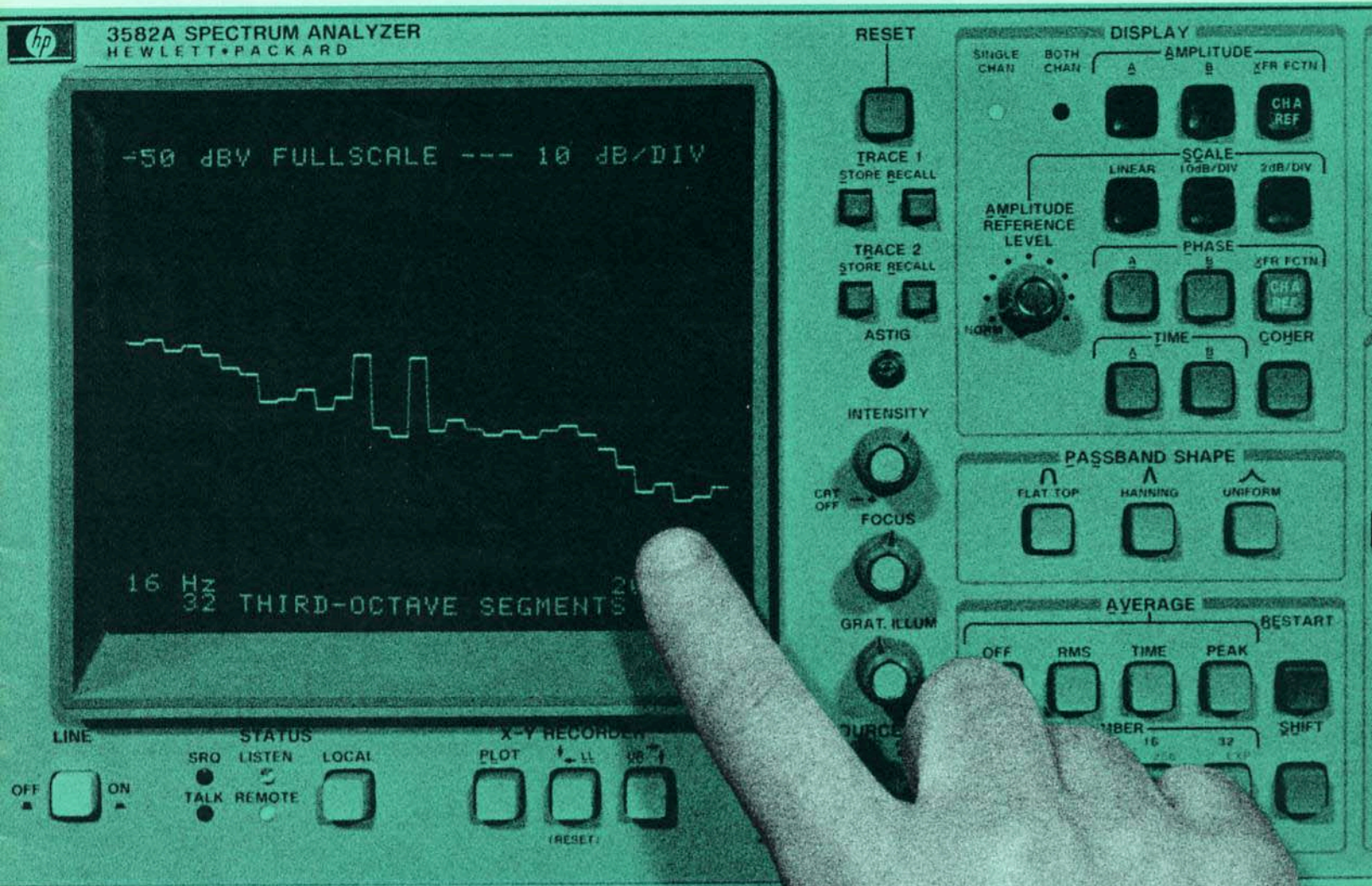


# THIRD OCTAVE ANALYSIS WITH THE HP 3582A SPECTRUM ANALYZER



## FOREWORD

Low frequency analyzers based on digital signal processing – especially the Fast Fourier Transform algorithm – are rapidly replacing older analog spectrum analyzers for a variety of measurement tasks. However, even the most enthusiastic FFT analyzer users recognize that there are some measurements for which they are not particularly suited. Log frequency sweep and 1/3 octave analysis are examples.

Nevertheless, the combination of an FFT analyzer and a “friendly” (i.e., easily programmed) small computer can perform a greater variety of measurements than the analyzer itself can do. For this to happen, it is essential to have fast, efficient communication between the two. The Hewlett-Packard Interface Bus (HP-IB\*) serves this need well.

1/3 octave analysis is the measurement of a frequency spectrum by the use of constant percentage bandwidth

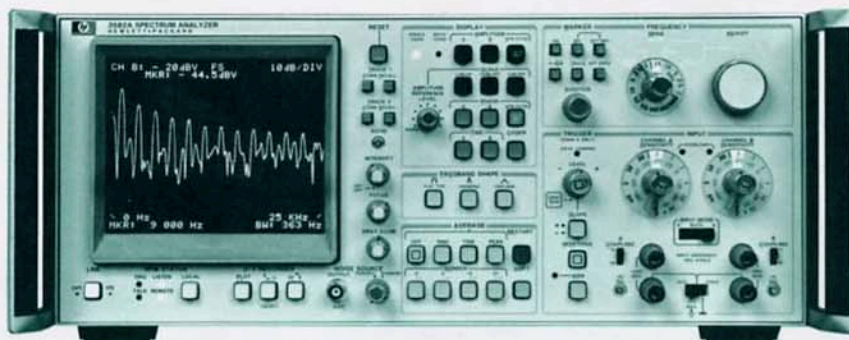
filters 1/3 octave wide and spaced 1/3 octave. It has long been popular for audio and acoustic applications, largely because of the relationship between this filtering technique and certain psychoacoustic properties of human hearing.

This application note offers a means for making 1/3 octave measurements with a 3582A Spectrum Analyzer controlled by a 9835A Desktop Computer. Enough information is included (program listing, flowcharts, and description) to enable the reader to use it directly or to modify it as he requires.

\*HP-IB is Hewlett-Packard's implementation of IEEE Standard 488 and identical ANSI Standard MC1.1 “Digital interface for programmable instrumentation.”

