SPECSYSTEM 2.0 is a software system composed of BASIC and machine language routines that will plot reverberation decays and calculate RT60 in 1/3 octave bands, plot 3 dimensional spectral surfaces, and perform real-time spectrum analysis with interactive keyboard control of measurement and display parameters. Input comes from the Eventide Spectrum Analyzer and output is displayed on the Apple HIRES screen.

SPECSYSTEM 2.0

A SOFTWARE PACKAGE FOR THE
EVENTIDE model APX 252
REAL-TIME SPECTRUM ANALYZER
for use with the
APPLE II and APPLE II PLUS

This software is compatible with the APPLE II and APPLE II PLUS computers using either INTEGER BASIC or APPLESOFT BASIC.

This package requires the use of:

1) An Eventide APX252 Spectrum Analyzer installed in any slot but zero.

2) a) Applesoft BASIC OR
   b) Integer BASIC with the Programmer's Aid #1 ROM OR
   c) either BASIC on an Apple Language Card.

3) 48K bytes of RAM

4) An Apple DISK II running under Apple DOS

5) A TV or video monitor. Color is strongly recommended.

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LIMITED WARRANTY

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> The machine readable medium supplied with the program is guaranteed to load when used with properly adjusted equipment as specified on the first page of this manual. In case of difficulty, please return the defective medium to Eventide, and it will be replaced at no cost. Because of the fragility of magnetic media, we recommend that a duplicate copy be made before any use is attempted.

The above provision is limited to a period of 30 days from purchase from Eventide or from an authorized dealer. After this period there will be a nominal charge for replacing a defective disk or cassette.

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Date of printing: 22 DECEMBER 1982

SPECSYSTEM 2.0

WARRANTY CARD

NAME_____ DATE PURCHASED_____

COMPANY_____

ADDRESS_____

_____

FROM WHOM PURCHASED_____

_____

The above must be filled in and mailed within ten days of purchase in order to ensure warranty protection.

If you have time, we should be grateful if you would answer the questions below, which will help us to keep you informed of further products, or new applications for current products.

For what applications are you using your SPECSYSTEM?_____

_____

_____

_____

Are there any applications which you can envisage, but would like some help in implementing?_____

_____

_____

Do you have any programs which you think might be of interest to other users?_

_____

_____

_____

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T A B L E O F C O N T E N T S

I L L U S T R A T I O N S

INTRODUCTION

SPECSYSTEM 2.0 is a package of applications software for the Eventide Spectrum Analyzer that will allow you to perform reverberation time (RT60) measurements and plot decay curves at the 31 ISO 1/3 octave frequencies. This type of display is shown in Figure 2. The system is also capable of plotting spectral information in the form of 3-dimensional spectral surfaces (frequency vs. amplitude vs. time) on the Apple HIRES screen. This type of display is illustrated in Figure 1. Viewing the spectral surface created by a reverb decay can often give a good intuitive impression of the acoustics of a particular space. Spectral surfaces are also useful for studying the timbral envelopes of musical instruments and in voice analysis applications.

Because the various functions performed by the SPECSYSTEM package are complex and are often dependent upon execution speed, the bulk of this software (approximately 6K bytes) is written in 6502 machine code. Linkage and parameter passing to these routines is accomplished via high-level BASIC-type commands that can be issued in immediate or deferred-execution mode (i.e., from within a program). This is the same method used to execute the various built-in functions of the APX 252 card, the details of which are fully explained in the APX manual.

The basic sequence of operations in SPECSYSTEM is:

1. Use the standard RTA routines built into the APX card to set up the various operating modes and parameters (such as gain, averaging period, etc.).

2. Perform Spectrum Analysis in real-time, and store the resulting data in memory (creating a spectral data buffer).

3. Display the stored spectral data as a spectral surface. Alternatively, the user may prefer to

4. Subject stored data to RT60 analysis and display.

There are 4 basic groups of high-level commands used in SPECSYSTEM that correspond to the four groups of operations listed above: the RTA group, the MAKEBUFFER group, the SPECSURF group, and the RT60 group. The RTA group is actually the ROM-resident routines used in the standard-configuration APX card, called by the standard APX command 'WARMRTA'. For details on the RTA commands and function keys, see the APX manual.

The MAKEBUFFER group of commands create large buffers (arrays) of spectral data. Data is captured by performing real-time analysis on the input signal, taking the 32 resulting numbers (the amplitudes of the 31 filters plus the level channel) and storing them in memory. The process is repeated for some specified period of time (actually, some number of repetitions at a fixed interval of time between analyses) and the resulting blocks of 32 numbers are stored sequentially in memory. The area where the numbers are stored is known as the "spectral data buffer". Once this buffer has been created, the data in the buffer can then be subjected to analysis and display.

The SPECSURF group takes data buffers created by MAKEBUFFER, and uses the Apple HIRES screens to plot the buffer data as the isometric view of a geo-

metrical surface whose vertical axis is amplitude, horizontal axis is frequency, and whose diagonal axis represents time. The surface will have a shape that corresponds to the level in each filter channel as it varied over the time period of the reading. A reverberation decay, for example, will appear as an irregular sloping surface, like the side of a hill, as the levels in the filters decay at their own rates.

The buffers of spectral data created by MAKEBUFFER are also used by the RT60 command. RT60 will look through the buffer at data from a particular filter channel, displaying the curve created as its amplitude varies over time. In a typical reverberation decay the level will be steadily decreasing (as the sound dies away) and RT60 can calculate the time it would take the level to fall 60 dB. The information is displayed on the HIRES screen along with the time vs. amplitude curves of up to 8 filters in the HIRES colors. The parameters which control this display are set interactively from the keyboard, in a manner similar to the control of the RTA routines.

Included in the SPECSYSTEM package is a program written in BASIC (a version is included in both Integer and Applesoft) that executes the commands in response to menu choices. This executive, or driver program, provides a convenient way to execute the commands (using single keystrokes) and displays the current status of operating parameters. In addition, it gives you the ability to store and recall buffers of data and HIRES images from the disk and view the HIRES screens. Four main menu choices in the BASIC driver correspond to the 4 main groups of commands: REAL-TIME ANALYSIS, CREATE A NEW SPECTRAL DATA BUFFER, PLOT A SPECTRAL SURFACE, and RT60 REVERBERATION DISPLAY. The first sections of this manual, A SAMPLE RUN-THROUGH and the BASIC DRIVER OPERATIONAL DESCRIPTION will be devoted to this driver program. A later section, CREATING YOUR OWN DRIVER PROGRAMS, will give details on the operation of the individual SPECSYSTEM commands.

The executive BASIC program provided is only a general example of the type of driver that could be written to control the SPECSYSTEM routines. Other driver program can be written to use the commands for a particular application that doesn't require such extensive control over all aspects of SPECSYSTEM's operation. Because the commands can be issued in immediate mode, you can also operate SPECSYSTEM without a driver program at all, just by typing commands at the keyboard. Also, at the end of this manual we've provided a brief discussion of SPECSYSTEM control parameters and subroutine theory of operation that should be sufficient to allow assembly language programmers to interface SPECSYSTEM to assembly language driver programs. Appendix #4 is a memory map and table of subroutine entry points and variable locations that will provide address information for this type of application.

This manual assumes that you are familiar with either the Integer or Applesoft BASIC language, the basic commands of the Apple's DOS (Disk Operating System) and the concept of 1/3 octave spectrum analysis as applied to the Eventide model APX252 Spectrum Analyzer. If you are unsure about any of these, refer to the appropriate BASIC, DOS, or Eventide Spectrum Analyzer manual. A knowledge of assembly language programming and the Apple Monitor is useful but NOT necessary to understand this manual and operate the software.

