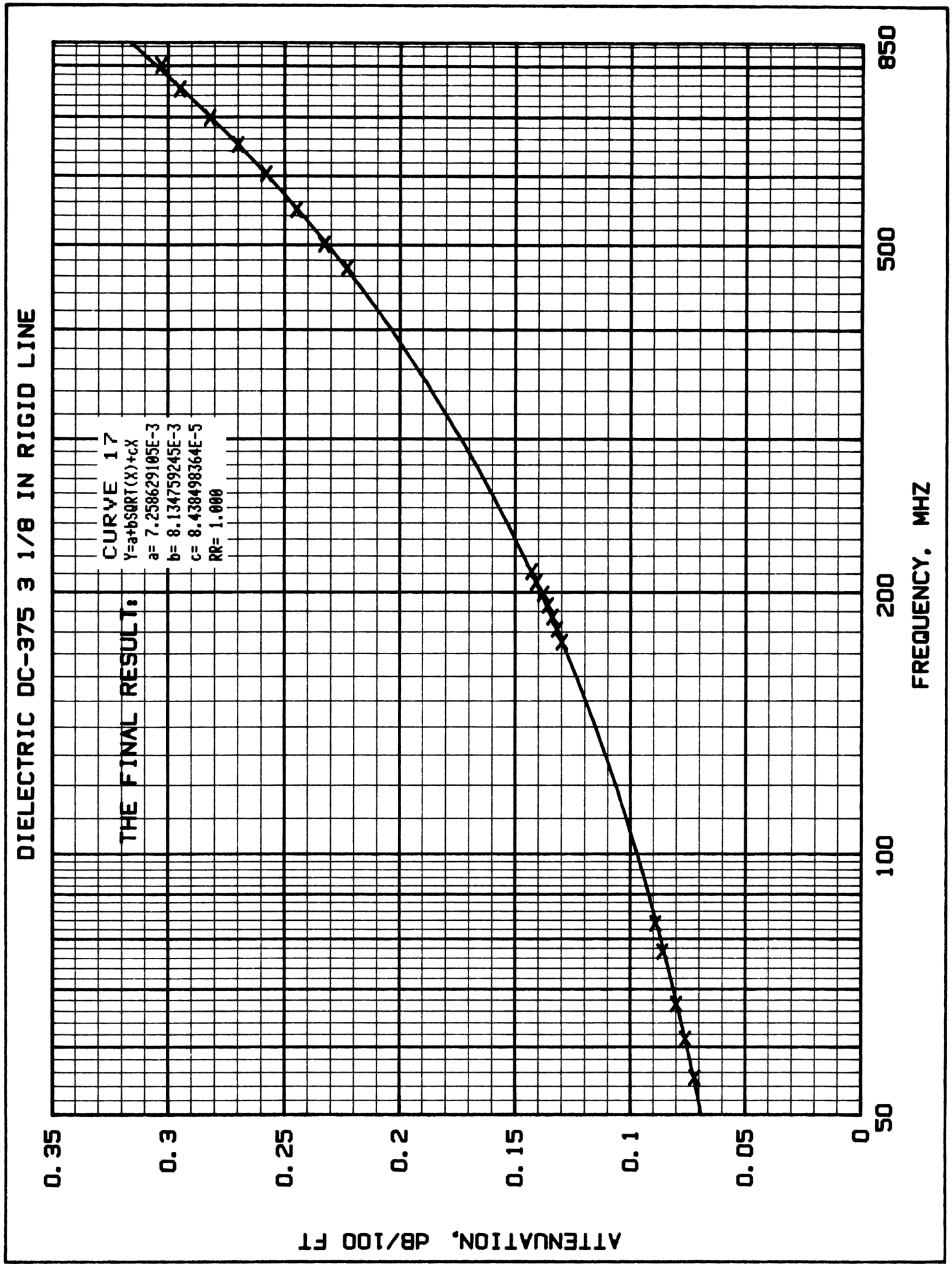
This is the calculator configuration at the completion of the plot:

CAT 1

```
LBL'U80
LBL'U81
LBL'U82
LBL'U83
LBL'U84
END          188 BYTES
LBL'MCFC
END          289 BYTES
LBL'PLTLBL
.END.        699 BYTES
```

CAT 4

```
XYDAT   D040
GRAT    P083
TICK    P078
PLTLBL  P100
HPPLOT  P181
LABELS  A022
CRVDAT  D004
          78.000    ***
```


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
THE FINAL RESULT:
CURVE 17
Y=a+bSQRT(X)+cX
a= 7.258629105E-3
b= 8.134759245E-3
c= 8.438498364E-5
RR= 1.000
ATTENUATION, dB/100 FT
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
50
100
200
500
850
FREQUENCY, MHZ

EXAMPLE III

Example III demonstrates a linear-log plot. Several curves are discontinuous where they go negative over part of their domain. This demonstrates the ability of HPPLOT to accomodate zero and negative values of X and Y, even in the log-log mode.

Flag 08 was SET, so a tabulation of (X,Y) values was printed. Flag 01 was SET, so HPPLOT automatically called GRAT, GRAT automatically called TICK, and TICK automatically called PLTLBL. Flag 09 was CLEAR, so no pen prompts between curves were made, and a single pen was used to plot all curves. Flag 03 was CLEAR, so a plot linear in X was generated. Flag 04 was SET, so a logarithmic plot in Y was generated. Flag 05 was CLEAR, so f(x) instead of the percent errors of f(x) was plotted.

```
MCFA
                    READP

                    XEQ A
```

Make sure the HP41CX is in USER mode. Use LABEL A to initialize registers and start the data entry process.

Calculator status at the start of MCFA:

```
LBL'MCFA
.END.       546 BYTES
                    CAT 4
DIR EMPTY
          600.0000    ***
```

```
      1.000000000 ENTER↑
      10.00000000    RUN

X1=1.00000
Y1=10.00000
          2.00000 ENTER↑
        100.00000    RUN

X2=2.00000
Y2=100.00000
          3.00000 ENTER↑
       1,000.00000    RUN

X3=3.00000
Y3=1000.00000
          4.00000 ENTER↑
      10,000.00000    RUN

X4=4.00000
Y4=10000.00000

                    XEQ E
```

Calculator status at the end of MCFA:

```
                    CAT 1
LBL'MCFA
.END.       546 BYTES
                    CAT 4
XYDAT   D008
          590.00000    ***
```

LABEL E is used to terminate the data entry portion. The four input pairs have been stored in the XYDAT file in extended memory, created by MCFA. MCFB is now called from digital cassette drive.

Calculator status at the start of MCFB:

```
                    CAT 1
LBL'MCFB
.END.       1491 BYTES
                    CAT 4
XYDAT   D008
          590.00000    ***
```

```
AUTO SELECT?
          3.00000    RUN
MIN RR?
          0.00000    RUN
```

MCFB prompts whether automatic curve selection is desired. Any non-zero entry is interpreted as "yes".

An RR of zero is used to insure that all 20 curve types are fitted.

```
CURVE 1
Y=a+bX
a= -4.940000000E3
b= 3.087000000E3
RR= 0.519
```

MCFB now proceeds to print the least-squares curve fits to all 20 curve types.

CURVE 1 LINEAR

CURVE 2
Y=1/(a+bX)
a= 1.049500000E-1
b= -3.087000000E-2
RR= 0.519

CURVE 2 RECIPROCAL

CURVE 3
Y=a+bX+c/X
a= -2.517791005E4
b= 7.434402900E3
c= 1.798925340E4
RR= 0.682

CURVE 3 LINEAR-HYPERBOLIC

CURVE 4
Y=a+b/X
a= 7.228461529E3
b= -8.545846145E3
RR= 0.029

CURVE 4 HYPERBOLA

CURVE 5
Y=X/(aX+b)
a= -4.529230762E-2
b= 1.402892306E-1
RR= 0.925

CURVE 5 RECIPROCAL HYPERBOLA

CURVE 6
Y=a+b/X+c/X↑2
a= 2.429287500E4
b= -7.830748224E4
c= 5.414335937E4
RR= 0.319

CURVE 6 SECOND ORDER HYPERBOLA

CURVE 7
Y=a+bX+cX↑2
a= 6.197500000E3
b= -8.050500000E3
c= 2.227500000E3
RR= 0.886

CURVE 7 PARABOLA

CURVE 8
Y=1/[c+a(X+b)↑2]
a= 2.227500000E-2
b= -3.192929293E0
c= -1.076411370E-2
RR= 0.886

CURVE 8 CAUCHY DISTRIBUTION

CURVE 9
Y=aX↑b
a= 6.723722146E0
b= 4.846766035E0
RR= 0.941

CURVE 9 POWER

CURVE 10
Y=aX↑(bX)
a= 1.368334663E1
b= 1.228195336E0
RR= 0.984

CURVE 10 SUPER GEOMETRIC

CURVE 11
Y=aX↑(b/X)
a= 1.009507028E1
b= 1.300575397E1
RR= 0.398

CURVE 11 MODIFIED GEOMETRIC

CURVE 12
Y=a(b↑X)(X↑c)
a= 9.999999950E-1
b= 1.000000002E1
c= 0.000000000E0
RR= 1.000

CURVE 12 HOERL FUNCTION

CURVE 13
Y=a(b↑1/X)(X↑c)
a= 6.946807170E-4
b= 1.4545718 43E4
c= 1.011475175E1
RR= 0.997

CURVE 13 MODIFIED HOERL FUNCTION

CURVE 14
Y=aEXP[(1/c)(b-LNX)↑2]
a= 7.930561070E0
b= -3.120848064E-1
c= 4.057833756E-1
RR= 0.999

CURVE 14 LOG-NORMAL

CURVE 15
Y=a+bLNX
a= -1.768699288E3
b= 5.721991545E3
RR= 0.259

CURVE 15 LOGARITHMIC

CURVE 16
Y=1/(a+bLNX)
a= 8.647400753E-2
b= -7.388044464E-2
RR= 0.765

CURVE 16 RECIPROCAL LOG

CURVE 17
Y=a+bSQRT(X)+cX
a= 3.508591003E4
b= -5.660518490E4
c= 2.186767910E4
RR= 0.785

CURVE 17 COAX FUNCTION

CURVE 18
Y=ab↑X
a= 9.999999950E-1
b= 1.000000002E1
RR= 1.000

CURVE 18 MODIFIED POWER

CURVE 19
Y=ab↑(1/X)
a= 2.285463819E4
b= 2.696306374E-4
RR= 0.794

CURVE 19 ROOT

```
CURVE 20
Y=aEXP[(1/c)(X-b)↑2]
a= 0.000000000E0
b= -9.210340132E7
c= 8.000000000E7
RR= 1.000
```

CURVE 20 NORMAL DISTRIBUTION

CURVE 20 didn't do too well! The "a" coefficient came out equal to zero, and the adjusted coefficient of determination came out equal to one. This underscores that the RR should be only considered as an indication that a curve is worth plotting to see how well it fits the data.