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## THE HEWLETT-PACKARD MODEL 3582A SPECTRUM ANALYZER



The HP 3582A is a spectrum analyzer covering the frequency range of DC to 25 kHz. Although it is a FFT-based, digital instrument, a special design effort has made it as straightforward to use as a conventional swept analyzer. With dual measurement channels it is possible to measure transfer function gain and phase, as well as the coherence function. A built-in random or pseudo-

random noise source, whose spectrum tracks the analysis range, is a useful measurement stimulus. Band Selectable Analysis enables narrowband, high resolution analysis to be applied to any portion of the frequency range. The instrument comes equipped with a flexible HP-IB interface for control and two-way data transfers.

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## Section 1: Third octave analysis

In concept, "third octave" analysis is straightforward: imagine a set of parallel-connected filters being used to examine an audio signal. The center frequencies of the filters are scaled by a factor of 1/3 octave; that is, each filter is located at a frequency  $2^{1/3}$  times its lower neighbor. In addition the nominal bandwidth of each filter is  $2^{1/3} - 1$  times its center frequency. To cover the audio range of, say, 20 Hz to 20 kHz (9.97 octaves), with this technique requires 30 filters. Because of the multiplicative frequency spacing and bandwidth of the filters, it is convenient to display their characteristics on a log frequency plot, such as illustrated by Figure 1.

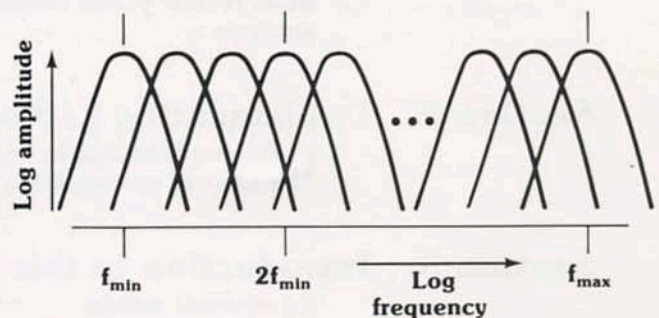
Historically, this kind of analyzer has been implemented with an actual parallel bank of filters. The instantaneous signal amplitude in each filter is detected and converted to dB. The data is displayed on an oscilloscope in the form of a bar graph: log amplitude (vertical) versus log frequency (horizontal).

Although parallel analog filters are still being used in some current instruments, there are at least two newer alternative techniques: digital filtering and FFT synthesis. Of these, the digital filter approach is preferable from the point of view of performance. This is primarily because the hardware can be optimized for the 1/3 octave task

and the display is "real time." However, for the many cases for which "real time" operation is not necessary — meaning that the signal to be analyzed has a stationary spectrum — the FFT technique is attractive, especially if you already have an FFT analyzer! Advantages of the FFT synthesis technique include easy modification of the frequency range and the use of frequency weighting functions if desired.

Figure 1.

Representation of a 1/3 octave analyzer composite filter characteristic



## Section 2: Implementing 1/3 octave analysis with an FFT analyzer

Why can't an FFT analyzer, such as the 3582A, be modified so that it produces a 1/3 octave analysis directly? Primarily because the FFT algorithm generates data on a set of linearly spaced sample points in the frequency domain. Its display has a linear frequency axis, not logarithmic as required by the 1/3 octave data. Also, the individual FFT filters, or "bins," have all the same bandwidth rather than bandwidths proportional to their center frequencies.

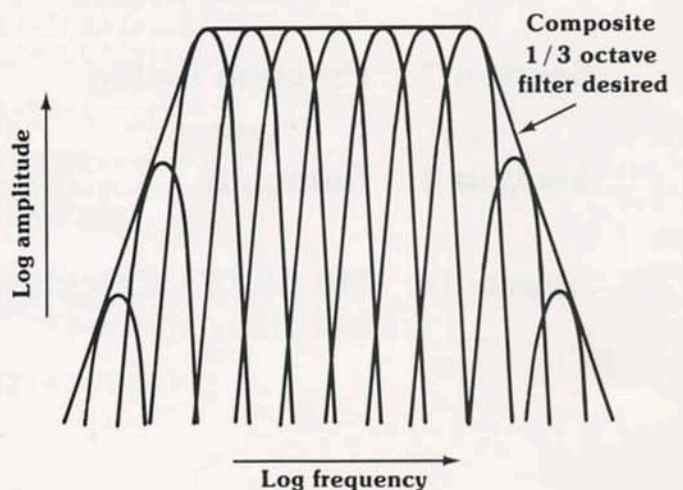
The approach used in this application note is to synthesize the frequency characteristics of 1/3 octave filters by combining the signals from several FFT bins. This requires weighting the contribution from each bin so that the composite "filter" is a good approximation to the specified shape of the 1/3 octave filter in question. Figure 2 indicates how this is done.

At lower frequencies the approximation is not as good because only a few FFT bins can be used. In fact, in the 3582A the bin spacing is 100 Hz when using the 0-25 kHz span. If only this span were used, the lowest frequency third octave filter that could be synthesized would be about 500 Hz. This is certainly not satisfactory for audio analysis. Therefore, to adequately cover the audio range, three spans are used: 0-250 Hz, 0-5 kHz, and

0-25 kHz. The result is 32 third octave filters, with center frequencies ranging from 15.85 Hz to 19.95 KHz (Fig. 3).

Figure 2.

Synthesizing a composite 1/3 octave filter by combining the weighted responses of several FFT filters, or "bins"



## Section 3: Introduction to this program

The equipment needed to use this program for 1/3 octave analysis is a 3582A Spectrum Analyzer (standard equipment includes HP-IB), a 9835A Desktop Computer with a 98332A I/O ROM installed, and a 98034A HP-IB Interface. The program is written in BASIC; it will run on another language-compatible calculator with the appropriate I/O, such as the 9845A. Memory requirements are approximately 15000 bytes for program and variable storage. Using the program listing and the flow diagrams, one can rewrite the program in another language. See the Appendix for the 9825A Calculator version.

Operating the program is simple. Pressing RUN causes the necessary initialization and then the user is asked, "Do you want RMS averaging?" The reason for this is that many spectra are random in nature, and a better estimate of the spectrum — and thus a better 1/3 octave analysis — is obtained when the 3582A is allowed to average the data. (Application Note 245-1, "Signal Averaging with the 3582A Spectrum Analyzer," deals with averaging in detail.) After the user answers the question, the program proceeds to:

- a) set the 3582A to each frequency range in turn
- b) bring the amplitude data for each range from the 3582A display into the controller for processing
- c) convert the data, apply weights, and combine to form 32 synthesized results as if from 1/3 octave filters
- d) format and output these results in the form of a bar-graph display on the 3582A
- e) return to the beginning for another analysis, if desired

Step (c) requires some explanation. How exactly should the data from several FFT bins be combined to approximate the result expected from a 1/3 octave filter? It should be done on the basis of power rather than linear addition. This is because the signals in adjacent FFT bins are uncorrelated when the input is a random time signal. And when a coherent signal is analyzed, such as a sinusoid, the sum of signal power remains constant as the signal frequency varies. This means there is no ripple in the synthesized passband.