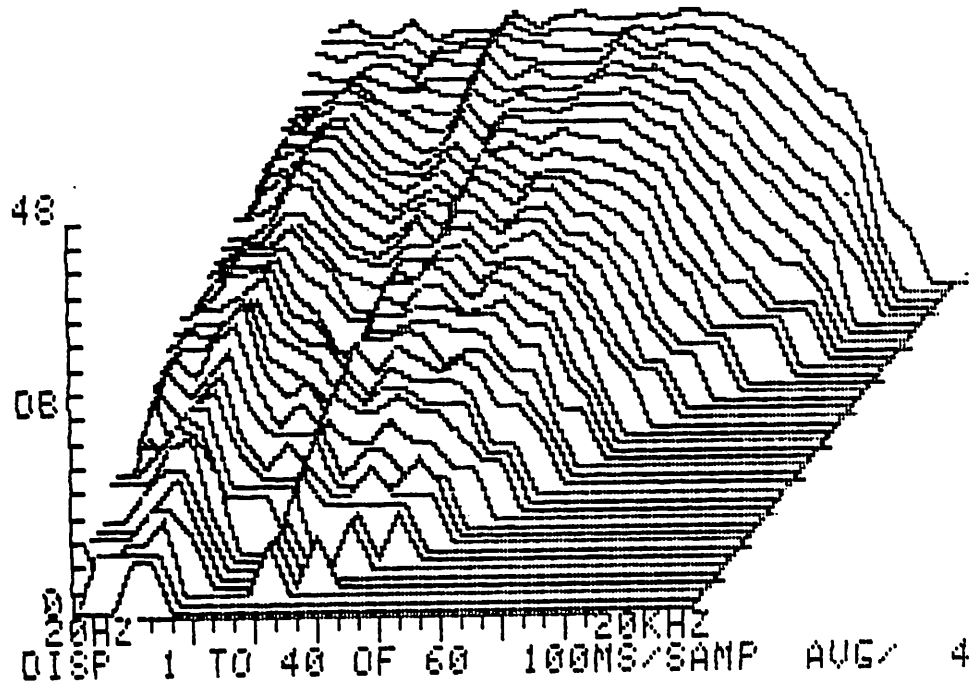

Figure 1: SPECTRAL SURFACE OF A REVERB DECAY

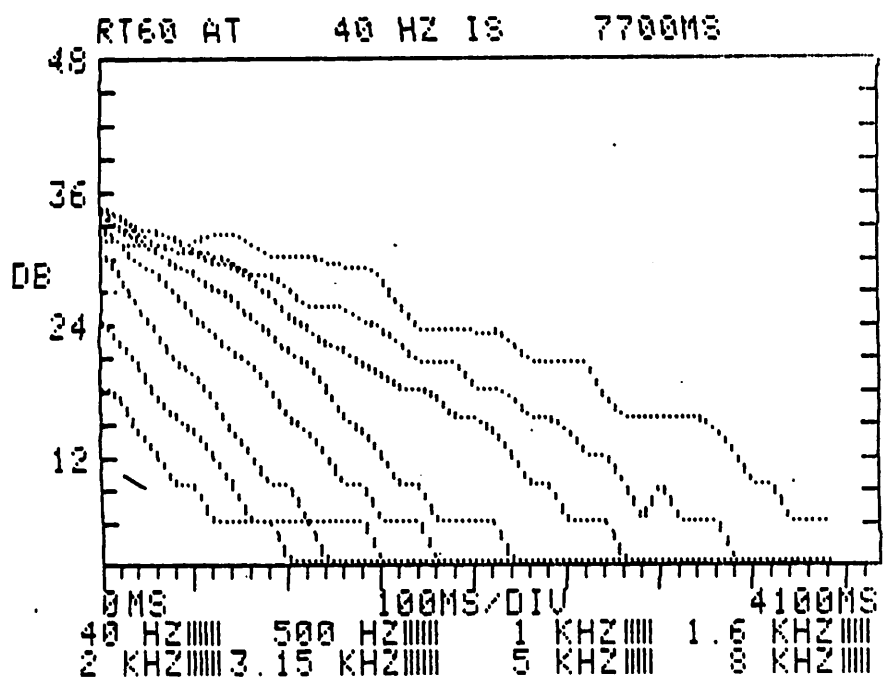

Figure 2: RT60 DISPLAY OF A REVERB DECAY

BACKUP PROCEDURE

Before using the diskette provided by Eventide we highly recommend that you BACK IT UP! The easiest way to accomplish this uses the COPY or COPYA program that's on the SYSTEM MASTER diskette that came with your disk drive. COPY will duplicate the entire contents of a source (Eventide's) disk onto an uninitialized destination disk (supplied by you). Run either of the two programs and answer the prompts. When the process is complete, label the backup disk clearly and save the Eventide-supplied disk in a safe place. The backup disk now becomes your working copy. NEVER USE YOUR ORIGINAL EXCEPT TO MAKE BACKUPS.

LOADING AND RUNNING

Using your backup disk, insert it in your drive and boot it. The 'HELLO' program will print out a welcome message and a disk catalog and fall into whichever BASIC is the default in your machine (you can simply type CATALOG if DOS is already booted in your machine). 7 files should be listed:

```
DISK VOLUME 001

 B 002 HELLO
 B 022 SPCODE
 I 030 SPDRIVER.INT
 A 030 SPDRIVER.SFT
 A 003 GETDRIVER.SFT
 B 017 REVERB.BUF
 B 034 REVERB.SCR
```

HELLO is a binary 'welcome' program that will give a greeting message, print a disk catalog, and drop into your default BASIC, each time you boot the disk. SPCODE is the machine language SPECSYSTEM code, and REVERB.BUF and REVERB.SCR are binary files containing a spectral data BUFfer and a HIRES SCReen image, respectively. The two BASIC programs SPDRIVER.INT and SPDRIVER.SFT are the Integer and Applesoft versions of the SPECSYSTEM BASIC driver program.

The other file shown in the catalog is GETDRIVER.SFT. This is what is known as a 'loader' program for the SPDRIVER.SFT Applesoft driver program. A few words about Applesoft's memory mapping characteristics are in order here: Applesoft programs usually begin loading in memory starting at address 2048 (hex address $800) and grow upward. However, a look at the memory map in Appendix #4 shows that if SPDRIVER.SFT were to begin loading at its normal address, it would run into conflict with the area of memory reserved for data buffers ($10F9-1FFF) Thus the function of the GETDRIVER.SFT loader program is to shift Applesoft's load point (by executing some POKEs in the page zero locations that specify this point) and then to "RUN SPDRIVER.SFT".

What all this means in practical terms is this: to run the INTEGER version of the SPECSYTEM drver, type "RUN SPDRIVER.INT". To run the APPLESOFT version, type "RUN GETDRIVER.SFT". To run ANY OTHER Applesoft program after using the SPECSYSTEM Applesoft driver however, you should type "NEW" before loading it, or re-boot DOS (either of which will reset Applesoft's load point).

The only real difference between the two versions of the BASIC drivers, aside from the different BASIC syntaxes, is that the Applesoft version passes a flag to the machine language routines to tell them they are operating under Applesoft (default operation is under Integer BASIC). This is necessary because the routines used to plot and draw on the HIRES screen are written directly into Applesoft, but from Integer BASIC these same functions require the Programmer's Aid ROM or the equivalent code existing in the Language Card version of Integer BASIC.

Now just type RUN SPDRIVER.INT (or GETDRIVER.SFT if you're in Applesoft) and the BASIC driver program will load and begin running. The next section will take you through a quick run-through of the program to introduce the major features.

A SAMPLE RUN-THROUGH

Now we'll detail a sample run-through that will touch on the main functions of the SPECSYSTEM driver program. Try following each step in the example as it's explained to familiarize yourself with the major functions and the necessary sequences of operations.

Run whichever version of the BASIC driver you have language ROMs for, as detailed in the last section. The screen will clear and the program will ask you to wait while it finishes loading the machine code routines from the disk. You will be asked for the number of the slot holding the spectrum analyzer card and you should answer by typing a number from 1 to 7 and hitting "RETURN".

The main menu for the SPECSYSTEM driver will now appear on the screen, as shown in Figure 3. Pressing "1" will cause the program to branch to the APX RTA routines. Assuming you have something connected to the input of the analyzer, you should see activity on the screen corresponding to the audio signal. If no bargraph appears, hit "G" several times to increase the gain of the analyzer. After you are satisfied that a proper input level is being received, hit "ESC" to return to the main menu.

Now hit "2" to select the DATA BUFFER CREATION sub-menu. At this point you have the opportunity to alter the values of the various parameters that control the acquisition of the spectra that will form the data buffer. The default parameters are sufficient for our example, however, so just hit "7" to ENABLE the TRIGGER. This readies MAKEBUFFER to begin taking data; it will now wait for any keypress as a trigger signal to begin saving spectra. This allows you to synchronize the data capture to some audio event. Once the trigger has occurred (you've pressed a key) the data is captured and the main menu will reappear. (Using the default values, data capture will appear to be instantaneous. If you increase the number of spectra or the time between spectra, the data capture procedure could require up to two minutes).