This is the calculator configuration at the end of MCFB:

```
                    CAT 1                          CAT 4
LBL'MCFB                              XYDAT   D008
.END.       1491 BYTES                CRVDAT  D080
                                            508.000    ***
```

The coefficients for all curves have now been calculated and printed. A data file has been created in extended memory, called CRVDAT, containing the curve number, adjusted coefficient of determination, and coefficients a, b, and c, for each curve. MCFB now prompts "XEQ EDTDAT?" The R/S response is interpreted as "no", causing program PLTPRP to be called from digital cassette drive. PLTPRP takes several minutes to run, as it calls U80, HPPLOT, GRAT, TICK, PLTLBL, and MCFC from digital cassette drive and places these programs into RAM and into extended memory, as appropriate. Upon completion of PLTPRP, HPPLOT is in RAM and has prompted "SET FLAGS". The calculator configuration at the completion of PLTPRP is as follows:

```
XEQ EDTDAT?
                  RUN
SET FLAGS
```

```
                    CAT 1
LBL'U80
LBL'U81                                          CAT 4
LBL'U82                               XYDAT   D008
LBL'U83                               CRVDAT  D080
LBL'U84                               GRAT    P083
END         188 BYTES                 TICK    P078
LBL'MCFC                              PLTLBL  P100
END         289 BYTES                 HPPLOT  P181
LBL'HPPLOT                                58.00000000    ***
.END.       1266 BYTES
```

```
                    XEQ A
SET FLAGS
                    CF 00
                    SF 01
                    CF 02
                    CF 03
                    SF 04
                    CF 05
                    SF 08
                    CF 09
                      RUN
FUNCTION?
MCFC                  RUN
X MIN?
          1.00000   RUN
X MAX?
          3.00000   RUN
DELTA X?
           .05000   RUN
GRAT DLTA X?
           .50000   RUN
NMBR TICKS?
          5.00000   RUN
Y MIN?
          5.00000   RUN
Y MAX?
      5,000.00000   RUN
FRAME?
          3.00000   RUN
DIGITIZE?
                    RUN
PEN?
                    RUN
PEN?
                    RUN
LINE TYPE?
                    RUN
PLOT PTS?
          3.00000   RUN
                1.00000
               10.00000

                2.00000
              100.00000

                3.00000
            1,000.00000

                4.00000
           10,000.00000


CURVE 1
             1.000000000
            -1,853.000000
              1.050000000
            -1,698.650000
```

LABEL A of HPPLOT is used to start the plotting process.

FC00: vertically-orinted plot
FS01: auto execution of GRAT/TICK/PLTLBL
FC02: full length minor graticules
FC03: linear X
FS04: logarithmic Y
FC05: plot f(X), not percent errors of f(X)
FS08: print (X,Y) values
FC09: no pen prompts between curves; whatever pen is selected at the start of the plotting process will be used for all curves

Specifying MCFC as the called function causes flag 06 to be SET and invokes special subroutines in HPPLOT to cause automatic plotting of "X" symbols at each point in the XYDAT data file in extended memory, and the plotting of each curve type found in the CRVDAT data file in extended memory.

These are the four input pairs in the XYDAT data file. Note that only the first three pairs are plotted, as the last pair is off-scale.

Note that HPPLOT accomodates negative f(X) values in the log mode! The plotted curve is simply discontinuous over X values resulting in negative f(X)'s.

1.100000000
-1,544.300000
1.150000000
-1,389.950000
1.200000000
-1,235.600000
1.250000000
-1,081.250000
1.300000000
-926.9000000
1.350000000
-772.5500000
1.400000000
-618.2000000
1.450000000
-463.8500000
1.500000000
-309.5000000
1.550000000
-155.1500000
1.600000000
-0.800000000
1.650000000
153.5500000
1.700000000
307.9000000
1.750000000
462.2500000
1.800000000
616.6000000
1.850000000
770.9500000
1.900000000
925.3000000
1.950000000
1,079.650000
2.000000000
1,234.000000

Intermediate values
not shown for brevity

2.900000000
4,012.300000
2.950000000
4,166.650000
3.000000000
4,321.000000

CURVE 2

1.000000000
13.49892009
1.050000000
13.78616283
1.100000000
14.08589579

Intermediate values
not shown for brevity

2.900000000
64.82141700
2.950000000
72.02794684
3.000000000
81.03727715

CURVE 3

1.000000000
245.7462500
1.050000000
-239.1647100
1.100000000
-646.2001300

Intermediate values
not shown for brevity

2.300000000
-257.3688600
2.350000000
-52.06178000
2.400000000
160.1791600
2.450000000
378.9294700
2.500000000
603.7985600
2.550000000
834.4265300
2.600000000
1,070.481110
2.650000000
1,311.655150
2.700000000
1,557.664220
2.750000000
1,808.244620
2.800000000
2,063.151430
2.850000000
2,322.156960
2.900000000
2,585.049190
2.950000000
2,851.630510
3.000000000
3,121.716450

CURVE 4

1.000000000
-1,317.384616
1.050000000
-910.4395610
1.100000000
-540.4895120
1.150000000
-202.7090320

1.200000000
106.9230750
1.250000000
391.7846130
1.300000000
654.7337250
1.350000000
898.2051250
1.400000000
1,124.285711

Intermediate values
not shown for brevity

2.900000000
4,281.618031
2.950000000
4,331.564531
3.000000000
4,379.846147

CURVE 5

1.000000000
10.52665674
1.050000000
11.32291461
1.100000000
12.15903681

Intermediate values
not shown for brevity

2.900000000
324.3289729
2.950000000
441.8202735
3.000000000
679.9163091

CURVE 6

1.000000000
128.7521300
1.050000000
-1,176.056510
1.100000000
-2,149.167230
1.150000000
-2,860.429500
1.200000000
-3,363.805080
1.250000000
-3,701.360790
1.300000000
-3,906.159050
1.350000000
-4,004.376940

1.400000000
-4,016.877940
1.450000000
-3,960.390100
1.500000000
-3,848.397880
1.550000000
-3,691.823480

Intermediate values
not shown for brevity

2.000000000
-1,325.026280
2.050000000
-1,022.289600
2.100000000
-718.9965100
2.150000000
-416.2061100
2.200000000
-114.7906100
2.250000000
184.5341300
2.300000000
481.1831700

Intermediate values
not shown for brevity

2.900000000
3,728.268680
2.950000000
3,969.552600
3.000000000
4,206.309740

CURVE 7

1.000000000
374.5000000
1.050000000
200.2937500
1.100000000
37.22500000
1.150000000
-114.7062500
1.200000000
-255.5000000
1.250000000
-385.1562500
1.300000000
-503.6750000

Intermediate values
not shown for brevity

2.450000000
-155.6562500
2.500000000
-6.875000000
2.550000000
153.0437500
2.600000000
324.1000000
2.650000000
506.2937500
2.700000000
699.6250000
2.750000000
904.0937500
2.800000000
1,119.700000
2.850000000
1,346.443750
2.900000000
1,584.325000
2.950000000
1,833.343750
3.000000000
2,093.500000

CURVE 8

1.000000000
10.37828863
1.050000000
10.92586461
1.100000000
11.51964244

Intermediate values
not shown for brevity

2.400000000
308.5467505
2.450000000
653.4079564
2.500000000
-14,545.44185
2.550000000
-642.4412513
2.600000000
-340.9478278
2.650000000
-238.2051209
2.700000000
-186.8547650
2.750000000
-156.3950916
2.800000000
-136.5187702
2.850000000
-122.7813025
2.900000000
-112.9592491
2.950000000
-105.8250044
3.000000000
-100.6542520

CURVE 9

1.000000000
6.723722146
1.050000000
8.517444910
1.100000000
10.67162163

Intermediate values
not shown for brevity

2.900000000
1,171.506410
2.950000000
1,272.703234
3.000000000
1,380.717566

CURVE 10

1.000000000
13.68334663
1.050000000
14.57196626
1.100000000
15.56375773

Intermediate values
not shown for brevity

2.900000000
606.9403563
2.950000000
689.3508169
3.000000000
783.7663759

CURVE 11

1.000000000
10.09507028
1.050000000
18.47434996
1.100000000
31.15388025

Intermediate values
not shown for brevity

2.700000000
1,207.717247
2.750000000
1,207.463600
2.800000000
1,205.366484
2.850000000
1,201.596322

2.900000000
1,196.314632
2.950000000
1,189.673637
3.000000000
1,181.816088

CURVE 12

1.000000000
9.999999970
1.050000000
11.22018451
1.100000000

Intermediate values
not shown for brevity

2.900000000
794.3282353
2.950000000
891.2509389
3.000000000
1,000.000001

CURVE 13

1.000000000
10.10463011
1.050000000
10.48623136
1.100000000
11.08579094

Intermediate values
not shown for brevity

2.900000000
900.0199271
2.950000000
1,011.614328
3.000000000
1,135.864907

CURVE 14

1.000000000
10.08194055
1.050000000
10.93162981
1.100000000
11.93812169

Intermediate values
not shown for brevity

2.750000000
595.0544833
2.800000000
669.8190505
2.850000000
753.5725624

2.900000000
847.3365206
2.950000000
952.2413979
3.000000000
1,069.537518

CURVE 15

1.000000000
-1,768.699288
1.050000000
-1,489.522381
1.100000000
-1,223.335245
1.150000000
-968.9826353
1.200000000
-725.4568820
1.250000000
-491.8737740
1.300000000
-267.4531850
1.350000000
-51.50334700
1.400000000
156.5920050
1.450000000
357.3842400

Intermediate values
not shown for brevity

2.900000000
4,323.566547
2.950000000
4,421.380748
3.000000000
4,517.550941

CURVE 16

1.000000000
11.56416857
1.050000000
12.06718499
1.100000000
12.58931346

Intermediate values
not shown for brevity

2.750000000
85.20440539
2.800000000
96.10517267
2.850000000
109.9189235

2.900000000
127.9966435
2.950000000
152.6773370
3.000000000
188.3933449

CURVE 17

1.000000000
348.4042300
1.050000000
43.91879000
1.100000000
-227.6617300
1.150000000
-468.5571300

Intermediate values
not shown for brevity

2.350000000
-299.1494000
2.400000000
-124.0354700
2.450000000
60.59492000
2.500000000
254.4519600
2.550000000
457.2602000
2.600000000
668.7575600
2.650000000
888.6946500
2.700000000
1,116.833650
2.750000000
1,352.947820
2.800000000
1,596.820510
2.850000000
1,848.244860
2.900000000
2,107.023000
2.950000000
2,372.965560
3.000000000
2,645.891090

CURVE 18

1.000000000
9.999999970
1.050000000
11.22018451
1.100000000
12.58925409

Intermediate values
not shown for brevity

```
              2.900000000
              794.3282353
              2.950000000
              891.2509389
              3.000000000
             1,000.000001

   CURVE 19
              1.000000000
              6.162310663
              1.050000000
              9.113956644
              1.100000000
              13.00825712

Intermediate values
not shown for brevity

              2.900000000
             1,343.399314
              2.950000000
             1,409.501745
              3.000000000
             1,476.490861

   CURVE 20
              1.000000000
              0.000000000
              1.050000000
              0.000000000
              1.100000000
              0.000000000

Intermediate values
not shown for brevity

              2.900000000
              0.000000000
              2.950000000
              0.000000000
              3.000000000
              0.000000000
```

All done plotting the 20 curve types. Since flag 01 is SET, HPPLOT automatically executed GRAT, TICK, and PLTLBL. Because no LABELS text file existed in extended memory, PLTLBL defaulted to the text editor mode even though flag 01 was SET. The text editor was then used to create three lines of text.

```
   RVW TITLES?
            3.00000    RUN
   TITLE TEXT
   X-AXIS TITLE
   Y-AXIS TITLE
   OK?
            3.00000    RUN
   DONE
                       RUN
   SET FLAGS
```

PLTLBL automatically branched to LABEL E, secured the pen, printed "DONE", and stopped program execution. The subsequent "R/S" caused HPPLOT to be called from extended memory, overwriting PLTLBL. HPPLOT then prompted "SET FLAGS".