In the program, line 3090 converts the FFT bin signals to power (that is, volts squared) from dBV, and line 3180 converts the sum of weighted powers back to dBV.

**Figure 3.**

**Center frequencies of 1/3 octave filters synthesized by this program**

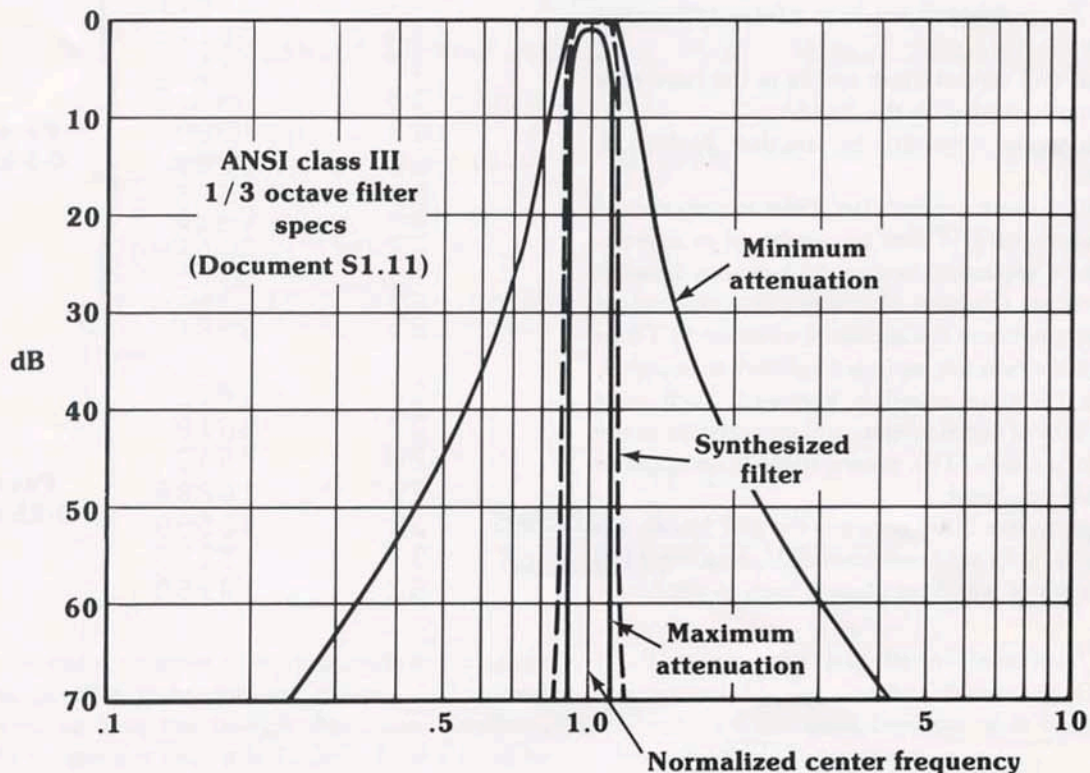
FILTER NUMBER	CENTER FREQ	
1	15.85	}
2	19.95	
3	25.12	
4	31.62	
5	39.81	
6	50.12	
7	63.1	
8	79.43	
9	100	
10	125.9	
11	158.5	
12	199.5	
<b>Pass.1 0-250 Hz</b>		
13	251.2	}
14	316.2	
15	398.1	
16	501.2	
17	631	
18	794.3	
19	1000	
20	1259	
21	1585	
22	1995	
23	2512	
24	3162	
25	3981	
<b>Pass.2 0-5 kHz</b>		
26	5012	}
27	6310	
28	7943	
29	10000	
30	12590	
31	15850	
32	19950	
<b>Pass.3 0-25 kHz</b>		

## Section 4: Comparison with ANSI class III 1/3 octave filters

The American National Standards Institute publishes a document\* recognized as setting proper standards for these filters. The filters synthesized by this program conform closely to the specifications for "Third-Octave Band Filters - Class III," as defined in this paper. Here are the principal characteristics of the filters:

- a) Center frequencies: Strictly speaking, the ANSI document defines these in "tenth decade" intervals, but the difference from third octave is negligible. The greatest deviation from the specified value occurs in filter #20, whose geometric mean frequency is 0.7% below the specified value of 1259 Hz. ( $\pm 3\%$  is allowable).
- b) Transmission loss limits: All filters meet these criteria, although the rolloff rates differ due to the varying number of FFT bins used in the synthesis of individual filters. Filter #13, which uses only 4 bins, reaches -72 dB loss at 1/5 its center frequency, rather than the specified -75 dB. The other extreme is filter #12, which uses 49 bins. The attenuation characteristics of these two filters are shown in Figures 4 and 5, with the specification limits superimposed.
- c) Effective bandwidth (noise bandwidth): This specification requires that the power output from a filter, when the input is white noise, be within 10% of the noise passed by an ideal rectangular 1/3 octave filter. Filter #10 has the greatest deviation, with a noise bandwidth 2.9% higher than standard.
- d) Passband uniformity (passband ripple): The synthesized filters have no perceptible ripple within the defined band-edge frequencies, and so the ripple specification (0.5 dB) does not apply.
- e) Variation of minimum loss among filters: Theoretically, all filters in this program have zero mid-band loss. Some variation will be encountered due to individual 3582A amplitude accuracy characteristics, specifically gain variations between different frequency spans. These will be well within the allowed  $\pm 1$  dB.
- f) Transient response: The program cannot meet this specification, since it is necessary that the signal being analyzed be statistically stationary during the acquisition of data.

**Figure 4.**  
**Filter #12**



\*"AMERICAN NATIONAL STANDARD SPECIFICATION FOR OCTAVE, HALF-OCTAVE, AND THIRD-OCTAVE BAND FILTER SETS," ANSI Specification

S1.11-1966  
American National Standards Institute, Inc.  
1430 Broadway, New York, N.Y. 10018

## Section 5: Suggested extensions to the program

Because of the modular structure of the program, it is simple to modify by adding or deleting sections.