Now that there is data in the buffer, we can do an RT60 analysis. First, however, let's try plotting a spectral surface to get an overall idea of the nature of the data. Hit "3" and the SPECTRAL SURFACE PLOTTING submenu will appear. Again, there are several parameters that control the plot output, but we'll use the default parameters, so hit "7", to PLOT SURFACE. The selected HIRES page (default=2) is cleared, the axes are drawn, and successive spectra are plotted diagonally across the screen, beginning with the first one received after the trigger ocurred. If the audio input was from a source such as the radio or recorded music, you'll probably see a series of irregular "hills and valleys" as the amplitude in each 1/3 octave band rose and fell during the sampling period. You can interrupt the plotting process by hitting any key; hitting any key but "ESC" will resume plotting. Hitting ESC while plotting is interrupted will return to the menu, leaving the display is its interrupted state. If plotted to completion, the image will remain until you hit ESC to return to the menu.

It would be nice now to perform some RT60 measurements on the data that's in the buffer. However, unless you were very lucky, or were actually monitoring a reverberation device or chamber, you probably don't have data in the buffer that will be recognized by the RT60 routines as a reverb decay. For that reason on the SPECSYSTEM disk is a block of data previously recorded from a reverb

device that can be used to demonstrate the RT60 routines. Return to the main menu by hitting "ESC" and then hit "6". This calls the BASIC routines that exchange buffer data between the disk and RAM. Answer the prompts for transfer direction (DISK TO MEMORY), transfer data (SPECTRAL BUFFER) and filename to transfer buffer named "REVERB" off the disk. When the disk has finished running the main menu will reappear.

Now hit "4" to select the RT60 reverb display menu item. You will see a set of axes printed on the HIRES screen and a 1 KHZ label with a flashing X, signifying the next frequency band to be plotted. Hit "D" to draw the curve of amplitude vs. time at 1 kHz over the period of time shown on the horizontal axis. You should see a flashing curve whose height steadily decreases to the right (forward in time). Once a curve is drawn you can hit "T" and a subroutine will calculate the RT60, based on the displayed data, and print it above the display area. A white line will be superimposed on the plot to show the decay slope used by the calculation subroutine. Hitting any key reactivates the display. Now hit "N" and use the right and left arrow keys to select a new frequency, and hit "D" to draw new curves. You can fit up to 8 curves at a time on the display. The "1" and "2" keys will allow you to toggle between the two HIRES pages. Try experimenting with the arrow keys, "D", "T", "N", and "R". Hitting "C" clears the display and begins again with the same data, and "ESC" returns you to the main menu.

Since the reverb decay is in the buffer, we could now plot a spectral surface of this data. Instead, try utilizing the HIRES SCREEN TRANSFER function by hitting "6" again from the main menu. The transfer direction remains the same so use '2' to select HIRES SCREEN IMAGE as the data to be transfered. To avoid loading the screen data over the residue of the RTA display, use '3' to change the screen to be used for the transfer; you'll get a brief glimpse of HIRES page 2 (so you know what you're losing). Now hit '4' to initiate the transfer and type "REVERB" when prompted for a filename. The secondary HIRES page will be displayed and the disk will load the binary file of the stored screen image on top of the previous image. The program will pause for a moment after loading the image and then return to the main menu. Hitting "5" now allows you to view either of the HIRES pages by pressing "1" or "2". As usual, "ESC" returns you to the main menu.

To exit the program and get back into BASIC, hit "CTRL-C" and type TEXT. If you have an Autostart ROM, RESET will perform the same function.

That covers the main functions of the SPECSYSTEM 2.0 package. More details on the various options, control parameters, and specific operation of the software are covered in the next section. If you had any trouble with the run-through outlined above, go back and try again, step by step. If your problem persists, check the section of this manual listing SOME COMMON ERRORS to see if yours is among them.

BASIC DRIVER OPERATIONAL DESCRIPTION

This section decribes the operation of the SPECSYSTEM software in greater detail. Figure 3 shows the main menu displayed upon entry to the program. The various menu items represent the functional sections of the program. The first four items correspond to the four main groups of SPECSYSTEM commands: RTA, MAKEBUFFER, SPECSURF, and RT60. The other items correspond to utility functions that allow disk transfer and HIRES page display. Hitting the numerical key associated with an item will branch immediately to that section of the program; hitting "RETURN" after the entry is not necessary. Out of range or invalid keys are ignored- this is true in general for the entire program. Also, hitting "ESC" in place of a menu choice or during display of a HIRES screen will generally return you to the main menu.

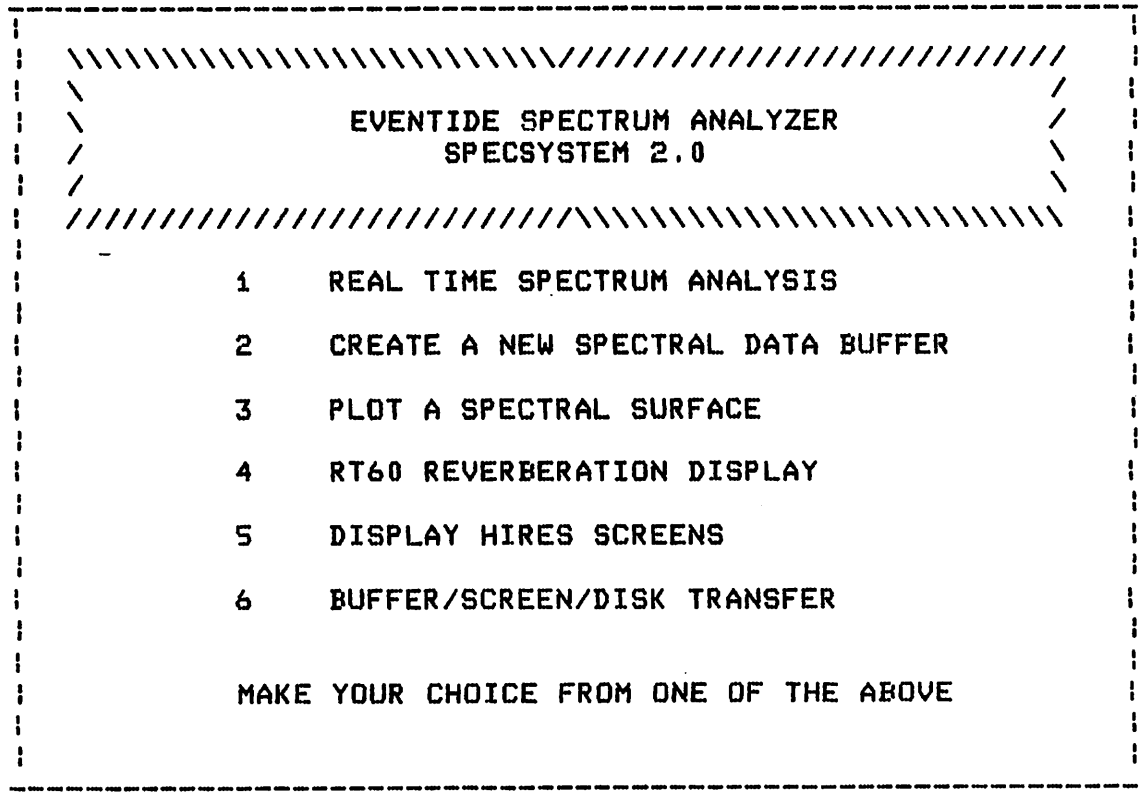

Figure 3: MAIN MENU

MENU ITEM 1: REAL-TIME ANALYSIS

Choosing the first menu item, REAL TIME ANALYSIS, causes the BASIC program to perform the standard APX command WARMRTA (INIT is executed when the program starts up). All features of the standard RTA display are supported. Refer to the APX manual for a list of valid function keys; all other keys are ignored. Since all operating parameters are preserved upon exit from RTA, it is used to set the GAIN, RANGE, mode (AVG, PEAK or FLOAT), and averaging period that are used in subsequent calls to the MAKEBUFFER and SPECSURF command groups.