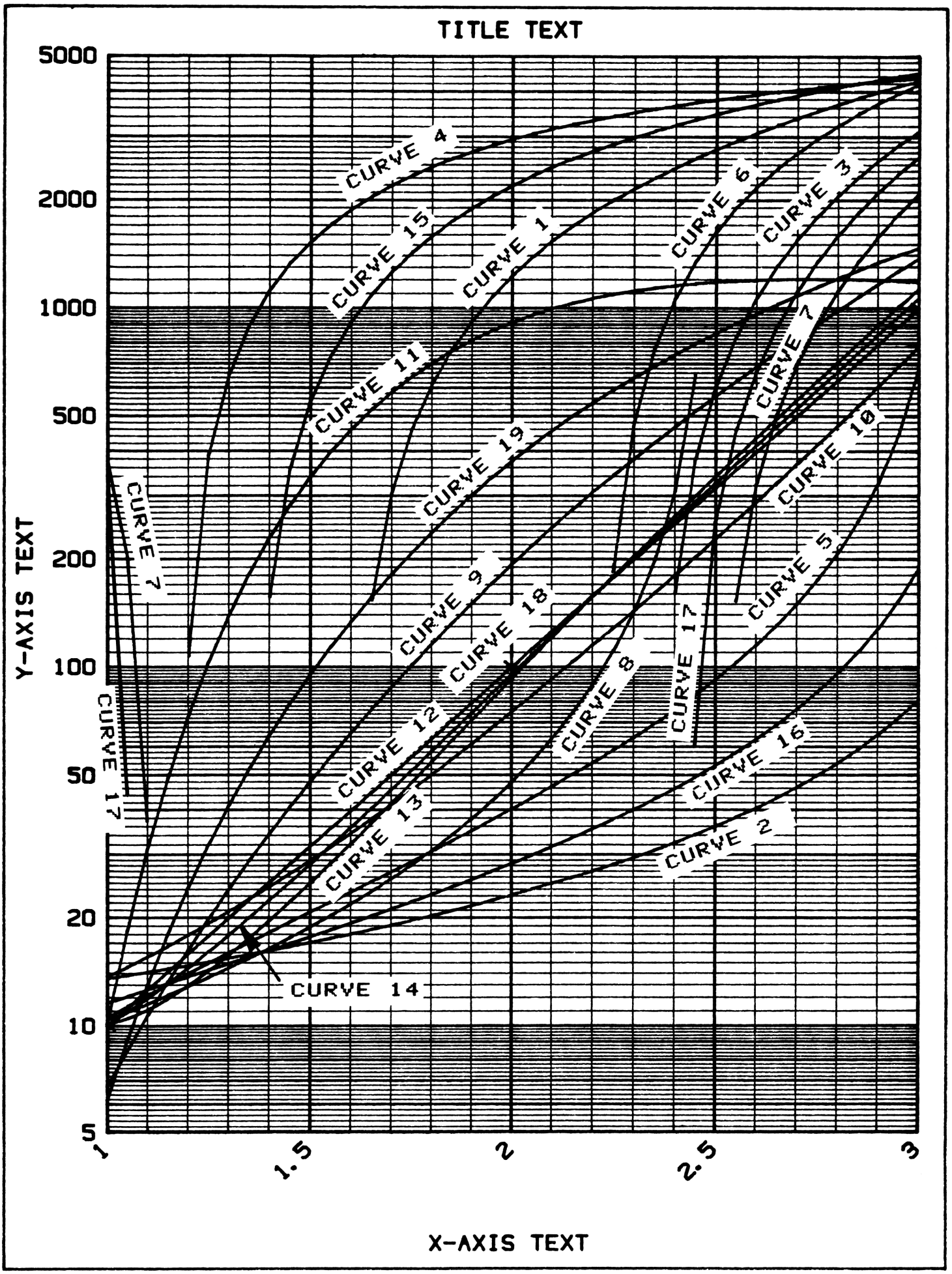
This is the calculator configuration at the completion of PLTLBL:

```
                CAT 1
LBL'U80                                          CAT 4
LBL'U81                          XYDAT   D008
LBL'U82                          CRYDAT  D080
LBL'U83                          GRAT    P083
LBL'U84                          TICK    P078
END         188 BYTES            PLTLBL  P100
LBL'MCFC                         HPPLOT  P181
END         289 BYTES            LABELS  A022
LBL'PLTLBL                             34.000   ***
.END.       699 BYTES
```

Note that PLTLBL created a size 022 ASCII text file in extended memory, called LABELS.

This is the calculator configuration after HPPLOT has been returned to RAM by PLTLBL:

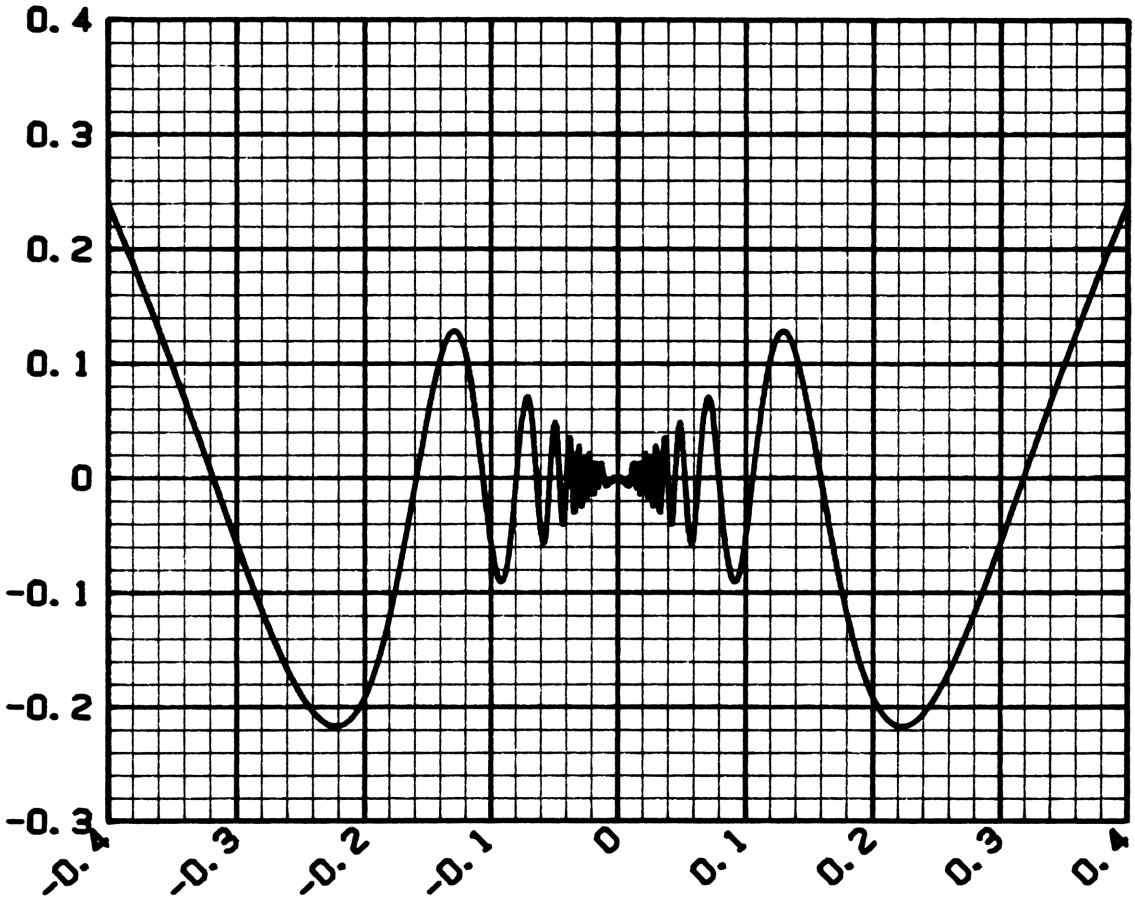
```
                CAT 1
LBL'U80                                          CAT 4
LBL'U81                          XYDAT   D008
LBL'U82                          CRYDAT  D080
LBL'U83                          GRAT    P083
LBL'U84                          TICK    P078
END         188 BYTES            PLTLBL  P100
LBL'MCFC                         HPPLOT  P181
END         289 BYTES            LABELS  A022
LBL'HPPLOT                             34.000   ***
.END.       1266 BYTES
```


TITLE TEXT
Y-AXIS TEXT
X-AXIS TEXT
5000
2000
1000
500
200
100
50
20
10
5
1
1.5
2
2.5
3
CURVE 4
CURVE 15
CURVE 1
CURVE 6
CURVE 3
CURVE 11
CURVE 7
CURVE 19
CURVE 10
CURVE 7
CURVE 9
CURVE 18
CURVE 5
CURVE 17
CURVE 12
CURVE 8
CURVE 16
CURVE 13
CURVE 2
CURVE 14
CURVE 17

SAMPLE TITLE

EXAMPLE IV

Example IV demonstrates the the DIGITIZE option. A graph can be drawn with the lower left and upper right points determined by digitization. For example, a graph can be made to fit on this sheet (the plotted function is Y=Xsin(1/X)):



This allows creating a graph in smaller areas. Alternatively, the DIGITIZE option could be used to plot onto pre-printed graph paper, or to plot onto an existing graph, to see how well a curve fit matches the source graph.

SAMPLE X-AXIS

```
                CAT 4
XYDAT   D008
CRVDAT  D080
GRAT    P083
TICK    P078
PLTLBL  P100
HPPLOT  P181
LABELS  A022
     34.00000000    ***

CRVDAT
                PURFL
PLTPRP
                READP
                  RUN
XSIN1/
                READP
               GTO ..
PACKING
HPPLOT
                 GETP
```

First purge any existing CRVDAT or POLYn data files from extended memory; then use the PLTPRP program to configure the calculator for plotting. Then load and PACK program XSIN1/. Finally, call HPPLOT from extended memory, but do not PACK.

Note that a LABELS text file exists from Example III.

```
                CAT 1
    LBL'U80
    LBL'U81
    LBL'U82
    LBL'U83
    LBL'U84
    END         188 BYTES
    LBL'XSIN1/
    END          24 BYTES
    LBL'HPPLOT
    .END.       1265 BYTES
```

```
                                CAT 4
XYDAT   D008
LABELS  A022
GRAT    P083
TICK    P078
PLTLBL  P100
HPPLOT  P181
          116.0000000    ***
```

```
                XEQ A
SET FLAGS
                CF 00
                SF 01
                CF 02
                CF 03
                CF 04
                CF 08
                  RUN
FUNCTION?
XSIN1/            RUN
X MIN?
        -.40000   RUN
X MAX?
         .40000   RUN
DELTA X?
         .00100   RUN
GRAT DLTA X?
         .10000   RUN
NMBR TICKS?
        5.00000   RUN
Y MIN?
        -.30000   RUN
Y MAX?
         .40000   RUN
GRAT DLTA Y?
         .10000   RUN
NMBR TICKS?
        5.00000   RUN
FRAME?
        3.00000   RUN
```

Use LABEL A to start HPPLOT

FC00: vertically-oriented plot
FS01: auto execution of GRAT/TICK/PLTLBL
FC02: full length minor graticules
FC03: linear X
FC04: linear Y
FC08: no tabulation of (X,Y) values

Note: Flag 09 doesn't matter since the called function is not MCFC or POLY

Flag 05 doesn't matter since HPPLOT will automatically CLEAR flag 05 if the called function is not MCFC or POLY

```
DIGITIZE?
        3.00000    RUN
NEW POINTS?
        3.00000    RUN

INSERT SIGHT
                   RUN

RMVE SIGHT
                   RUN
PEN?
                   RUN
PEN?
                   RUN
DONE
```

Any non-zero answer to the "DIGITZE?" prompt is interpreted as "yes".