"Modular" means that the action portions of the program are written as subroutines called up as needed by a control sequence located in lines 50 to 150.

Here are some possible modifications:

**PRINTED OUTPUT.** Some users may want a permanent record of the analysis results. The structure of this program makes this an easy job. Simply write an output routine to the desired printer (internal or HP-IB external), listing the contents of "Thirdmag" (dBV) together with the 1/3 octave filter number or center frequency. The center frequency is readily calculated as  $10^{((\text{filter number} + 11)/10)}$  Hz. Append this routine to the program and call it by a statement like

145 GOSUB Printer

This method also could be used to save the data on a mass storage device, like the tape cassette.

**DISPLAY ANNOTATION.** It may be desirable to identify individual filters more readily on the 3582A display. Since there are 32 third octave filters and also room for 32 characters on each of the four display lines, you can fill the lower two lines with digits so that they give the filter number when read vertically:

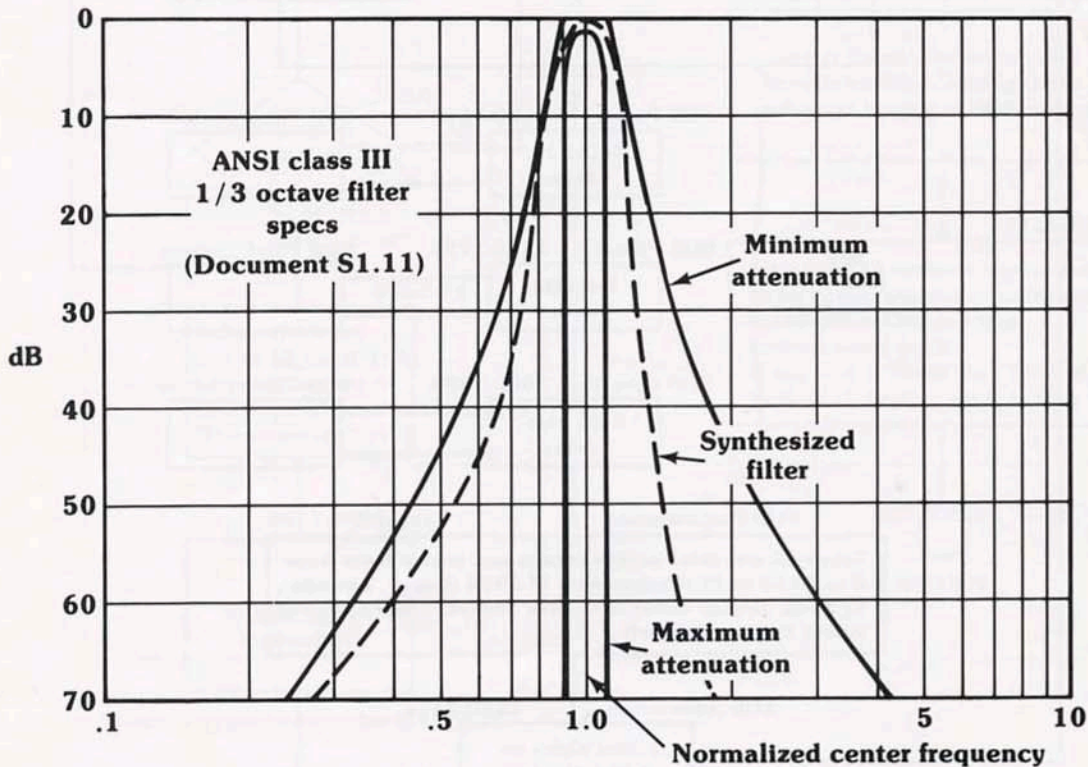
```
0000. . . 2333
1234. . . 9012
```

This change would be made in lines 2540 and 2550 of the program.

**FREQUENCY WEIGHTING.** Some measurements require the application of special shaping to measured spectra. An example is "A" weighting sometimes used in acoustics measurements. It is simple to do this with the present program. What is required is a table of dB loss values for the center frequency of each of the 1/3 octave filters in the program. Then a routine should be written to modify the dBV numbers in "Thirdmag" by these values. The routine should be called up before the display routine by adding, for example, the line