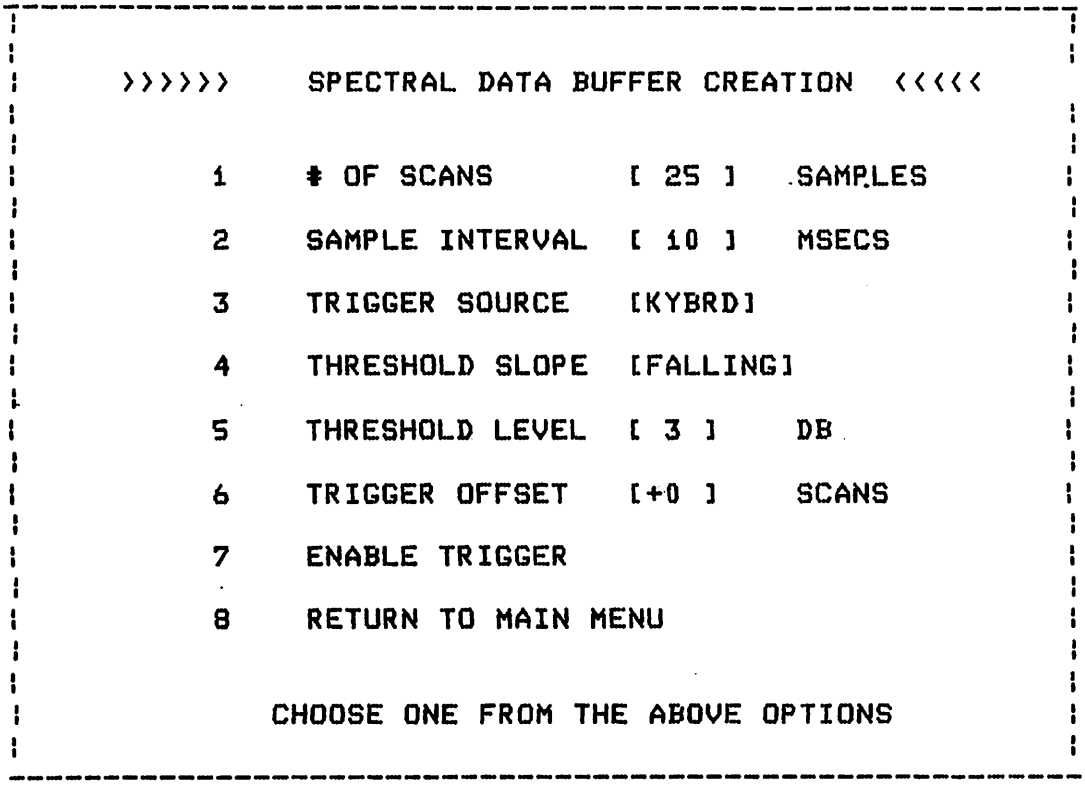

Figure 4: DATA BUFFER MENU

MENU ITEM # 2: SPECTRAL DATA BUFFER CREATION

Choosing the second menu item in Figure 3, CREATE A SPECTRAL DATA BUFFER, will cause a branch to a BASIC routine that prints the sub-menu shown in Figure 4. The bracketted items are printed in inverse video, and are the current values of the parameters controlling the MAKEBUFFER subroutines. The values shown in Figure 4 are those defaulted to when the system is initialized.

To change the state of a 'toggle-type' variable such as TRIGGER SOURCE or THRESHOLD SLOPE just hit the associated numeric key, and the label will reflect the new value. To change a variable with a range of values, such as SAMPLE INTERVAL, hit the numeric key, and then use the unshifted '<' and '>' keys (actually ',' and '.' respectively) to change the variable up or down by it's smallest increment (In the case of SAMPLE INTERVAL this increment value is 10 milliseconds). By holding down the shift key while changing the variable the increment value will be 5 times the unshifted value (or 50 milliseconds for SAMPLE INTERVAL). When a variable is incremented past its maximum legal range, it will wrap around to its minimum value, and vice versa. Holding down the REPEAT key when incrementing or decrementing will save you lots of keystrokes. When the variable has the desired value, hit any key besides '<' or '>' and the variable will be set. This method of setting parameter values is consistent throughout the driver program.

The # OF SCANS option allows you to specify the number of spectra to be captured in the data buffer (and in conjunction with the INTERVAL, the duration of the sampling period). This is the total number of spectra that will be available for subsequent spectral surface display or RT60 analysis. The # OF

SCANS can range from a maximum of 120 to a minimum of 1 spectrum (RT60 display and analysis requires at least 3 spectra, however).

The SAMPLE INTERVAL option controls how often spectra are captured by BUFFMAKER by inserting a variable time delay between SCANs. The minimum interval is 10 milliseconds and the maximum is 1 second (1000 msec). When AVG mode is in effect, however, the lower limit becomes 20 msec. This is due to the extra time required by the SCAN routine to perform the averaging process.

TRIGGER SOURCE allows you to specify the source of the trigger that causes MAKEBUFFER to begin saving spectral data in the buffer. The source of the trigger can be either the keyboard (KEYBRD) or the data itself (AUTO mode). In KEYBRD mode MAKEBUFFER waits for the receipt of a keypress as a trigger signal. In AUTO mode MAKEBUFFER generates its own trigger internally when the level of the signal being measured crosses a previously defined threshold (the THRESHOLD LEVEL parameter). In addition, the trigger can be specified to occur only if the signal either falls below or rises above the threshold (the THRESHOLD SLOPE flag). The filter channel used for level comparison is the channel (excluding LEVEL) with the highest amplitude in the current SCAN. In AUTO mode, the keyboard remains enabled to allow manual triggering in case the AUTO trigger conditions aren't met. Spectra will be saved starting with the first sample that EXCEEDED (not equaled) the theshold level in the indicated direction.

THRESHOLD LEVEL sets the level, in dB, used in the AUTO trigger mode. The legal range of THRESHOLD is 1 to 47 dB, since levels cannot pass ACROSS 0 or 48 dB, the limits of the analyzer's dynamic range.

THRESHOLD SLOPE is a flag indicating a direction, either rising or falling. In AUTO mode, the SLOPE indicates whether a trigger will occur as the level of the filter data rises above the threshold or falls below it (similar to the + or - slope control on a 'scope trigger).

TRIGGER OFFSET allows you to define the point in time at which spectra begin to be saved in the data buffer. This point is specified as some number of sample intervals pre- or post-trigger, from -63 to +63. This means that the receipt of a trigger (in both KEYBRD and AUTO mode) can be used to signify the start, end, or some point in the middle of a sampling period. Trigger offsets are illustrated in Figure 5. Note that the pre-trigger offset is limited to either 63 or the total number of spectra that are to be saved (as specified in the # OF SCANS option), whichever is smaller.