The "NEW POINTS?" prompt must be answered "yes", since this is an initial setting of the plot boundaries by digitization

HPPLOT prompts for a digitzing sight to be placed in stall 2

Digitize the plot boundaries using the plotter front panel controls. Set the lower left point first, then the upper right point. The lower left point is at the rear of the plotter, next to the on-off siwtch and AC power cord. The upper right is at the front of the plotter, next to the plotter's keyboard.

Prompt to remove digitizing sight

Prompt for pen to be used for framing

Prompt for pen to be used for plotting

The function has been plotted; GRAT, TICK, and PLTLBL have been executed. Since a LABELS file already existed in extended memory, from Example III, that file was automatically used since flag Ø1 was SET. Note that the title, X-axis, and Y-axis labels are still printed at the positions shown in the Appendix. If this is a problem, insure that a LABELS file does not already exist, or that flag Ø1 is CLEAR. This will keep PLTLBL from automatically labeling the plot.

Calculator configuration at the end of Example IV:

CAT 1

```
LBL'U80
LBL'U81
LBL'U82
LBL'U83
LBL'U84
END          188 BYTES
LBL'XSIN1/
END          24 BYTES
LBL'PLTLBL
.END.        698 BYTES
```

CAT 4

```
XYDAT    D008
LABELS   A022
GRAT     P083
TICK     P078
PLTLBL   P100
HPPLOT   P181
          116.000    ***
```

Program listing for Y=Xsin(1/X):

```
 01◆LBL "XSI
N1/"
 02 RAD
 03 ENTER↑
 04 X=0?
 05 GTO 01
 06 1/X
 07 SIN
 08 *
 09◆LBL 01
 10 DEG
 11 RTN
 12 .END.
```

EXAMPLE V

Example V demonstrates polynomial curve fitting program POLYN. First, set the HP41CX to SIZE 043. Then load POLYN from digital cassette drive. Insure that USER mode is set. Start the data entry process bu executing LABEL A. For comparison purposes, the same twenty points used in EXAMPLE II will again be used.

Be cautioned that a polynomial curve fit may be "ill behaved" outside of the range of fitted data. Extrapolate with care.

Assume that EXAMPLE II was the last program run. The calculator configuration is as follows:

```
                CAT 1
LBL'U80
LBL'U81                                  CAT 4
LBL'U82          XYDAT   D040
LBL'U83          GRAT    P083
LBL'U84          TICK    P078
END        188 BYTES  PLTLBL  P100
LBL'MCFC         HPPLOT  P181
END        289 BYTES  LABELS  A022
LBL'PLTLBL       CRVDAT  D004
.END.      699 BYTES          78.000   ***
```

U80

PCLPS

CRVDAT

PURFL

PCLBUF

Clear all programs from main memory using the PCLPS command. Purge the CRVDAT file from extended memory. Restore the plotter buffer registers to available memory.

The calculator configuration is now as follows:

```
                                         CAT 4
                 XYDAT   D040
                 GRAT    P083
                 TICK    P078
                 PLTLBL  P100
                 HPPLOT  P181
                 LABELS  A022
          CAT 1          84.000   ***
.END.      07 BYTES
```

```
              SIZE 043
POLYN
                 READP
                 XEQ A
INITIALIZING

X1, Y1?
           55.25 ENTER↑
            .072    RUN
X1=55.25000
Y1=0.07200

X2, Y2?
           61.25 ENTER↑
            .076    RUN
X2=61.25000
Y2=0.07600

X3, Y3?
           67.25 ENTER↑
             .08    RUN
X3=67.25000
Y3=0.08000

X4, Y4?
           77.25 ENTER↑
            .086    RUN
X4=77.25000
Y4=0.08600

X5, Y5?
           83.25 ENTER↑
            .089    RUN
X5=83.25000
Y5=0.08900

X6, Y6?
          175.25 ENTER↑
              .13    RUN
X6=175.25000
Y6=0.13000

X7, Y7?
          181.25 ENTER↑
             .132    RUN
X7=181.25000
Y7=0.13200

X8, Y8?
          187.25 ENTER↑
             .134    RUN
X8=187.25000
Y8=0.13400

X9, Y9?
          193.25 ENTER↑
             .136    RUN
X9=193.25000
Y9=0.13600
```

Set the HP41CX to SIZE 043. Load POLYN from digital cassette drive. Insure that USER mode is set. Start the data entry process by executing LABEL A.

First (X,Y) point

Second (X,Y) point

```
X10, Y10?
          199.25 ENTER↑
             .138    RUN
X10=199.25000
Y10=0.13800

X11, Y11?
          205.25 ENTER↑
             .141    RUN
X11=205.25000
Y11=0.14100

X12, Y12?
          211.25 ENTER↑
             .143    RUN
X12=211.25000
Y12=0.14300

X13, Y13?
          471.25 ENTER↑
             .223    RUN
X13=471.25000
Y13=0.22300

X14, Y14?
          501.25 ENTER↑
             .233    RUN
X14=501.25000
Y14=0.23300
```

```
X15, Y15?
          549.25 ENTER↑
             .245    RUN
X15=549.25000
Y15=0.24500

X16, Y16?
          603.25 ENTER↑
             .258    RUN
X16=603.25000
Y16=0.25800

X17, Y17?
          651.25 ENTER↑
              .27    RUN
X17=651.25000
Y17=0.27000

X18, Y18?
          699.25 ENTER↑
             .282    RUN
X18=699.25000
Y18=0.28200

X19, Y19?
          753.25 ENTER↑
             .295    RUN
X19=753.25000
Y19=0.29500
```

```
X20, Y20?
          801.25 ENTER↑
            .303    RUN
X20=801.25000
Y20=0.30300

X21, Y21?
                  XEQ E
MIN, ↑, MAX?
               1 ENTER↑
               7    RUN
```

Last (X,Y) point. Use LABEL E to terminate the data entry portion of POLYN.

POLYN now prompts for the lowest and highest order polynomials to be fitted. The lowest possible order is one (first order, or linear) and the highest possible order is nine. If only a single order polynomial is desired, enter the same integer twice.

POLYN will now calculate the least-squares polynomial coefficients for all requested orders. POLYN will automatically PSIZE as required for the higher order matrices. Of course, sufficient room must be available for the expanding SIZE.

```
SIZE=49

B1=3.089E-4
B0=6.939E-2
RR=0.98906
```

FIRST-ORDER POLYNOMIAL COEFFICIENTS

```
SIZE=55

B2=-1.836E-7
B1=4.568E-4
B0=5.223E-2
RR=0.99883
```

SECOND-ORDER POLYNOMIAL COEFFICIENTS

```
SIZE=63

B3=2.445E-10
B2=-4.887E-7
B1=5.599E-4
B0=4.442E-2
RR=0.99980
```

THIRD-ORDER POLYNOMIAL COEFFICIENTS

```
SIZE=73

B4=-5.780E-13
B3=1.187E-9
B2=-9.768E-7
B1=6.458E-4
B0=4.037E-2
RR=0.99992
```

FOURTH-ORDER POLYNOMIAL COEFFICIENTS

```
SIZE=85

B5=1.246E-15
B4=-3.332E-12
B3=3.389E-9
B2=-1.737E-6
B1=7.501E-4
B0=3.619E-2
RR=0.99993
```

FIFTH-ORDER POLYNOMIAL COEFFICIENTS

```
SIZE=99

B6=-1.013E-17
B5=2.750E-14
B4=-2.959E-11
B3=1.611E-8
B2=-4.795E-6
B1=1.082E-3
B0=2.444E-2
RR=0.99998
```

SIXTH-ORDER POLYNOMIAL COEFFICIENTS

```
SIZE=115

B7=-1.980E-20
B6=4.908E-17
B5=-4.299E-14
B4=1.281E-11
B3=2.573E-9
B2=-2.579E-6
B1=9.127E-4
B0=2.910E-2
RR=0.99998
```

SEVENTH-ORDER POLYNOMIAL COEFFICIENTS

The last polynomial order has been calculated. POLYN now prompts "XEQ PLTPRP?" Any non-zero response is interpreted as "yes".

```
XEQ PLTPRP?
```

This is the calculator configuration at the end of POLYN, before PLTPRP has been called to re-configure the calculator for plotting:

```
                                                    CAT 4
                                          GRAT    P083
                                          TICK    P078
                                          PLTLBL  P100
                                          HPPLOT  P181
                                          LABELS  A022
                                          XYDAT   D040
                                          POLY1   D003
                                          POLY2   D004
                                          POLY3   D005
                                          POLY4   D006
                                          POLY5   D007
                                          POLY6   D008
                                          POLY7   D009
                                                  28.00000    ***
                          CAT 1
                LBL'POLYN
                .END.     882 BYTES
```

```
        3.00000    RUN
SET FLAGS
```

PLTPRP takes several minutes to run, and leaves the HP41CX configured as follows:

```
                          CAT 1
LBL'U80
LBL'U81
LBL'U82
LBL'U83
LBL'U84
END          188 BYTES
LBL'POLY
END          121 BYTES
LBL'HPPLOT
.END.        1266 BYTES
```

```
                          CAT 4
LABELS  A022
XYDAT   D040
POLY1   D003
POLY2   D004
POLY3   D005
POLY4   D006
POLY5   D007
POLY6   D008
POLY7   D009
GRAT    P083
TICK    P078
PLTLBL  P100
HPPLOT  P181
          28.0000    ***
```

```
                  XEQ A
SET FLAGS
                  CF 00
                  CF 01
                  CF 02
                  SF 03
                  CF 04
                  CF 05
                  SF 08
                  SF 09
                    RUN
FUNCTION?
POLY                RUN
X MIN?
         50.00000   RUN
X MAX?
        850.00000   RUN
Y MIN?
          0.00000   RUN
Y MAX?
           .35000   RUN
GRAT DLTA Y?
           .05000   RUN
NMBR TICKS?
          5.00000   RUN
FRAME?
          3.00000   RUN
DIGITIZE?
                    RUN
PEN?
                    RUN
```

Execute LABEL A to start the plotting process.