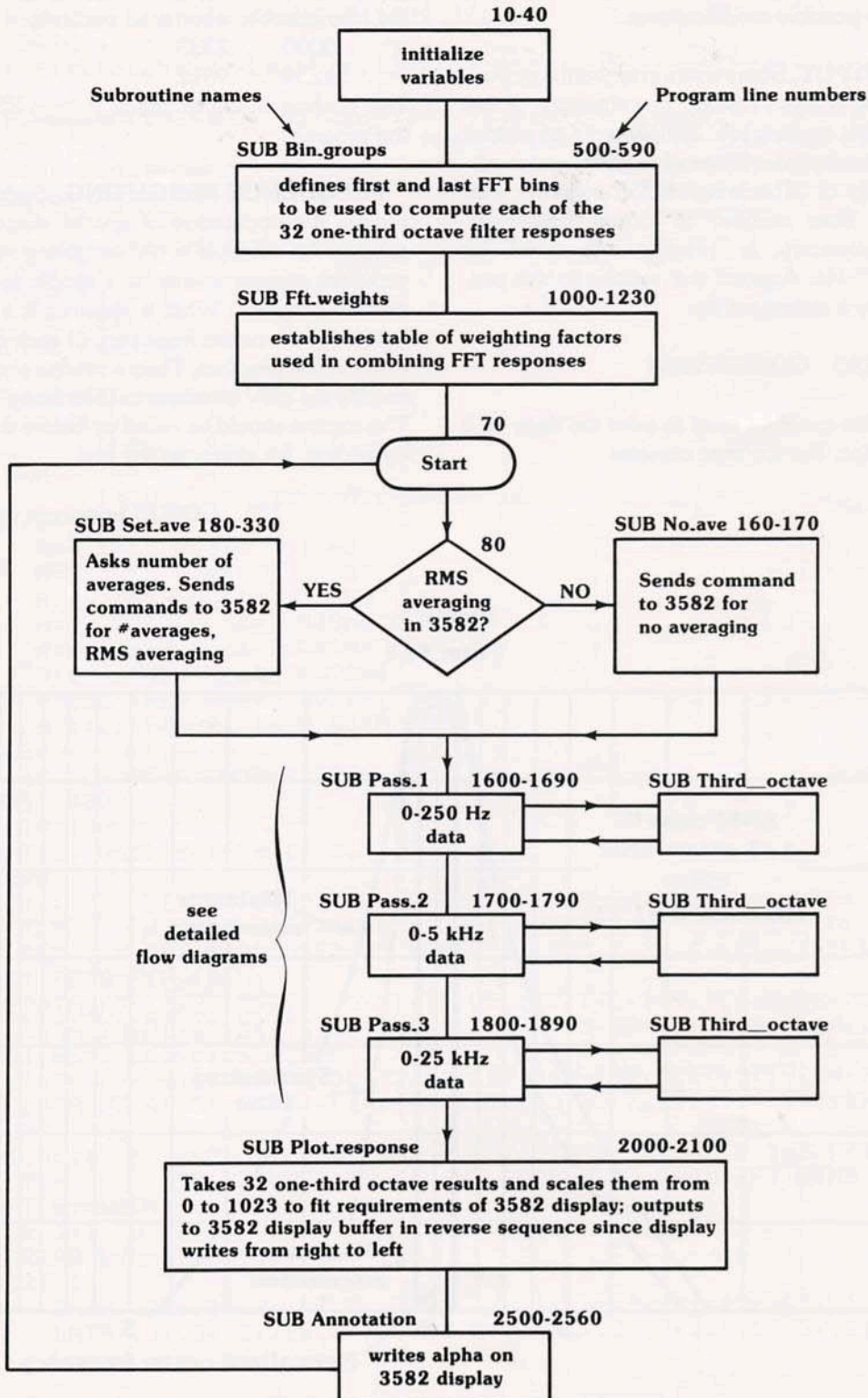
125 GOSUB Spectrum.weight

**Figure 5.**  
**Filter #13**



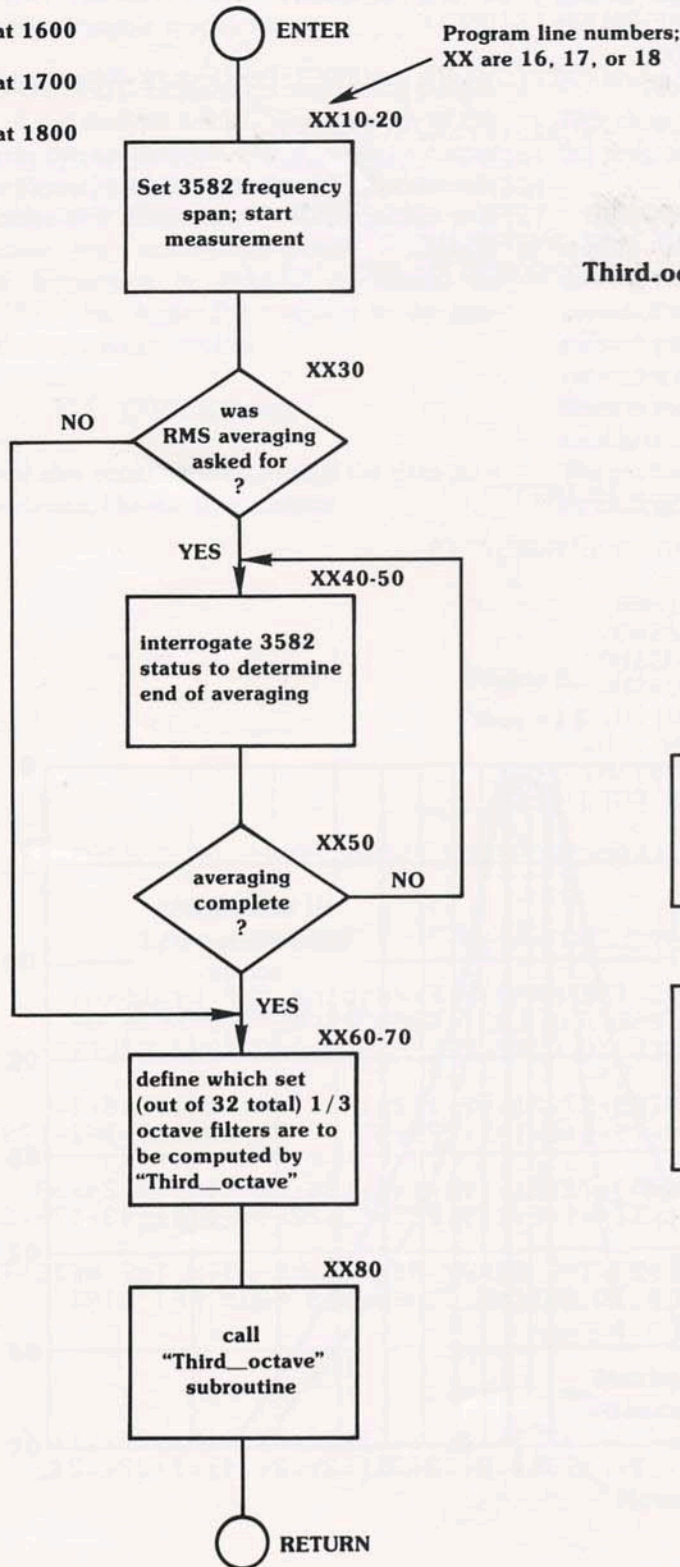
## Section 6: Flow diagrams

**Main Flow Diagram - 1/3 octave program**

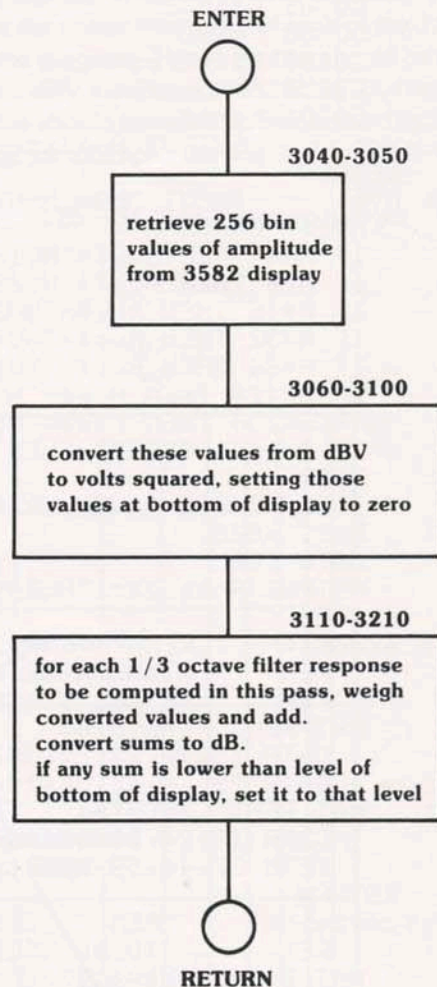


**Detailed Flow Diagram**  
**Pass subroutines - 1/3 octave program**

Pass.1 begins at 1600  
 Pass.2 begins at 1700  
 Pass.3 begins at 1800



**Detailed Flow Diagram**  
**Third.octave subroutine - 1/3 octave program**



## Section 7: Program listing

```

1  REM  1/3 OCTAVE ANALYSIS PROGRAM FOR THE H-P 3582A SPECTRUM
2  REM  ANALYZER AND THE 9800 SERIES 35 CALCULATOR.
3  REM  H-P LOVELAND INSTRUMENT DIVISION.
10 OPTION BASE 1
20 INTEGER Firstbins(32),Lastbins(32),Graphics(256),Analyzer,First_third,Last_
third,A,I,J,K
30 SHORT Binweight(32,49),Thirdmag(32),Fftmag(256),Temp
40 Analyzer=711 !REM  LINES 50 TO 150 COMPRISE THE MAIN
50 GOSUB Bin_groups !REM  CONTROL PROGRAM WHICH CALLS
60 GOSUB Fft_weights !REM  SUBROUTINES IN THE PROPER SEQUENCE
70 Start: INPUT "DO YOU WANT RMS AVERAGING?";Averaging$
80 ON (Averaging$="YES")+1 GOSUB No_ave,Set_ave
90 GOSUB Setup
100 GOSUB Pass_1
110 GOSUB Pass_2
120 GOSUB Pass_3
130 GOSUB Plot_response
140 GOSUB Annotation
150 GOTO Start
160 No_ave: OUTPUT Analyzer;"HLTAV1"
170 RETURN
180 Set_ave: INPUT "HOW MANY AVERAGES?";A
190 Ave$="ERROR"
200 IF A=4 THEN Ave$="NU1SH0"
210 IF A=8 THEN Ave$="NU2SH0"
220 IF A=16 THEN Ave$="NU3SH0"
230 IF A=32 THEN Ave$="NU4SH0"
240 IF A=64 THEN Ave$="NU1SH1"
250 IF A=128 THEN Ave$="NU2SH1"
260 IF A=256 THEN Ave$="NU3SH1"
270 IF Ave$<>"ERROR" THEN GOTO 320
280 BEEP
290 DISP "CHOSE A NUMBER FROM THOSE ON FRONT PANEL OF 3582A"
300 WAIT 4000
310 GOTO 180
320 OUTPUT Analyzer;"HLTAV2LST0",Ave$
330 RETURN
500 Bin_groups: REM  LOADS THE ARRAYS Firstbins AND Lastbins
510 REM  WITH THE FIRST AND LAST NUMBERS OF THE SETS OF
520 REM  FFT BINS USED TO COMPUTE EACH 1/3 OCTAVE FILTER
530 MAT READ Firstbins
540 DATA 15,18,23,29,36,45,57,71,89,112,142,178,12,15,18,23
550 DATA 29,36,45,56,71,89,112,141,178,45,57,71,89,112,142,179
560 MAT READ Lastbins
570 DATA 19,24,30,37,46,58,72,91,114,143,180,226,15,19,24,30
580 DATA 37,46,58,72,91,114,143,179,225,58,72,91,114,143,179,225
590 RETURN
1000 Fft_weights: REM  LOADS THE ARRAY Binweight WITH THE WEIGHTS
1010 REM  TO BE USED IN ADDING RESPONSES FROM FFT BINS