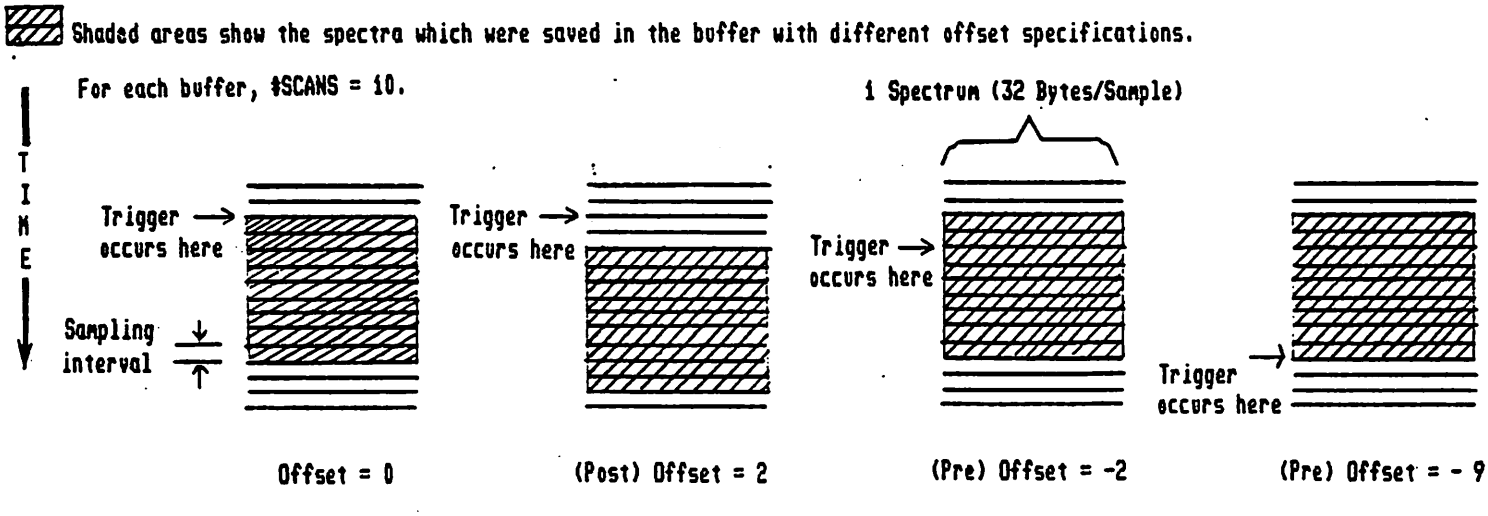

Figure 5: EFFECTS OF VARIOUS TRIGGER OFFSETS

Choosing the ENABLE TRIGGER menu item causes BASIC to execute the BUFFER command. This enables the trigger, as indicated by the printed screen message and a blinking "E" in the lower right-hand corner of the screen. Once the trigger has occurred (either with a keypress, or with the proper data conditions,) the "E" will change to a flashing "T" to indicate that spectra are being saved in the buffer. After the specified number of spectra have been collected, control is transferred back to BASIC at the main menu.

The last item, RETURN TO MAIN MENU, is self-explanatory; it merely causes a branch back to the main menu without creating a data buffer. Pressing the "ESC" key instead of any menu item number will have an identical effect.

```
     >>>>>    SPECTRAL SURFACE PLOTTING   <<<<

     1    # OF SPECTRA TO PLOT   [ 25  ] SPECTRA
     2    PLOT OFFSET            [ 0   ]  SPECTRA
     3    RANGE                  [ 48  ]  DB
     4    VERTICAL SCALE         [ 2 ]    LINES/DB
     5    PLOT DIRECTION         [RIGHT]
     6    CURRENT PLOT PAGE      [ 1 ]
     7    BEGIN PLOTTING
     8    RETURN TO MAIN MENU

          CHOOSE ONE FROM THE ABOVE OPTIONS
```

Figure 6: SPECTRAL SURFACE PLOTTING MENU

MENU ITEM 3: PLOT A SPECTRAL SURFACE

Once a buffer of spectral data exists, choosing the next item on the main menu, PLOT A SPECTRAL SURFACE, will cause the sub-menu in Figure 6 to be printed. Again, the bracketted values are displayed in inverse video and are the default values for the associated parameters.

The first parameter, # OF SPECTRA TO PLOT, specifies how many spectra, out of the total number saved in the buffer, will be used to plot the spectral surface (and also the number to use in the RT60 display and calculations). Each time a new buffer is created, this value is initialized to the total number of spectra available, so that the default condition is to plot the entire buffer contents. This parameter is also affected by the value of the PLOT OFFSET parameter (see item #2) so that the sum of the two does not exceed the total number of spectra available in the buffer.

PLOT OFFSET is a variable that specifies an offset from the first spectrum saved in the buffer to the first spectrum to be used in the spectral surface (and RT60) display. This value and the value of # OF SPECTRA TO PLOT can be manipulated to plot any subset of the buffer contents. This offset will also be automatically adjusted when altering the # OF SPECTRA TO PLOT parameter so that the sum of the two does not exceed the number of spectra available in the buffer.

RANGE controls whether the top 12, 24 or full 48 dB of spectral data is to be displayed in the spectral surface plot. RANGE can be used in conjunction with the SCALE parameter (see below) to increase or decrease the display resolution and "shadow" or "unshadow" spectra from each other.

SCALE allows you to adjust the vertical scale factor (multiplier) to 4, 2, or 1 screen line per dB. Data will be limited automatically to prevent plotting out of the bounds of the HIRES display, but SCALE will be be halved if the number of spectra to plot would cause even the limited data to exceed the display bounds.

The PLOT DIRECTION parameter controls the apparent perspective of the spectral surface plot to simulate viewing from the left or the right. It can often be useful to plot one perspective on one HIRES screen and the opposite perspective on the other. Flipping between HIRES pages simulates rotation of the 3-dimensional surface.

PLOT PAGE specifies one of the two Apple HIRES screen memory areas to be used for the spectral surface display.

BEGIN PLOTTING causes BASIC to execute the SPECSURF command to print the axes and to begin plotting sequential spectra. You can interrupt the plotting process temporarily by hitting any key. This is useful for viewing spectra that may be "shadowed" or covered up by subsequent curves. Hitting any key but "ESC" will cause plotting to resume, while "ESC" causes an immediate return to BASIC and the main menu, leaving the spectral surface partially completed.

MENU ITEM 4: RT60 REVERBERATION DISPLAY

Referring to Figure 3, the fourth menu item is RT60 REVERBERATION DISPLAY. The idea here is that we can plot the time vs. amplitude curves for any of the 32 filter channels using the buffer data, essentially drawing a curve of a diagonal cross-section of the the spectral surface plot. We can use that buffer data to calculate the time it would take the level in each channel to decay 60 dB. The variables from the # OF SPECTRA TO PLOT and PLOT OFFSET items from the SPECTRAL SURFACE menu are operative here also, so that the same subset of buffer data used to plot spectral surfaces are used for RT60 display and calculation.

When you choose the RT60 menu item, BASIC executes the RT60 command that in turn calls subroutines to draw the RT60 axes and to print the labels. The first available frequency (1 kHZ) is shown next to a flashing "X", and keyboard is polled for valid command keys. The labelled frequency may be incremented or decremented by 1/3 octaves to point to the filter channel whose data you want to plot. Once the proper frequency is selected as the current filter, the RT60 at that frequency can be calculated. Up to 8 plots may be made simultaneously on the screen in four HIRES colors, with each plot identified by a frequency label adjacent to a cursor of the matching color.

The following are valid key commands in RT60:

"->" Hitting the right or left arrow keys when the flashing "X" is present
"<-" will increment or decrement the frequency label from 1 kHZ through LEVEL to point to the next filter channel to be plotted. Once plotted, the same keys are used to select the "current" filter from the curves that have already been plotted. The selected curve will then flash, along with the colored cursor adjacent to the curve's frequency label, allowing you to distinguish 2 curves that are plotted in the same HIRES color.

"D" causes a new curve to be Drawn for the frequency denoted by the flashing "X". This curve then becomes the currently selected one. The "D" key is only operative when the flashing "X" is present.

"N" calls a routine to create a New plot, flashing the "X" and displaying the 1 kHZ label. The new frequency is entered in the first available (empty) label position, or replaces the last one if the screen has been filled (8 curves already present).

"R" is similar to "N", calling a routine to choose a new filter, but uses the new filter to Replace the currently selected one. The existing curve is erased once the new filter has been chosen and Drawn. This allows adding new curves without completely filling the screen area.

"T" causes RT60MON to call the routine that calculates the RT60 (reverberation Time) for the currently selected filter. The time will be displayed at the top of the screen in seconds or milliseconds. A white line segment will be superimposed on the selected curve. This segment shows the endpoints and the slope (decay rate) used in the RT60 estimate, allowing you to see how well this estimate matches the actual data. If the software is unable to make an RT60 determination, an error message will be printed. The display can be reactivated by hitting any key.

"C" clears the display of all curves and begins from scratch. This is essentially a "cold" restart of the RT60 routines.

"1" causes display of HIRES page 1 while "2" causes display of page 2. The
"2" SPECSYSTEM BASIC driver always plots the RT60 display on page 1, so page 2 may be used to hold the spectral surface of the data being used in RT60 analysis. This allows you to compare the two forms of presentation of the data by flipping the page display back and forth.

"ESC" as usual, returns control to the calling routine, in this case returning to the BASIC driver's main menu.

Any other keys, or keys that are not currently valid, will be ignored.

When BASIC first executes RT60 after the creation of a new buffer, there are no existing curves to display, so the display is started 'cold'. After plotting some curves and exiting RT60, reentry will cause the display to restart where it left off on the last exit. "C" can then be used if you want to start from scratch with a clean display. Changing the # OF SPECTRA TO DISPLAY or PLOT OFFSET parameters will cause a cold start, as will (naturally) creating a new data buffer. Plotting a spectral surface on HIRES page 1, which will erase any existing RT60 display, also causes RT60 to cold-start.