FC00: vertically-oriented plot
FC01: no auto execution of GRAT/TICK/PLTLBL
FC02: full length minor graticules
FS03: logarithmic X
FC04: linear Y
FC05: plot f(x), not % errors of f(x)
FS08: print (X,Y) tabulation
FS09: pen prompts between curves

Select the framing pen

```
PEN?
                    RUN
LINE TYPE?
                    RUN
PLOT PTS?
          3.00000   RUN
                55.25000
                 0.07200

                61.25000
                 0.07600

                67.25000
                 0.08000

                77.25000
                 0.08600
```

Select the pen for plotting the "X" symbols

Any non-zero response to the "PLOT POINTS?" prompt causes "X" symbols to be plotted at each (X,Y) pair in the XYDAT file

Start plotting the input data points

Intermediate values
not shown for brevity

```
               753.25000
                 0.29500

               801.25000
                 0.30300
```

```
PEN?
          2.00000   RUN
LINE TYPE?
                    RUN

ORDER=1
               50.00000
                0.08484
               55.00000
                0.08638
               60.00000
                0.08793
               65.00000
```

Select pen and line type for first-order plot; mark pen color used on printout, if desired

FIRST-ORDER plot

Intermediate values
not shown for brevity

```
              750.00000
                0.30109
              800.00000
                0.31654
              850.00000
                0.33198
```

```
PEN?
        2.00000    RUN
LINE TYPE?
                   RUN

ORDER=2                          SECOND-ORDER plot
                50.00000
                 0.07461
                55.00000
                 0.07680
                60.00000
                 0.07898
                65.00000
                 0.08114

Intermediate values
not shown for brevity

               750.00000
                 0.29155
               800.00000
                 0.30016
               850.00000
                 0.30785


   PEN?
          2.00000    RUN
   LINE TYPE?
                     RUN

   ORDER=3                       THIRD-ORDER plot
                50.00000
                 0.07122
                55.00000
                 0.07378
                60.00000
                 0.07631
                65.00000
                 0.07882

Intermediate values
not shown for brevity

               750.00000
                 0.29263
               800.00000
                 0.30479
               850.00000
                 0.31744


   PEN?
          2.00000    RUN
   LINE TYPE?
                     RUN
```

```
ORDER=4                          FOURTH-ORDER plot
                50.00000
                 0.07036
                55.00000
                 0.07312
                60.00000
                 0.07585
                65.00000
                 0.07853

Intermediate values
not shown for brevity

               750.00000
                 0.29338
               800.00000
                 0.30313
               850.00000
                 0.31114



   PEN?
          2.00000    RUN
   LINE TYPE?
                     RUN

ORDER=5                          FIFTH-ORDER plot
                50.00000
                 0.06976
                55.00000
                 0.07273
                60.00000
                 0.07563
                65.00000
                 0.07848


Intermediate values
not shown for brevity



               750.00000
                 0.29298
               800.00000
                 0.30339
               850.00000
                 0.31373



   PEN?
          2.00000    RUN
   LINE TYPE?
                     RUN
```

```
ORDER=6                          SIXTH-ORDER plot
              50.00000
               0.06839
              55.00000
               0.07186
              60.00000
               0.07521
              65.00000
               0.07843


Intermediate values
not shown for brevity

             750.00000
               0.29397
             800.00000
               0.30296
             850.00000
               0.30561



  PEN?
         2.00000    RUN
  LINE TYPE?
                    RUN

ORDER=7
              50.00000          SEVENTH-ORDER plot
               0.06867
              55.00000
               0.07202
              60.00000
               0.07526
              65.00000
               0.07841


Intermediate values
not shown for brevity

             750.00000
               0.29421
             800.00000
               0.30291
             850.00000
               0.30130



  PEN?
         2.00000    RUN
  LINE TYPE?
                    RUN
  XEQ GRAT?
      3.000000000   RUN
```

All curves have been plotted. HPPLOT now prompts "XEQ GRAT?", since flag Ø1 is CLEAR.

```
PEN?                                    Major graticules pen selection
                    RUN
MAX FIX?                                Use default line type of 1
                    RUN
XEQ TICK?                               Use default MAX FIX of 3
          3.00000   RUN
PEN?
          2.00000   RUN
LABEL?
          3.00000   RUN



EDIT FILE?
          3.00000   RUN
EXISTING FILE
PURGE?
                    RUN
RVW TITLES?
          3.00000   RUN
DIELECTRIC DC-375 3 1/8
IN RIGID LINE
FREQUENCY, MHZ
ATTENUATION, dB/100 FT
OK?
          3.00000   RUN
PEN?
                    RUN
DONE
```

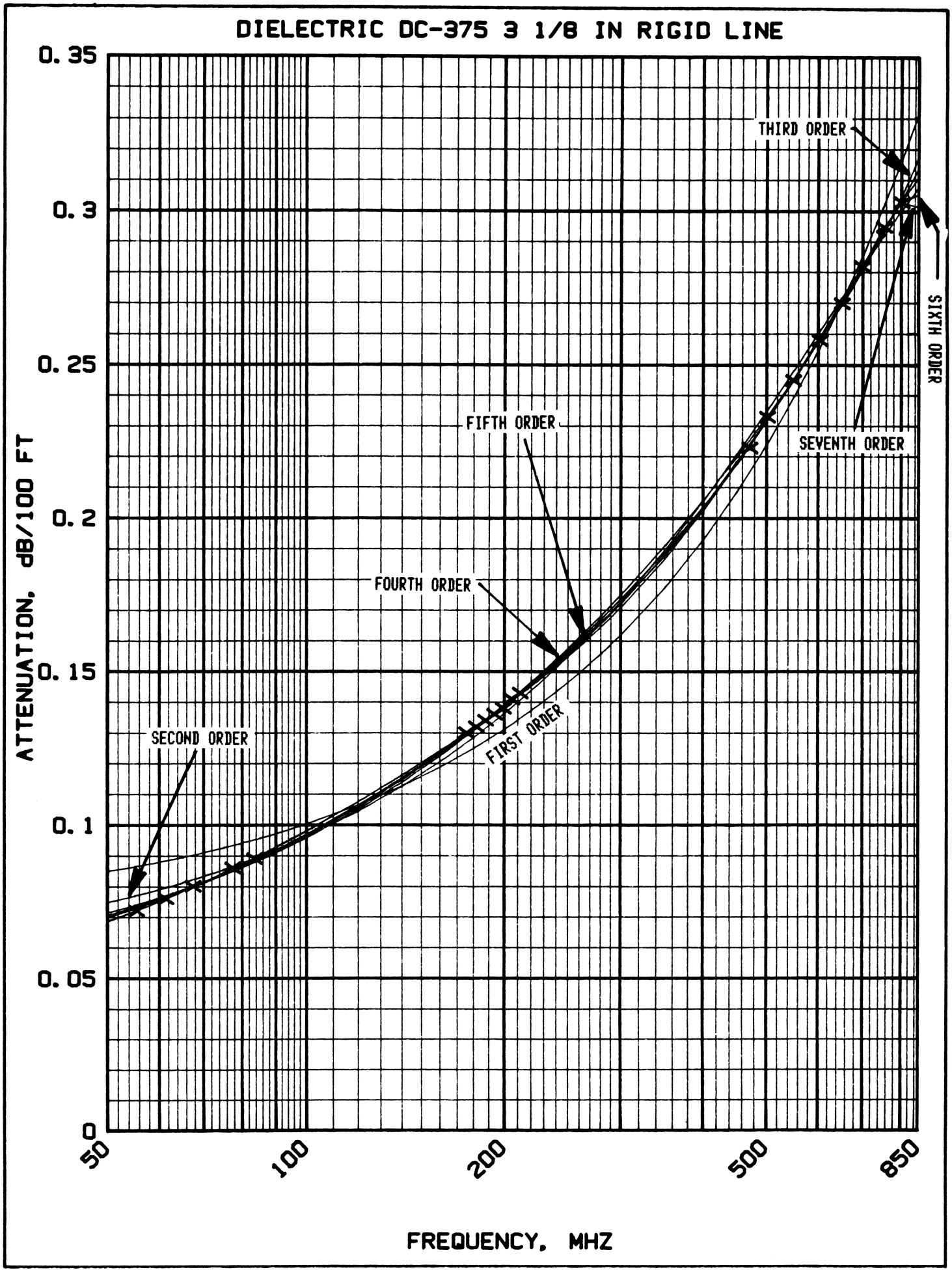
GRAT and TICK have now been called from extended memory and executed. TICK prompts "LABEL?"; a "yes" response causes PLTLBL to be called from extended memory, overwriting TICK. PLTLBL prompts "EDIT FILE?" since a LABELS file was found to exist from a prior run. Entering the text editor mode shows that the LABELS file from EXAMPLE II is also appropriate for EXAMPLE V. PLTLBL next prompts "RVW TITLES?"; a "yes" response causes the text file to be printed on the peripheral printer for review. Finding the text satisfactory, a "yes" response is made to the "OK?" prompt. PLTLBL then proceeds to label the plot.

This is the calculator configuration at the end of PLTLBL:

```
                CAT 1                                   CAT 4
LBL'U80                                 LABELS  A022
LBL'U81                                 XYDAT   D040
LBL'U82                                 POLY1   D003
LBL'U83                                 POLY2   D004
LBL'U84                                 POLY3   D005
END         188 BYTES                   POLY4   D006
LBL'POLY                                POLY5   D007
END         121 BYTES                   POLY6   D008
LBL'PLTLBL                              POLY7   D009
.END.       699 BYTES                   GRAT    P083
                                        TICK    P078
                                        PLTLBL  P100
                                        HPPLOT  P181
                                              28.000    ***
```

```
                    RUN
SET FLAGS
```

A "R/S" after the "DONE" display causes PLTLBL to call HPPLOT from extended memory, overwriting itself.


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
ATTENUATION, dB/100 FT
50
100
200
500
850
FREQUENCY, MHZ
THIRD ORDER
SIXTH ORDER
FIFTH ORDER
SEVENTH ORDER
FOURTH ORDER
SECOND ORDER
FIRST ORDER

```
                    XEQ A
SET FLAGS
                    CF 00
                    CF 01
                    CF 02
                    SF 03
                    CF 04
                    SF 05
                    SF 08
                    SF 09
                      RUN
FUNCTION?
                      RUN
X MIN?
                      RUN
X MAX?
                      RUN
Y MIN?
          -3.00000  RUN
Y MAX?
           3.00000  RUN
GRAT DLTA Y?
           1.00000  RUN
NMBR TICKS?
           5.00000  RUN
FRAME?
           3.00000  RUN
DIGITIZE?
                      RUN
PEN?
                      RUN



PEN?
                      RUN
LINE TYPE?
                      RUN

 ORDER=1
              55.25000000
              20.08253668
              61.25000000
              16.20133407
              67.25000000
              12.70825171
              77.25000000
               8.437109128

Intermediate values
not shown for brevity
```

The higher order polynomial curves match the data so well it is difficult to tell which curve best fits the data, or the lowest order polynomial which fits the data to the user's required precision. Therefore, re-plot the seven curves with flag 05 SET, so the percent errors of f(x) are plotted instead of f(x).

FC00: vertically-oriented plot
FC01: no auto execution of GRAT/TICKPLTLBL
FC02: full length minor graticules
FS03: logarithmic X
FC04: linear Y
FS05: plot percent error of f(x)
FS08: tabulate (X,Y) values
FS09: pen and line type prompts between curves

The prior function name, Xmin, and Xmax values are re-used if no entry is made

Note that the Ymin and Ymax values have been re-set to +-3%

Pen selection for framing

Note that there is no "PLOT PTS?" prompt when flag 05 is SET, as the ordinate is a percent errors scale, and not an f(x) scale

The percent errors of f(x) are now printed. For brevity, intermediate values are not shown.