1020 MAT Binweight=(.67)
1030 FOR I=1 TO 32
1040 READ Binweight(I,1)
1050 NEXT I
1060 DATA .25,.1,.3,.3,.3,.2,.2,.2,.1,.2,.3,.2,.15,.25,.1,.2
1070 DATA .3,.3,.2,.2,.2,.1,.1,.2,.2,.1,.2,.2,.1,.1,.3,.2

```

```

1080     FOR I=1 TO 32
1090         READ Binweight(I,2)
1100     NEXT I
1110         DATA .67,.4,.4,.5,.5,.4,.5,.4,.4,.4,.4,.4,.67,.67,.4,.4
1120         DATA .5,.5,.4,.4,.4,.4,.3,.5,.5,.4,.67,.4,.3,.4,.5,.5
1130     FOR I=1 TO 32
1140         READ Binweight(I,Lastbins(I)-Firstbins(I))
1150     NEXT I
1160         DATA .67,.4,.4,.5,.5,.4,.5,.4,.4,.4,.4,.4,.67,.67,.4,.4
1170         DATA .5,.5,.4,.4,.4,.4,.3,.5,.5,.4,.67,.4,.3,.4,.5,.5
1180     FOR I=1 TO 32
1190         READ Binweight(I,Lastbins(I)-Firstbins(I)+1)
1200     NEXT I
1210         DATA .25,.2,.25,.3,.3,.2,.2,.2,.1,.2,.3,.2,.5,.25,.2,.2
1220         DATA .3,.3,.2,.2,.2,.1,.1,.2,.2,.1,.2,.2,.1,.1,.3,.2
1230     RETURN
1500 Setup:     REM     INITIALIZES THE CONTROL SETTINGS OF THE 3582A.
1510         REM     CHAN "A" SENSITIVITY IS OBTAINED FOR PROPER DISPLAY SCALING.
1520         REM     THREE CONSTANTS ARE CALCULATED.
1530     OUTPUT Analyzer;"AA1AB0AX0SC2PA0PB0PX0CH0PS2FR1RP1MD2IM1TR0RR0"
1540     OUTPUT Analyzer;"LAS"
1550     ENTER Analyzer;Sensitivity
1560     Minimum=10↑((Sensitivity-80)/10)
1570     Display_scale=1023/80
1580     Input_scale=8/1023
1590     RETURN
1600 Pass_1:     REM     0 TO 250 Hz
1610     OUTPUT Analyzer;"SP8RUNRE"
1620     WAIT 2000
1630     IF Averaging$<>"YES" THEN GOTO 1660
1640     OUTPUT Analyzer;"LST0"
1650     IF BIT(READBIN(Analyzer),6)=0 THEN GOTO 1640
1660     First_third=1
1670     Last_third=12
1680     GOSUB Third_Octave
1690     RETURN
1700 Pass_2:     REM     0 TO 5 KHz
1710     OUTPUT Analyzer;"SP12RUNRE"
1720     WAIT 1000
1730     IF Averaging$<>"YES" THEN GOTO 1760
1740     OUTPUT Analyzer;"LST0"
1750     IF BIT(READBIN(Analyzer),6)=0 THEN GOTO 1740
1760     First_third=13
1770     Last_third=25
1780     GOSUB Third_Octave
1790     RETURN
1800 Pass_3:     REM     0 TO 25 KHz
1810     OUTPUT Analyzer;"SP14RUNRE"
1820     WAIT 1000
1830     IF Averaging$<>"YES" THEN GOTO 1860
1840     OUTPUT Analyzer;"LST0"
1850     IF BIT(READBIN(Analyzer),6)=0 THEN GOTO 1840
1860     First_third=26
1870     Last_third=32
1880     GOSUB Third_Octave
1890     RETURN