MENU ITEM 5: VIEW HIRES PAGES

Item 5 from the main menu allows you to view the two HIRES screen pages. This is accomplished straightforwardly from BASIC with POKEs to the Apple's "soft switches" that control graphic modes and page selection. Choosing this menu item will immediately display HIRES page 1, and hitting the "1" or "2" keys will display the respective page. If no display has been created yet on the selected page you'll most likely see garbage instead of a coherent image. Hitting "ESC" in this HIRES display mode returns you to the main menu.

```
>>>>>  SCREEN/BUFFER/DISK TRANSFER   <<<<

1.   TRANSFER DIRECTION  FROM: [ DISK ]
                            TO: [MEMORY]
2.   TRANSFER DATA    [HIRES SCREEN IMAGE]
3.   HIRES TRANSFER PAGE        [1]
4.   CATALOG / TRANSFER
5.   RETURN TO MAIN MENU

     CHOOSE ONE FROM THE ABOVE OPTIONS
```

Figure 7: DATA TRANSFER MENU

MENU ITEM 6: SCREEN/BUFFER/DISK TRANSFER

Choosing item 6 from the main menu, SCREEN/BUFFER/DISK TRANSFER, branches to the BASIC code that transfers spectral data buffers and HIRES screen images in RAM to binary type files on the disk, or vice versa. This means that you can capture data now and leave analysis to a later time, store many examples of data you want to compare, or store and recall the RESULTS of analysis, i.e., spectral surface and RT60 plots. This submenu is shown in Figure 7.

TRANSFER DIRECTION, the first item on the submenu, should be self-explanatory: this controls whether data will be transfered from disk to memory (the default) or from memory to disk.

TRANSFER DATA allows you to choose whether spectral data captured by the analyzer or HIRES screen image data plotted by SPECSYSTEM will be involved in the transfer. The default is to transfer HIRES data. If the transfer is of

spectral data from memory to disk, but no buffer yet exists, a warning will be be printed: "CAUTION- BUFFER DOESN'T EXIST YET".

HIRES TRANSFER PAGE specifies the source or destination page for HIRES screen transfers. When selecting one page or the other you will get a brief glimpse of the image currently on the chosen screen, and a prompt will confirm which page has been selected.

CATALOG/TRANSFER is used to initiate the transfer process. Choosing this option causes a disk catalog to be printed. You are then prompted for the filename to be used in the transfer. If you hit the space bar, or any other non-alpha key, you'll be returned to the submenu; otherwise you will be expected to enter a valid filename. All filenames of spectral data buffers are saved to the disk with a ".BUF" suffix to allow you to identify them when looking at a disk directory. Likewise all filenames of HIRES screen images are saved with a ".SCR" appended to them. These suffixes are OPTIONAL when entering a filename and will be automatically appended if you leave them off. Care must be taken in disk to memory transfers that the rest of the filename actually corresponds to a file on the disk. Since Integer BASIC allows no error trapping, a fatal error will result (you'll have to restart the program) if DOS issues a FILE NOT FOUND error message. In Applesoft you will be returned to the menu. Once you've entered a valid filename the disk will whir a moment as DOS completes the trnasfer. If you are transfering a HIRES image onto one of the screens, that screen will be enabled as the transfer takes place.

An entire data buffer of 3845 bytes (120 spectra plus some status bytes) is always transferred between the disk and RAM, regardless of how many valid spectra are actually present in the buffer. This reduces the complexity of the BASIC code considerably, but means that more disk space is needed for the buffer storage. For this reason it's recommended that you use an otherwise blank disk when you create your work disk. Each data buffer saved requires 17 disk sectors, and a fatal error will occur in the Integer BASIC version if you get a DISK FULL error when trying to save buffers to the disk. Likewise with HIRES screens: each image requires 33 sectors, so be sure there is enough space on the disk to store the image. With about 410 sectors available on a version 3.3 disk for buffer and screen storage (once the SPECSYSTEM 2.0 BASIC drivers and machine code have been stored), this space restriction is not too critical, but is something to be aware of.

CREATING YOUR OWN DRIVER PROGRAMS

The main functions of SPECSYSTEM 2.0 can be controlled from BASIC with high-level commands that are identical in syntax and operation to the commands built into the firmware of the APX card itself. In fact, the same firmware routines are used to interpret the SPECSYSTEM commands (and evaluate their arguments). All the same rules apply: commands can be issued in immediate mode from Integer, Applesoft, or the Monitor or from within BASIC programs by enclosing them in PRINT R$;"<command>" statements. For more details on command syntax and behavior see the APX 252 manual.

Like the APX commands, these commands require that the APX system be previously initialized, using the PR#n command. They depend for their operation on the APX vectors and pointers, so you should ensure the integrity of the APX system before using these commands, lest unpredictable things occur. There is no explicit initialization command for the SPECSYSTEM routines to return parameters to their default values: parameter initialization is accomplished when the memory image is loaded from disk, which is the technique you should use unless you want to reset each variable explicitly. If you want to use the commands in immediate mode you won't need the BASIC drivers, so just BLOAD the SPECSYSTEM machine code. DON'T BRUN IT- it won't execute. As soon as the code is loaded it is integrated into the rest of the Analyzer structure (assuming the APX card is initialized) and you can execute commands at will.

Each command explained below corresponds to an item on one of the menus of the SPECSYSTEM BASIC driver program. The listing of the program in Appendix #2 will show that the driver is just a fancy formatter, bookeeper and parameter passer. All the "real work" in the program is accomplished by issuing the high-level commands to the SPECSYSTEM machine language routines. Unfortunately, the APX command structure doesn't provide a way to examine the current status of variables; the SPECSYSTEM driver needs these values for its menu displays, so it uses two techniques to keep track of the parameter values. In some cases the program maintains a BASIC variable in parallel with the SPECSYSTEM variables, making sure that both variables are equally affected by the relevant commands. It then needs only to refer to the BASIC variable to know the current value of the SPECSYSTEM variable. In other cases, the program PEEKs at the location of the SPECSYSTEM variable itself to determine its current value. This requires that the program know the address of the variable; these addresses are initialized at the beginning of the program. The listing of the program in Appendix #2 should be studied if you want examples of how you might write your own.

DESCRIPTION OF COMMANDS

BUFFER	KBD	SLOPE=R/F	#SPECTRA=n	DIRECTION=L/R
#SCANS=n	AUTO	TRIGOFF=n	PLTOFF=n	RT60
INTERVAL	THRESH=n	SPECSURF	SCALE=n	APSOFT=ON/OFF

BUFFER This command causes the MAKEBUFFER subroutines to enable the trigger to begin taking samples. The trigger condition is dependent on the trigger mode and possibly the threshold and threshold slope (set with the commands explained below). An inverse video 'E' and 'T' will indicate the trigger enabled and triggered states, respectively. Control returns to the

caller when MAKEBUFFER has finished collecting samples. Issuing this command corresponds to choosing item 7 (ENABLE TRIGGER) of the SPECTRAL DATA BUFFER CREATION menu in the BASIC driver program.

#SCANS=n This command sets the number of SCANs to be performed (i.e., number of spectra to be captured in the spectral data buffer) by MAKEBUFFER. The legal range of the argument n is 1 to 120. This is the total number of spectra that will be available for display by SPECSURF or RT60. This command corresponds to item 1 of the BUFFER CREATION menu.

INTERVAL=n This command sets the sampling interval used by MAKEBUFFER in multiples of 10 milliseconds. If the argument n is 50, MAKEBUFFER will wait 500 milliseconds each time it captures a spectrum in memory. The legal range of the argument is 1 to 100. If AVG mode is enabled and an argument of 1 is entered, the actual interval will be 20 ms (the minimum in AVG mode). This corresponds to item 2 of the BUFFER CREATION menu.

KEYBD This command sets the manual (keyboard) trigger mode.

AUTO This command sets the auto (threshold) trigger mode. The KEYBD and AUTO commands correspond to the options made available by the TRIGGER SOURCE item on the BUFFER CREATION menu.