Pen selection for FIRST-ORDER percent errors plot

```
                753.2500000
                2.404554915
                801.2500000
                4.594764620
                850.0000000



     PEN?
                      RUN
     LINE TYPE?
          4.000000000    RUN

     ORDER=2
                55.25000000
                6.814031153
                61.25000000
                4.629671882
                67.25000000
                2.647223650
                77.25000000
                0.488893605

Intermediate values
not shown for brevity
                753.2500000
               -0.971383797
                801.2500000
               -0.871116271
                850.0000000



     PEN?
                      RUN
     LINE TYPE?
          5.000000000    RUN

     ORDER=3
                55.25000000
                2.645620250
                61.25000000
                1.233747618
                67.25000000
               -0.076873738
                77.25000000
               -1.314202628

Intermediate values
not shown for brevity


                753.2500000
               -0.540054712
                801.2500000
                0.692168020
                850.0000000
```

Pen selection for SECOND-ORDER percent errors plot

Pen selection for THIRD-ORDER percent errors plot

```
     PEN?
                         RUN
     LINE TYPE?
          6.000000000    RUN

     ORDER=4                    Pen selection for FOURTH-ORDER percent
               55.25000000      errors plot
                1.751183417
               61.25000000
                0.687861592
               67.25000000
               -0.338573500
               77.25000000
               -1.217121488

Intermediate values
not shown for brevity

              753.2500000
               -0.320186712
              801.2500000
                0.115699637
              850.0000000



     PEN?
                         RUN
     LINE TYPE?
          7.000000000    RUN

     ORDER=5                    Pen selection for FIFTH-ORDER percent
               55.25000000      errors plot
                1.213924625
               61.25000000
                0.463578434
               67.25000000
               -0.318482263
               77.25000000
               -0.907771279

Intermediate values
not shown for brevity


              753.2500000
               -0.451667051
              801.2500000
                0.214712541
              850.0000000
```

```
PEN?
                    RUN
LINE TYPE?
     8.000000000    RUN

ORDER=6
           55.25000000
           0.048352500
           61.25000000
           0.037009579
           67.25000000
          -0.192908125
           77.25000000
          -0.173132965

Intermediate values
not shown for brevity

           753.2500000
          -0.115187932
           801.2500000
           0.039555941
           850.0000000
```

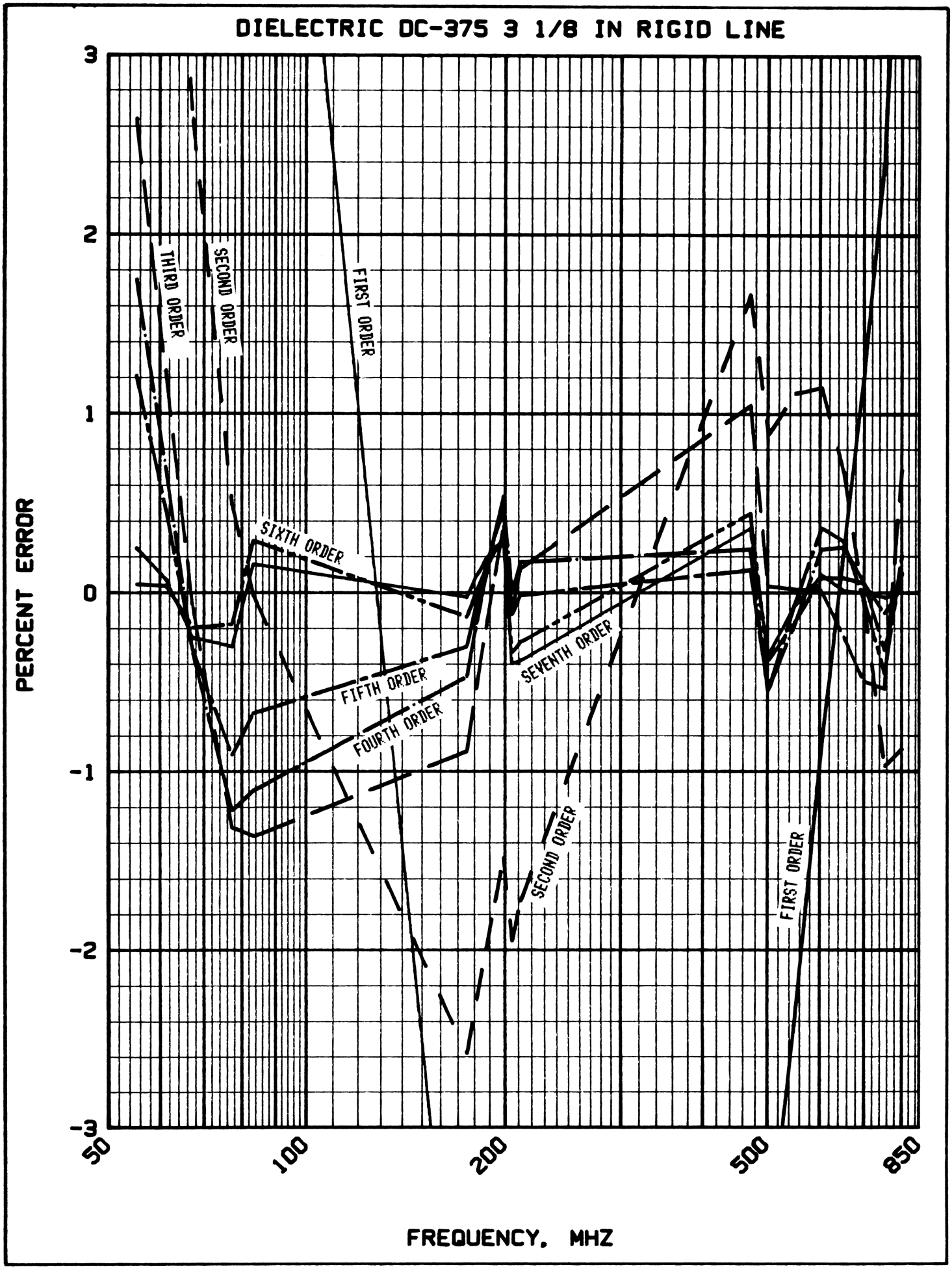
Pen selection for SIXTH-ORDER percent errors plot

```
PEN?
     2.000000000    RUN
LINE TYPE?
                    RUN

ORDER=7
           55.25000000
           0.250384583
           61.25000000
           0.075888908
           67.25000000
          -0.252789788
           77.25000000
          -0.300674651

Intermediate values
not shown for brevity

           753.2500000
          -0.026492339
           801.2500000
           0.010330957
           850.0000000

PEN?
                    RUN
LINE TYPE?
                    RUN
```

Pen selection for SEVENTH-ORDER percent errors plot

```
XEQ GRAT?
     3.000000000    RUN
PEN?
                    RUN
MAX FIX?
                    RUN
XEQ TICK?
         3.00000    RUN
PEN?
         2.00000    RUN
LABEL?
         3.00000    RUN
EDIT FILE?
         3.00000    RUN
EXISTING FILE
PURGE?
                    RUN
RVW TITLES?
         3.00000    RUN
DIELECTRIC DC-375 3 1/8
IN RIGID LINE
FREQUENCY, MHZ
PERCENT ERROR
OK?
         3.00000    RUN
PEN?
                    RUN
DONE
                    RUN
SET FLAGS
```

Since flag 01 was CLEAR, HPPLOT prompts for whether to execute GRAT. Any non-zero response is interpreted as "yes".


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
PERCENT ERROR
FREQUENCY, MHZ
3
2
1
0
-1
-2
-3
50
100
200
500
850
THIRD ORDER
SECOND ORDER
FIRST ORDER
SIXTH ORDER
FIFTH ORDER
FOURTH ORDER
SEVENTH ORDER
SECOND ORDER
FIRST ORDER

This is the calculator configuration at the completion of the percent errors plot. Note the POLYn files in extended memory.

```
                CAT 1
LBL'U80
LBL'U81
LBL'U82
LBL'U83
LBL'U84
END          188 BYTES
LBL'POLY
END          121 BYTES
LBL'HPPLOT
.END.        1266 BYTES
```

```
                                CAT 4
LABELS  A022
XYDAT   D040
POLY1   D003
POLY2   D004
POLY3   D005
POLY4   D006
POLY5   D007
POLY6   D008
POLY7   D009
GRAT    P083
TICK    P078
PLTLBL  P100
HPPLOT  P181
                  28.000    ***
```

```
POLY1
        PURFL
POLY2
        PURFL
POLY3
        PURFL
POLY4
        PURFL
POLY5
        PURFL
POLY7
        PURFL
```

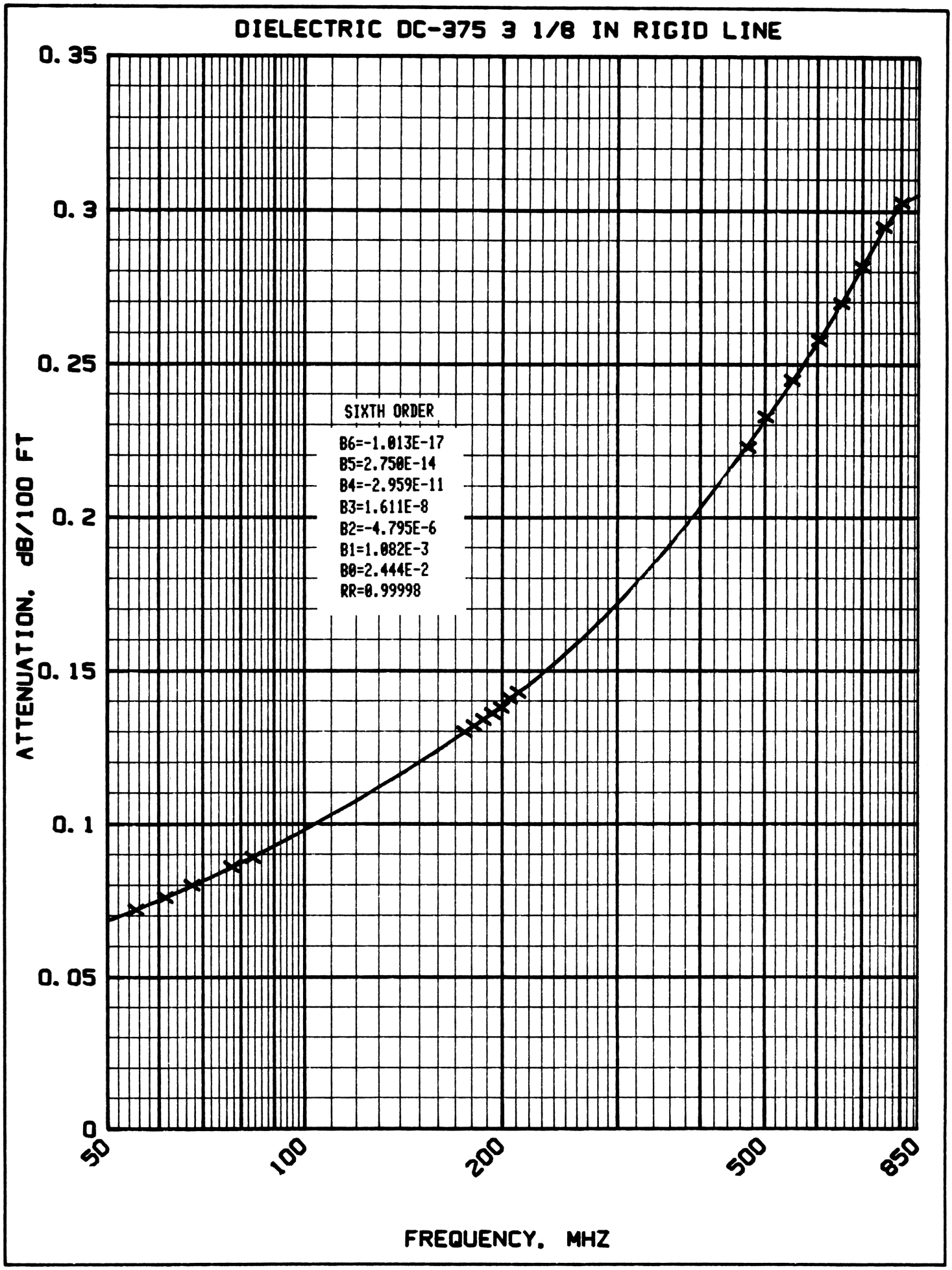
Examine the percent errors plot to determine which polynomial order (if any) models the data to the desired accuracy. A sixth-order polynomial models the data within +-0.5%. Use the PURFL command to delete the POLY1, POLY2, POLY3, POLY4, POLY5, and POLY7 files from extended memory, leaving only the POLY6 file