```

```

2000 Plot_response:      REM      OUTPUTS GRAPHIC RESULTS TO 3582A DISPLAY
2010   FOR I=1 TO 32
2020     Temp=Display_scale*(Thirddma(33-I)+80-Sensitivity)
2030     IF Temp>1023 THEN Temp=1023
2040     IF Temp<0 THEN Temp=0
2050     FOR J=1 TO 8
2060       Graphics(8*I+J-8)=Temp
2070     NEXT J
2080   NEXT I
2090   OUTPUT Analyzer USING "13A/256(Y)";"WTM,74400,256",Graphics(*)
2100   RETURN
2500 Annotation:      REM      OUTPUTS 3 LINES OF ALPHA TO 3582A DISPLAY,
2510     REM      LEAVING THE 2ND LINE BLANK
2520   OUTPUT Analyzer USING "5A,DDD,32A";"WTA1,";Sensitivity;" dBV FULLSCALE
--- 10 dB/DIV "
2530   OUTPUT Analyzer;"WTA2,"
2540   OUTPUT Analyzer;"WTA3,16 HZ"
2550   OUTPUT Analyzer;"WTA4, 32 THIRD-OCTAVE SEGMENTS"
2560   RETURN
3000 Third_Octave:    REM      TAKES THE DISPLAY DATA OF THE 3582 IN
3010     REM      BINARY FORM AND CONVERTS THE NUMBERS TO VOLTS SQUARED;
3020     REM      APPLIES THE WEIGHTING FACTORS AND COMBINES THE DATA TO FORM
3030     REM      RESULTS AS IF FROM ANSI CLASS III FILTERS.
3040   OUTPUT Analyzer;"HLTLM,74400,256"
3050   ENTER Analyzer USING "#,Y";Fftmas(*)
3060   FOR I=1 TO 256 !REM      FORMAT BINARY DATA FROM DISPLAY
3070     Fftmas(I)=Input_scale*BINAND(Fftmas(I),1023)
3080     IF Fftmas(I)=0 THEN GOTO 3100
3090     Fftmas(I)=10*(Fftmas(I)+Sensitivity/10-8)
3100   NEXT I
3110   FOR I=First_third TO Last_third !REM      WEIGHT AND ADD FFT RESPONSES
3120     Temp=0
3130     FOR J=Firstbins(I) TO Lastbins(I)
3140       K=J-Firstbins(I)+1
3150       Temp=Temp+Binweight(I,K)*Fftmas(257-J)
3160     NEXT J
3170     IF Temp<Minimum THEN GOTO 3200
3180     Thirddma(I)=10*LGT(Temp)
3190     GOTO 3210
3200     Thirddma(I)=Sensitivity-80
3210   NEXT I
3220   RETURN

```

## Section 8: Summary

We hope this application note will provide some insight into one possible technique for making 1/3 octave measurements with the 3582A Spectrum Analyzer. While the program is written in BASIC, there should be enough flowcharts, program annotation, and comments to allow the interested reader to implement the measurement with a controller using another language.

The program has been developed, tested, and evaluated by the Product Marketing Group of HP's Loveland Instrument Division. It is based on a report from the R&D Department.

## Appendix

### HP 9825A Calculator Program

For the users of the popular 9825A Calculator, the 1/3 octave program is given here in HPL, the language of that machine.

The 9825A version is structurally the same as the 9835A program around which this application note is written. All subroutines have the same labels; this will

help you use the flow diagrams of Section 6 to follow the 9825A version. However, most of the variables are different, because HPL allows only single characters for simple, array, and string variables. Listed below is a table showing corresponding variables in both programs.

#### EQUIVALENT VARIABLES

9835A Program	9825A Program	Comments
Firstbins(32)	F[32]	
Lastbins(32)	L[32]	
Graphics(256)	M[256]	shared by "Plot_response" and
Fftmag(256)	M[256]	"Third_octave" routines.
Thirdmag(32)	T[32]	also used as a temporary in
		"Fft_weights" routine.
Binweight(32,49)	B\$(3136)	weight values times 100, stored in integer format.
Sensitivity	S	
Minimum	C	
Display_scale	D	
Input_scale	E	
First_third	M	
Last_third	L	
Temp	P	
I	I	
J	J	
K	K	
A	A	
Averaging\$	A\$(3)	
Ave\$	D\$(6)	
---	C\$(2)	used as temporary in "Fft_weights" and "Third_octave".