THRESHOLD=n This command sets the threshold in DB used by the BUFFER command as the trigger point, when in AUTO mode. The legal range of the argument is 1 to 47. This is the same threshold set by item 4 on the BUFFER CREATION menu.

SLOPE=R/F This command sets the threshold slope in auto mode to Rising or Falling, indicated by the characters 'R' and 'F', respectively. These 2 characters are the only legal arguments for this command, which corresponds to item 5 on the BUFFER CREATION menu.

TRIGOFF=n This command sets a positive or negative offset (in SCANs) to the trigger as the point at which MAKEBUFFER routines will begin saving spectral data. A leading '+' is optional for positive offsets, but a leading '-' (minus sign) is necessary to indicate negative offsets. The legal range of n is -63 to +63. This command corresponds to item 6 of the BUFFER CREATION menu.

SPECSURF This command causes a spectral surface to be plotted on the selected HIRES page at the specified range (set by the PLTPAGE=n and RANGE=n commands, respectively, as explained in the APX 252 manual). Other plot options include scale, direction, number of spectra to plot, and offset to the first plotted spectrum. Plotting may be interrupted by pressing any key, or aborted by hitting 'ESC'. On exit, control returns to the caller, though the HIRES page will remain displayed. This command corresponds to item 7, BEGIN PLOTTING, of the SPECTRAL SURFACE PLOTTING menu.

#SPECTRA=n This command is used to specify the number of spectra to be used for spectral surface and RT60 displays. Normally the displays are created using all the spectra available in the buffer, but this command, in conjunction with PLTOFF=n, can be used to create the displays from any subset of the data in the buffer. The maximum legal value for n is the total number of spectra in the buffer (previously specified by the #SCANS command). The minimum legal value of n is 1. This command corresponds to item 1 of the SPECTRAL SURFACE menu.

PLTOFF=n This command allows you to specify an offset from the first spectrum available in the buffer to the first spectrum to be displayed by the

spectral surface and RT60 display routines. The default offset is 0. The PLTOFF and #SPECTRA commands work in conjunction with each other: the plot offset will be automatically adjusted (if necessary) when the #SPECTRA command is issued, so that the sum of the two doesn't exceed the total number of spectra available in the buffer. Likewise, the number of spectra to display is adjusted when PLTOFF is issued. The maximum legal value of PLTOFF is the number of spectra in the buffer minus one. This command corresponds to item 2 of the SPECTRAL SURFACE menu.

SCALE=n This command specifies a vertical multiplying factor for the spectral surface display. The only legal values of n are 1, 2 or 4. This command corresponds to item 3 of the SPECTRAL SURFACE menu.

DIRECTION=L/R This command causes the spectral surface to plot from left to right (L) or right to left (R). The characters 'L' and 'R' are the only legal arguments for this command, which corresponds to item 4 of the SEPCTRAL SURFACE menu.

RT60 This command starts the RT60 display. If there was a previous display, it will be restarted, or else the selected HIRES screen will be cleared and the display cold started. See the discussion of MENU ITEM #4: RT60 REVERBERATION DISPLAY and the list of RT60 function keys in the back of this manual.

APSOFT=ON/OFF This command tells the SPECSYSTEM 2.0 software whether Integer or Applesoft graphics routines should be used for the spectral surface and RT60 displays. The default condition is to call Integer BASIC's routines, which actually reside in the Programmers Aid #1 ROM.

USING SPECSYSTEM FROM ASSEMBLY LANGUAGE

CAVEAT

Some knowledge of assembly language programming is necessary to understand portions of this section. EVENTIDE regrets that it cannot provide support for use of machine code subroutines beyond the documentation provided in this manual, nor can we answer questions over the telephone regarding this section. If you have a SPECIFIC question about something you feel isn't clear in the manual, please write to us and we will try to help. We cannot provide source listings or support undocumented features or entry points.

First we will describe some of the variables that control operation of the SPECSYSTEM routines. These variables are usually set by the high-level SPECSYSTEM commands, but an assembly language program could parameterize them as well. We will then discuss briefly the major subroutine entry points and the theory of operation of these subroutines.

CONTROL VARIABLES

This section will discuss the SPECSYTEM 2.0 control variables. Each variable is listed in Appendix #4: MEMORY USAGE. It may be helpful to refer to this list during the following discussion. Absolute addresses for each variable as well as for subroutine entry points are included in that section.

NOSCANS	NOSPEC	FRSPEC	APSFTFLAG
INTRVL	SCALE	TRIGBYTE	VALIDFLAG
NOSPEC	XDIR	TRIGOFF	DEVICE

NOSCANS controls the number of SCANs (spectra) stored in the buffer. This is the total number of spectra that the spectral surface plotter and the RT60 calculation subroutines will have available to use. In BASIC, NOSCANS is set via the # OF SCANS menu item. The default value of this variable is 25, and the range is 1 to 120. The maximum number is limited by the amount of memory reserved for the spectral data buffer.

TRIGBYTE is a control byte that determines the type of trigger looked for by the MAKEBUFFER subroutines as a signal to begin filling the buffer. There are two manual trigger modes, and two automatic trigger modes in which the trigger is derived from the data being collected. The four modes are specified according to the setting of particular bits in the trigger byte as shown below:

```
x= don't care                Threshold in dB from 1 to 47
                               v v  v v v v
  TRIGBYTE:    Bits 7 6 5 4  3 2 1 0
                    ^ ^

Threshold trigger =0 1 x x  x x x x = rising threshold
Threshold trigger =0 0 x x  x x x x = falling threshold

 Hardware trigger =1 x x x  x x x 0 = keyboard
 Hardware trigger =1 x 1 1  1 1 1 1 = other DEVICE
```

If bit 7 (the MSB) is set and bits 5 through 0 are NOT all 1's, then BUFFMAKER waits for a key to be pressed on the Apple keyboard as signal to begin saving SCAN data. If bit 7 and bits 5 through 0 are all set, then MAKEBUFFER routines look for a TRUE (non-zero) value at the location pointed to by DEVICE (see below) as a trigger signal. This DEVICE option is not supported by the BASIC driver.

If bit 7 is clear, then a trigger is generated internally as the SCAN data crosses a threshold value specified in dB (1-47) by the 6 least significant bits. If bit 6 is set, the trigger will be generated as the data rises above the specified threshold; if bit 6 is clear, it will occur as the data falls below the threshold. The reference data for the threshold comparison is automatically passed by SCAN in MAXFLT as a pointer to the filter with the maximum amplitude (excluding the LEVEL channel). In this trigger mode the keyboard is still active as a trigger device.

When used with TRIGOFF (see below), TRIGBYTE's threshold feature can be used to capture transient signals or trigger on a reverberation decay. The default value of TRIGBYTE is 128 (keyboard trigger). The legal threshold range is 1 to 47 dB.

TRIGOFF is a variable used as a pre-trigger or post-trigger offset, of a specified number of SCANs, to the head of the data buffer. When the trigger is generated, TRIGOFF tells the MAKEBUFFER routines to either wait a number of SCANs equal to the offset before establishing the pointers to the head of the buffer (post-trigger), or to fix the pointers that same number of SCANs PRIOR to the current buffer pointer (pre-trigger). This creates a positive or negative offset in the buffer from the occurrence of the trigger to the first spectrum to be "saved". See Figure 5 for an illustration of trigger offsets.

```
                              5 LSBits hold the offset, 0 to 63
                               v  v v v v
    TRIGOFF:     Bits  7 6 5 4  3 2 1 0
                       ^ ^ ^

Offset post-trigger: 0 x x            x= don't care
 Offset pre-trigger: 1 x x
```

Clearing bit 7 signifies creating an offset to the head of the buffer after the occurrence of the trigger, while setting bit 7 signifies an offset before the trigger. The maximum offset in either direction is 63 SCANs, but in the pre- direction the offset is also limited by MAKEBUFFER to NOSCANS. The various bits in TRIGOFF are set from the sum of variables set by the THRESHOLD menu item. See the BASIC listing for an example of this technique.

INTRVL is the number of 10 millisecond intervals between SCANs when performed by MAKEBUFFER. The minimum interval is 10 ms. unless AVG is set by PKFLAG, which requires at least 15 ms. between SCANs. To preserve statistical

validity, the time between SCANs must be at least as long as the inverse bandwidth of the lowest filter of interest. The legal range of INTRVL is 1 to 100, providing SCAN intervals of from 10 (or 15) ms to 1000 ms; the default value is 1. INTRVL is parameterized via the SAMPLING INTERVAL menu item.