This is now the calculator configuration:

```
                CAT 1
LBL'U80
LBL'U81
LBL'U82
LBL'U83
LBL'U84
END          188 BYTES
LBL'POLY
END          121 BYTES
LBL'HPPLOT
.END.        1266 BYTES
```

```
                                CAT 4
LABELS  A022
XYDAT   D040
POLY6   D008
GRAT    P083
TICK    P078
PLTLBL  P100
HPPLOT  P181
                  74.000    ***
```

```
                                  Re-execute HPPLOT to obtain the final curve
                  XEQ A           fit plot
SET FLAGS
                  CF 00           FC00: vertically-oriented plot
                  CF 01           FS01: auto execution of GRAT/TICK/PLTLBL
                  CF 02           FC02: full length minor graticules
                  SF 03           FS03: logarithmic X
                  CF 04           FC04: linear Y
                  CF 05           FC05: plot f(x), not percent errors of f(x)
                  CF 08           FC08: no tabulation of (X,Y) values
                  CF 09           FS09: pen prompts between curves
                    RUN
FUNCTION?
POLY                RUN
X MIN?
                    RUN
X MAX?
                    RUN
Y MIN?
          0.00000   RUN
Y MAX?
           .35000   RUN
GRAT DLTA Y?
           .05000   RUN
NMBR TICKS?
          5.00000   RUN
FRAME?
          3.00000   RUN
DIGITIZE?
                    RUN
PEN?                                Pen selection for framing
                    RUN
PEN?                                Pen selection for "X" symbols
                    RUN
LINE TYPE?
                    RUN
PLOT PTS?
          3.00000   RUN

ORDER=6
XEQ GRAT?
       3.000000000  RUN
PEN?
                    RUN
MAX FIX?
                    RUN
XEQ TICK?
          3.00000   RUN
PEN?
          2.00000   RUN
LABEL?
          3.00000   RUN
EDIT FILE?
          3.00000   RUN
EXISTING FILE
PURGE?
                    RUN
RVW TITLES?
          3.00000   RUN
```


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
ATTENUATION, dB/100 FT
SIXTH ORDER
B6=-1.013E-17
B5=2.750E-14
B4=-2.959E-11
B3=1.611E-8
B2=-4.795E-6
B1=1.082E-3
B0=2.444E-2
RR=0.99998
50
100
200
500
850
FREQUENCY, MHZ

```
DIELECTRIC DC-375 3 1/8
IN RIGID LINE
FREQUENCY, MHZ
ATTENUATION, dB/100 FT
OK?
        3.00000    RUN
PEN?
                   RUN
DONE
                   RUN


SET FLAGS
                 XEQ A
SET FLAGS
                 CF 00
                 SF 01
                 CF 02
                 CF 03
                 CF 04
                 CF 05
                 CF 08
                 CF 09
                   RUN
FUNCTION?
                   RUN
X MIN?
       400.00000   RUN
X MAX?
      1100.00000   RUN
DELTA X?
        10.00000   RUN
GRAT DLTA X?
       100.00000   RUN
NMBR TICKS?
         5.00000   RUN
Y MIN?
          .15000   RUN
Y MAX?
          .33000   RUN
GRAT DLTA Y?
          .05000   RUN
NMBR TICKS?
         5.00000   RUN
FRAME?
         3.00000   RUN
DIGITIZE?
                   RUN
PEN?
                   RUN
PEN?
                   RUN
LINE TYPE?
                   RUN
PLOT PTS?
         3.00000   RUN

ORDER=6
DONE
```

GRAT, TICK, and PLTLBL have been executed.

Notice that the curve appears to be ill behaved for values above 850 MHz. A closer look is in order.

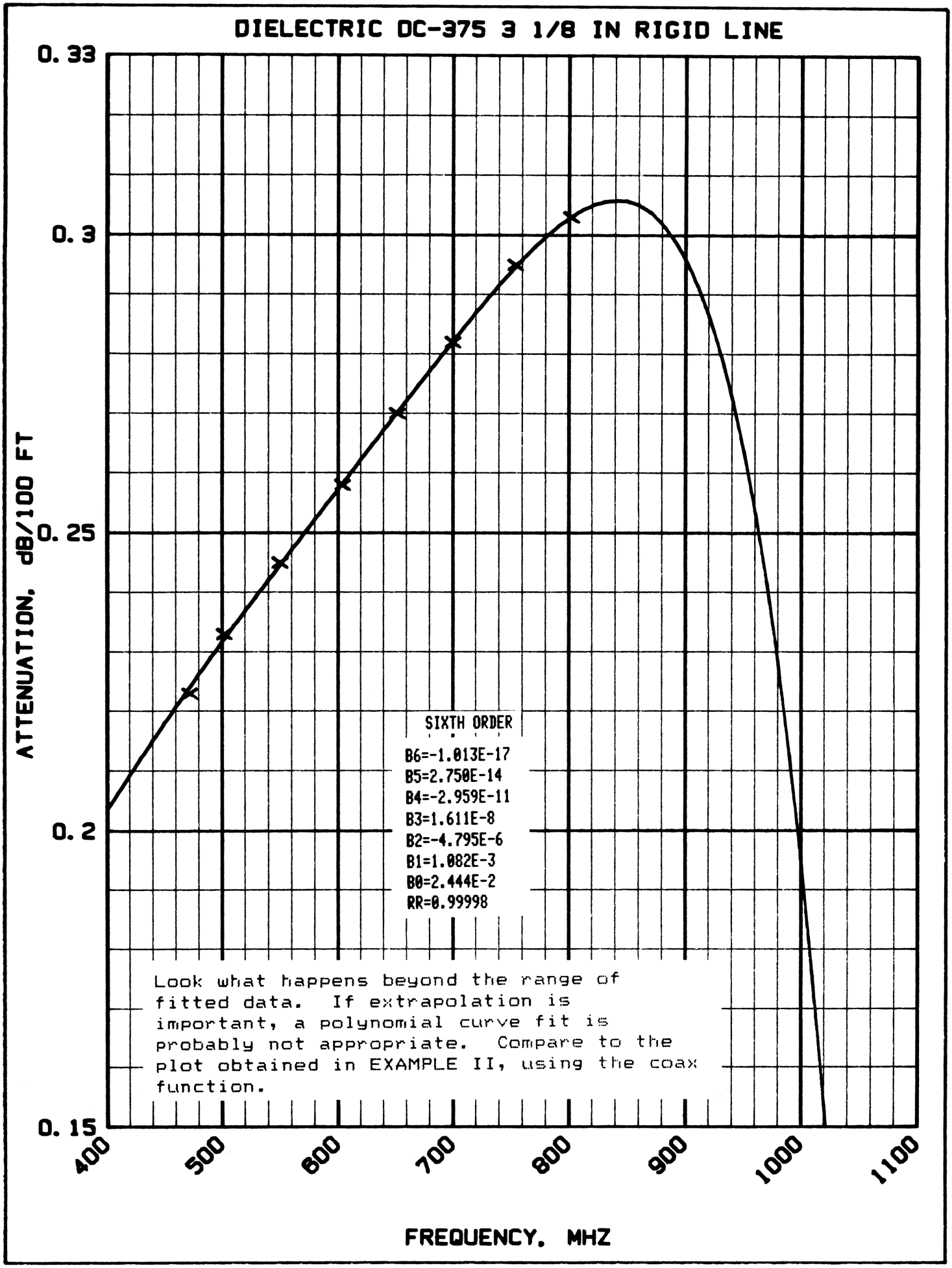
Re-plot to examine behavior above 850 MHz.

FC00: vertically-oriented plot
FS01: auto execution of GRAT/TICK/PLTLBL
FC02: full length minor graticules
FC03: linear X
FC04: linear Y
FC05: plot f(x), not percent errors of f(x)
FC08: no tabulation of (X,Y) values
FC09: no pen prompts between curves

Select pen for framing

Select pen for "X" symbols and for plotting

Plot completed. All done.


DIELECTRIC DC-375 3 1/8 IN RIGID LINE
0.33
0.3
0.25
0.2
0.15
ATTENUATION, dB/100 FT
400
500
600
700
800
900
1000
1100
FREQUENCY, MHZ
SIXTH ORDER
B6=-1.013E-17
B5=2.750E-14
B4=-2.959E-11
B3=1.611E-8
B2=-4.795E-6
B1=1.082E-3
B0=2.444E-2
RR=0.99998
Look what happens beyond the range of fitted data. If extrapolation is important, a polynomial curve fit is probably not appropriate. Compare to the plot obtained in EXAMPLE II, using the coax function.