## 9825A Program Listing

```
0: "1/3 octave analysis program for the H-P 3582A spectrum":
1: "analyzer and the 9825A calculator":
2: dim F[32],L[32],B#[3136],T[32],M[256],A#[3],D#[6],C#[2]
3: dev "Analyzer",711
4: esb "Bin_groups"
5: esb "Fft_weights"
6: "Start":ent "do you want RMS averaging?",A#
7: if A#="yes";esb "Set_ave"
8: if A##"yes";esb "No_ave"
9: esb "Setup"
10: esb "Pass_1"
11: esb "Pass_2"
12: esb "Pass_3"
13: esb "Plot_response"
14: esb "Annotation"
15: eto "Start"
16: "No_ave":wrt "Analyzer","HLTAV1";ret
17: "Set_ave":ent "how many averages?",A
18: "ERROR"→D#
19: if A=4;"NU1SH0"→D#
20: if A=8;"NU2SH0"→D#
21: if A=16;"NU3SH0"→D#
22: if A=32;"NU4SH0"→D#
23: if A=64;"NU1SH1"→D#
24: if A=128;"NU2SH1"→D#
25: if A=256;"NU3SH1"→D#
26: if D##"ERROR";eto +3
27: beep;dsp "chose a number from front panel"
28: wait 3000;eto "Set_ave"
29: wrt "Analyzer","HLTAV2LST0",D#
30: ret
31: "Bin_groups":15→F[1];18→F[2];23→F[3];29→F[4];36→F[5];45→F[6];57→F[7]
32: 71→F[8];89→F[9];112→F[10];142→F[11];178→F[12];12→F[13];15→F[14];18→F[15]
33: 23→F[16];29→F[17];36→F[18];45→F[19];56→F[20];71→F[21];89→F[22];112→F[23]
34: 141→F[24];178→F[25];45→F[26];57→F[27];71→F[28];89→F[29];112→F[30]
35: 142→F[31];179→F[32];19→L[1];24→L[2];30→L[3];37→L[4];46→L[5];58→L[6]
36: 72→L[7];91→L[8];114→L[9];143→L[10];180→L[11];226→L[12];15→L[13];19→L[14]
37: 24→L[15];30→L[16];37→L[17];46→L[18];58→L[19];72→L[20];91→L[21];114→L[22]
38: 143→L[23];179→L[24];225→L[25];58→L[26];72→L[27];91→L[28];114→L[29]
39: 143→L[30];179→L[31];225→L[32]
40: ret
41: "Fft_weights":fti (67)→C#
42: for I=1 to 1568;C#→B#[2I-1,2I];next I
43: .25→T[1];.1→T[2];.3→T[3]→T[4]→T[5];.2→T[6]→T[7]→T[8]
44: .1→T[9];.2→T[10];.3→T[11];.2→T[12];.15→T[13];.25→T[14]
45: .1→T[15];.2→T[16];.3→T[17]→T[18];.2→T[19]→T[20]→T[21]
46: .1→T[22]→T[23];.2→T[24]→T[25];.1→T[26];.2→T[27]→T[28]
47: .1→T[29]→T[30];.3→T[31];.2→T[32]
48: for I=1 to 32;fti (100T[I])→B#[98(I-1)+1,98(I-1)+2];next I
49: .67→T[1];.4→T[2]→T[3];.5→T[4]
50: .5→T[5];.4→T[6];.5→T[7];.4→T[8]→T[9]→T[10]→T[11]→T[12]
51: .4→T[15]→T[16];.5→T[17]→T[18];.4→T[19]→T[20]→T[21]→T[22]
52: .3→T[23];.5→T[24]→T[25];.4→T[26]→T[28];.3→T[29];.4→T[30]
53: .5→T[31]→T[32];.67→T[13]→T[14]→T[27]
54: for I=1 to 32;fti (100T[I])→B#[98(I-1)+3,98(I-1)+4];next I
55: .4→T[2]→T[3];.5→T[4]→T[5];.4→T[6];.5→T[7];.4→T[8]→T[9]→T[10]→T[11]→T[12]
56: .4→T[15]→T[16];.5→T[17]→T[18];.4→T[19]→T[20]→T[21]→T[22];.3→T[23]
57: .5→T[24]→T[25];.4→T[26]→T[28]→T[30]
58: .3→T[29];.5→T[31]→T[32];.67→T[1]→T[13]→T[14]→T[27]
59: for I=1 to 32;L[I]-F[I]*K
*776
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60: fti (100T[I])÷B#[98(I-1)+2K-1,98(I-1)+2K];next I
61: .25÷T[1]÷T[3]÷T[14];.2÷T[2]÷T[6]÷T[7]÷T[8]÷T[10]÷T[12]÷T[15]÷T[16]÷T[19]
62: .2÷T[20]÷T[21]÷T[24]÷T[25]÷T[27]÷T[28]÷T[32]
63: .3÷T[4]÷T[5]÷T[11]÷T[17]÷T[18]÷T[31];.5÷T[13]
64: .1÷T[9]÷T[22]÷T[23]÷T[26]÷T[29]÷T[30]
65: for I=1 to 32;L[I]-F[I]+1÷K
66: fti (100T[I])÷B#[98(I-1)+2K-1,98(I-1)+2K];next I
67: ret
68: "Setup":
69: wrt "Analyzer","AA1AB0AX0SC2PA0PB0PX0CH0PS2FR1RP1MD2IM1TR0RR0"
70: wrt "Analyzer","LAS";red "Analyzer",S
71: 10↑((S-80)/10)÷C
72: 1023/80÷D;8/1023÷E
73: ret
74: "Pass_1":wrt "Analyzer","SP8RUNRE"
75: wait 2000
76: if A##"yes";ato +3
77: wrt "Analyzer","LST0"
78: if bit(6,rdb("Analyzer"))=0;sto -1
79: 1÷M;12÷L;asb "Third_Octave"
80: ret
81: "Pass_2":wrt "Analyzer","SP12RUNRE"
82: wait 1000
83: if A##"yes";ato +3
84: wrt "Analyzer","LST0"
85: if bit(6,rdb("Analyzer"))=0;sto -1
86: 13÷M;25÷L;asb "Third_Octave"
87: ret
88: "Pass_3":wrt "Analyzer","SP14RUNRE"
89: wait 1000
90: if A##"yes";ato +3
91: wrt "Analyzer","LST0"
92: if bit(6,rdb("Analyzer"))=0;sto -1
93: 26÷M;32÷L;asb "Third_Octave"
94: ret
95: "Plot_response":for I=1 to 32
96: D(T[33-I]+80-S)÷P
97: if P>1023;1023÷P
98: if P<0;0÷P
99: for J=1 to 8;P÷M[8I+J-8];next J;next I
100: wrt "Analyzer","WTM;74400,256"
101: for I=1 to 256;wtb 731,shf(M[I],8);wtb 731,M[I];next I
102: ret
103: "Annotation":fmt 1,c5,f3.0,c29
104: wrt "Analyzer.1","WTA1,","S," dBV FULLSCALE --- 10 dB/DIV "
105: wrt "Analyzer","WTA2,
106: wrt "Analyzer","WTA3,16 Hz 20 KHz"
107: wrt "Analyzer","WTA4, 32 THIRD-OCTAVE SEGMENTS "
108: ret
109: "Third_Octave":wrt "Analyzer","HLTLFM,74400,256";red "Analyzer"
110: for I=1 to 256;ior(shf(rdb(731),-8),rdb(731))÷M[I];next I
111: for I=1 to 256;Eband(M[I],1023)÷M[I]
112: if M[I]=0;sto +2
113: 10↑(M[I]+S/10-8)÷M[I]
114: next I
115: for I=M to L;0÷P;for J=F[I] to L[I]
116: J-F[I]+1÷K;B#[98(I-1)+2K-1,98(I-1)+2K]÷C#
117: P+.01itf(C#)M[257-J]÷P;next J
118: if P<C;sto +2
119: 10log(P)÷T[I];sto +2
120: S-80÷T[I]
121: next I
122: ret
*9859

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