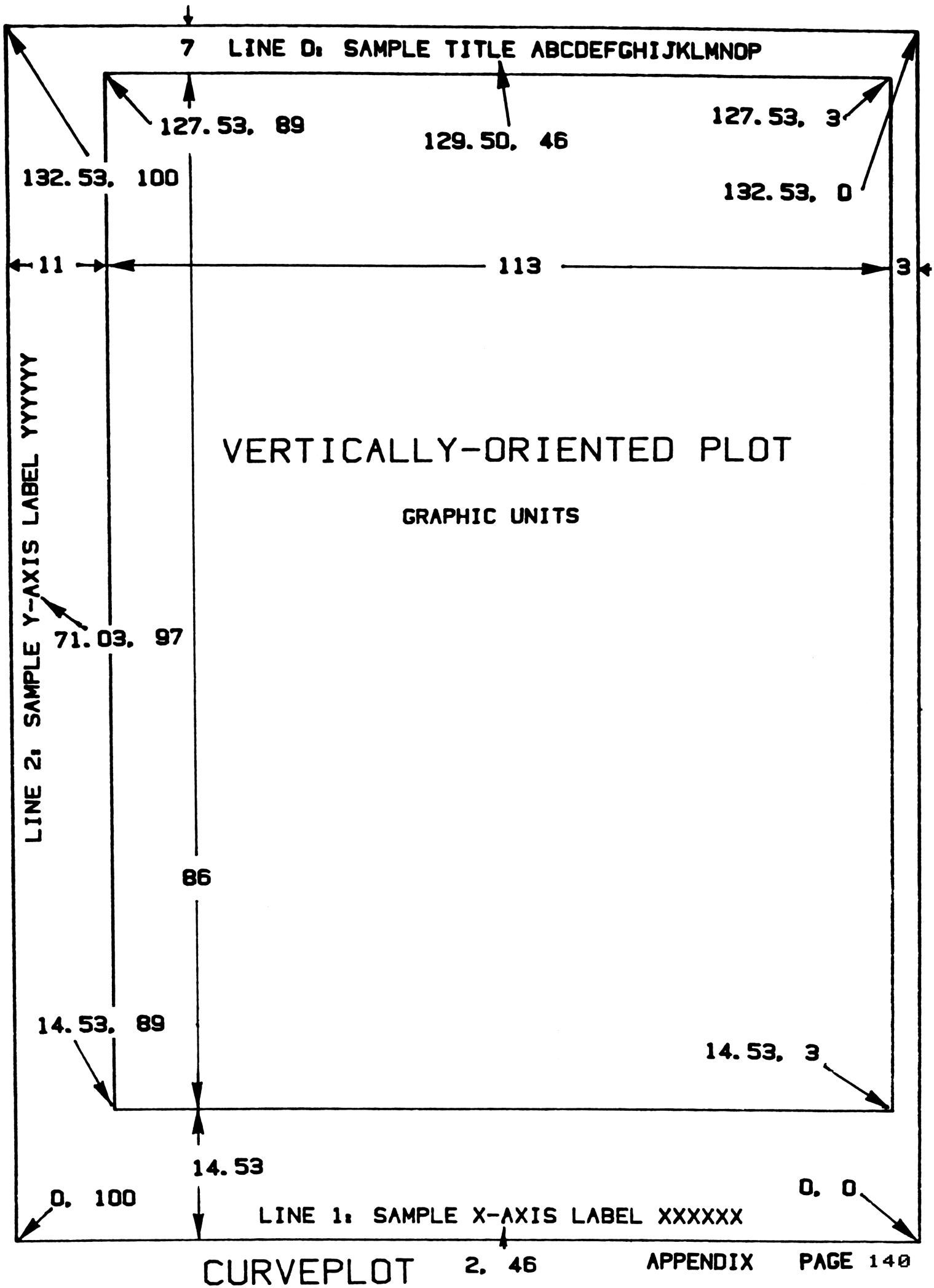
BYTE COUNTS

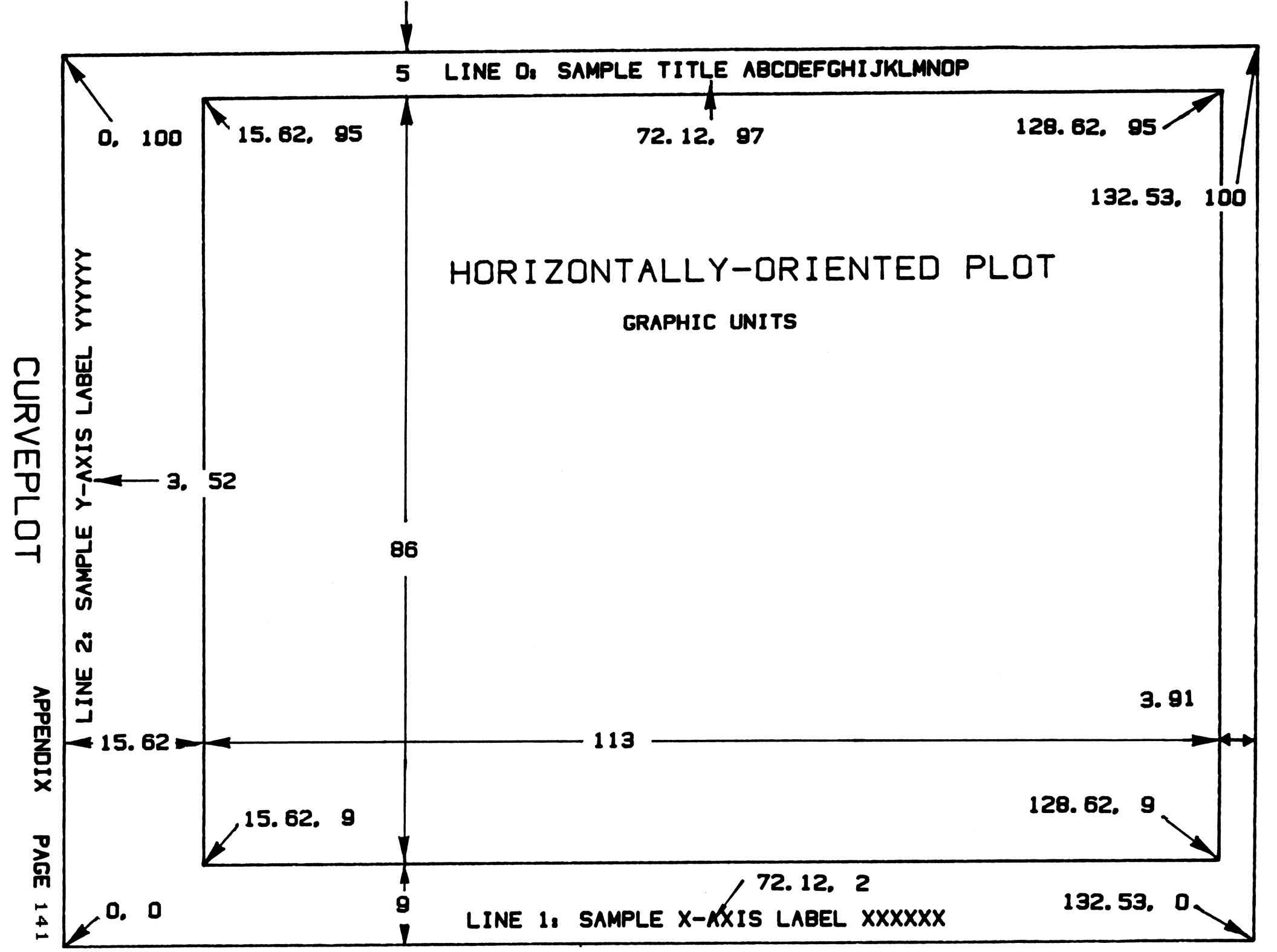
Program	Bytes	Extended Memory File Size
HPPLOT	1266	181
GRAT	575	83
TICK	545	78
PLTLBL	699	100
U80	188	
PLTPRP	23	
MCFA	546	
MCFB	1491	
MCFC	289	
EDTDAT	162	
POLYN	896	
POLY	121	

This is a directory of the programs included on the mini-data cassette provided with CURVEPLOT. To avoid inadvertent overwriting or purging, all files have been secured.

DIR

NAME	TYPE	REGS
MCFC	PR,S	42
U80	PR,S	27
PLTLBL	PR,S	100
TICK	PR,S	78
GRAT	PR,S	83
HPPLOT	PR,S	180
PLTPRP	PR,S	4
PLTPRP1	WA,S,A	336
PLTPRP2	WA,S,A	336
PLTPRP3	WA,S	336
POLY	PR,S	18
PLTPRP4	WA,S	336
PLTPRP5	WA,S	336
MCFA	PR,S	78
MCFB	PR,S	213
HOERL	PR,S	8
PREP1	PR,S	7
PREP2	PR,S	14
XSIN1/	PR,S	4
EDTDAT	PR,S	25
POLYN	PR,S	126


7 LINE 0: SAMPLE TITLE ABCDEFGHIJKLMNOP
127.53, 89
129.50, 46
127.53, 3
132.53, 100
132.53, 0
11
113
3
VERTICALLY-ORIENTED PLOT
GRAPHIC UNITS
LINE 2: SAMPLE Y-AXIS LABEL YYYYYY
71.03, 97
86
14.53, 89
14.53, 3
14.53
0, 100
0, 0
LINE 1: SAMPLE X-AXIS LABEL XXXXXX
2, 46


5 LINE 0: SAMPLE TITLE ABCDEFGHIJKLMNOP
0, 100
15.62, 95
72.12, 97
128.62, 95
132.53, 100
HORIZONTALLY-ORIENTED PLOT
GRAPHIC UNITS
LINE 2: SAMPLE Y-AXIS LABEL YYYYYY
3, 52
86
3.91
15.62
113
128.62, 9
15.62, 9
72.12, 2
0, 0
9
132.53, 0
LINE 1: SAMPLE X-AXIS LABEL XXXXXX

CURVEPLOT

LINE TYPES

HPPLOT adds a "LINE TYPE?" prompt to the "PEN?" prompt if flag 06 is SET. The eight line types are as follows:

The default line type is line one.

LINE 1

LINE 2

LINE 3

LINE 4

LINE 5

LINE 6

LINE 7

LINE 8

EPROM MODIFICATIONS

If the user has access to an 8K or larger plug-in EPROM for the HP41CX, such as the ERAMCO Systems EPROM, programs HPPLOT, GRAT, TICK, PLTLBL, MCFA, MCFB, and POLYN can be modified to simply go to the appropriate program, rather than calling programs from extended memory or digital cassette drive.

One benefit of placing the entire CURVEPLOT operating system into an EPROM is faster program execution, since no time is lost while waiting for programs to be retrieved from extended memory or digital cassette drive. Another benefit is the greatly expanded availability of extended memory for XYDAT, CRVDAT, POLYn, and LABELS data and text files; well over 200 (X,Y) pairs can be accomodated with two extended memory modules if extended memory is not needed for program storage.

A third benefit is the elimination of program PLTPRP, as there is no longer a need to specially configure the HP41CX. A fourth benefit is that all HP41CX RAM becomes available for called functions.

The following changes should be made to programs HPPLOT, GRAT, TICK, PLTLBL, MCFA, MCFB, and POLYN if an EPROM device is available:

HPPLOT CHANGES

1. Change line 412 from "GTO 00" to "GTO 'GRAT'".
2. Change line 417 from "GTO 00" to "GTO 'GRAT'".
3. Delete lines 421 through 424.

GRAT CHANGES

1. Change line 264 from "GTO 50" to "GTO 'TICK'".
2. Change line 268 from "GTO 50" to "GTO 'TICK'".
3. Change line 272 from "'PLTLBL'" to "GTO 'PLTLBL'".
4. Change line 273 from "X=0?" to "GTO 'HPPLOT'".
5. Change line 274 from "'HPPLOT'" to "GTO 49".
6. Delete lines 275 through 280.

TICK CHANGES

1. Change line 209 from "GTO 00" to "GTO 'PLTLBL'".
2. Change line 213 from "GTO 00" to "GTO 'PLTLBL'".
3. Change line 214 from "'HPPLOT'" to "GTO 'HPPLOT'".
4. Delete line 215.

PLTLBL CHANGES

1. Change line 311 from "'HPPLOT'" to "GTO 'HPPLOT'".
2. Delete line 312.

MCFA CHANGES

1. Change line 330 from "'MCFB'" to "GTO 'MCFB'".
2. Delete line 332.

MCFB CHANGES

1. Change line 682 from "GTO 00" to "GTO 'EDTDAT'".
2. Change line 683 from "'PLTPRP'" to "24".
3. Change line 684 from "READP" to "PSIZE".
4. Change line 685 from "GTO E" to "CLRG".
5. Change line 686 from "LBL 00" to "GTO 'HPPLOT'".
6. Delete lines 687 through 689.

POLYN CHANGES

1. Change line 460 from "XEQ PLTPRP?" to "23".
2. Change line 461 from "PROMPT" TO "PSIZE".
3. Change line 462 from "X=0?" to "CLRG".
4. Change line 463 from "GTO 00" to "GTO 'HPPLOT'".
5. Change line 464 from "STOP" to "GTO 90".
6. Delete lines 465 through 469.
7. Delete line 458.