SCALE is a vertical multiplier used in SPECSURF to give the desired vertical scaling to the spectral surface display, causing vertical compression or expansion. The legal values for SCALE are 1, 2, or 4, and correspond directly to 1, 2, or 4 vertical HIRES screen lines per dB. The default value is 2.

XDIR is a flag that determines the direction of plotting in SPECSURF. value of 0 causes the spectral surface to be plotted from left to right, and a value of 1 causes plotting from right to left. This is used to simulate 2 different visual perspectives of the 3-dimensional surface. 0 and 1 are the only legal values; the default is 0.

NOSPEC is the display analog of NOSCANS, holding the number of spectra to be used by the SPECSURF and RT60 routines. NOSPEC is initialized to be equal to NOSCANS after each new buffer is created, so that the spectral surface and RT60 routines default to plotting the full amount of data gathered by the MAKEBUFFER routines. The value of NOSPEC can be altered, however, so that when used in conjunction with FRSPEC (see below), any subset of the data in the buffer can be displayed. The legal range for NOSPEC is 1 to NOSCANS.

FRSPEC is the display analog of TRIGOFF, holding a (positive only) offset from the first spectrum saved in the buffer to the first spectrum to be displayed. FRSPEC is active in the SPECSURF and RT60 routines. FRSPEC can be set to display NOSPEC number of spectra anywhere within the range of NOSCANS. The legal range of FRSPEC is limited by SPECSURF so that NOSPEC+FRSPEC is less than or equal to NOSCANS. The default value of FRSPEC is 0.

DEVICE is a pointer, located at $0-1 (the lowest RAM addresses) in which you can place the address of any device to be used as an alternate trigger source (see TRIGBYTE). This device will usually be located in the Apple I/O space between addresses -16384 and -12288 ($C000 to DFFF). A simple example would be to use the pushbutton on a game controller, putting its address ($C062) into the pointer location, LSB first. Pushing the button when MAKEBUFFER was enabled, with TRIGBYTE =255, would then cause a trigger to occur. Use of this pointer is not supported by the BASIC driver included in the SPECSYSTEM package. There is no default address value for this pointer.

VALIDFLAG is a flag used by RT60 to indicate that a successful RT60 determination was made. A user program may check this byte to determine if the program should attempt a re-try. Logically this byte is inverted; VALIDFLAG= =0 if the RT60 was able to be calculated, and is set equal to 255 if invalid due to bad data.

APSFTFLAG is a flag passed to the SPECSYSTEM graphics routines that tell the routines whether they should branch to the built-in Integer or Applesoft graphics subroutines for plotting and line-drawing services. The default value of $00 indicates Integer; $FF indicates Applesoft.

SUBROUTINE THEORY OF OPERATION

Entry to SPECSYSTEM subroutines can be made indirectly through a table of addresses located near the bottom of the code (refer to Appendix # 4). This table holds addresses for executing the BUFFER, SPECSURF, and RT60 commands. In addition, there is an address for a routine called CALC that does RT60 determination without graphic output. These routines can be called with an indirect jump to the table locations, i.e., JMP ((table address)). Initialization, as mentioned before, is up to the user- there is no built-in function. The easiest way to reinitialize the system is to reload the code image from the disc. When running with Applesoft ROMs enabled, the APSFTFLAG described MUST be set before calling SPECSURF or RT60.

CREATING THE SPECTRAL DATA BUFFER

As mentioned previously, BUFFER performs the job of creating the buffer of spectral data in the proper format for SPECSURF and RT60. When called, it will continuously fill a circular buffer with data until receipt of a trigger from the specified trigger source, then store NOSCANS number of spectra more, exiting after writing a header to the buffer that contains status bytes needed by SPECSURF and RT60.

On entry, BUFFER does some initial range checking, and exits if any parameters are out of bounds. Next it clears the entire buffer to zeros and discharges the hold capacitors on the analyzer filter board. It then begins filling the buffer with data from the analyzer, SCANning, delaying, and checking its trigger source for a true condition. The circular buffer is 3840 bytes, enough memory for 120 blocks of 32 bytes, 1 byte per filter. BUFFER always keeps track of CURBUF, the pointer to the block currently being collected; SCAN will always deposit the logarithmic values of the filter amplitudes at the address to which CURBUF points. BUFFER updates this pointer each SCAN until the pointer runs past the upper boundary of the buffer, at which time it begins filling in the buffer from the bottom again. Between each SCAN there is a a time delay corresponding to the value of INTRVL to ensure the validity of any subsequent RT60 analysis on the data

Until the trigger is received, BUFFER checks TRIGBYTE after each SCAN to see what type of trigger to expect: manual, automatic, or a DEVICE trigger. Once the trigger is received, BUFFER checks TRIGOFF to see if an offset to the number of data blocks should be applied when setting the pointer to the head of the buffer; if the offset is "post-trigger" then BUFFER will SCAN the specified number of times before setting the pointer. If the offset is "pre-trigger" then it subtracts the offset from the current block pointer and sets the circular buffer pointer to a block of data that was previously SCANned and saved. If TRIGOFF number of SCANs have not yet taken place when the trigger is received, the pointer will be left pointing back into zeroed buffer space. If the offset is zero then BUFFER takes the pointer to the current block (CURBUF) and saves it as a pointer to the head of the circular buffer. This pointer, BEGBUF, along with copies of INTRVL, NOSCANS and PKFLAG (see the APX manual for details of PKFLAG) to the buffer so that this header information remains with the data in disk/buffer transfers. Appendix #4 details this header structure explicitly.

When the NOSCANS number of SCANs have been performed, and the valid spectral

data collected in the buffer, BUFFER will return to the routine that called it.

SPECTRAL SURFACE PLOTTING

SPECSURF is the subroutine that plots 3-dimensional spectral surfaces on the HIRES screen. It calls three other subroutines to format the plot to optimize screen usage, draw the labels and axes for the plot (including offset and timing information) and perform a hidden line algorithm. SPECSURF itself collects the data from the buffer, scales it and plots on the HIRES screen. The formatting subroutine accepts RANGE, SCALE, NOSPEC and XDIR as variables, and calculates the vertical and horizontal offsets for each successive plot, the horizontal step size, and the starting points for the plot and the axes. It attempts to use as much of the screen as possible, so that shadowing and graphic discontinuity due to the limited screen resolution are minimized, and the 3 dimensional illusion is enhanced. The subroutine reduces SCALE if RANGE and NOSPEC indicate that plotting off the screen might occur due to the limited screen height.

SPECSURF first does some range checking, exiting if values are found to be out of range. A ROM-resident routine is then called to set up the desired HIRES page and another subroutine is called to print the sample interval and mode (PEAK, AVG or FLOAT) found in the buffer header, the total number of spectra available to plot, and the number plotted, along with any plot offset introduced by FRSPEC.

Now SPECSURF finds the first block of data to be displayed by using FRSPEC as an offset from the head of the circular buffer. It finds each byte corresponding to a filter amplitude, scales it and truncates it if necessary to achieve the specified SCALE and RANGE. The resulting value is biased into the proper screen position and connected with a line to the last point plotted. All line drawing in the SPECSURF and RT60 routines is done using the graphics subroutines in either the Programmer's Aid ROM, Applesoft ROMS, or the equivalent code on the Language Card. When the line is drawn SPECSURF uses a hidden line algorithm to determine if there is graphic data from a previous spectrum that needs to be "shadowed", or erased. If so, it calls a subroutine to erase the data.

After each spectrum is plotted, SPECSURF checks the Apple keyboard for a keypress and, if one has occurred, interrupts plotting until it detects another keypress. If the second key hit is "ESC" then SPECSURF will exit to the program that called it. If allowed to plot to completion, SPECSURF will redraw the axes and return to the routine that called it, leaving the plot displayed on the screen.

RT60 ROUTINES

The RT60 group consists of 3 main subroutines: RTAXES, which draws axes and legends for the RT60 display, CALC, which does the numerical RT60 estimate on the data in the buffer, and RT60MON, the interactive keyboard monitor. The RT60 subroutine entry point jumps directly into RT60MON. RT60MON can plot up to 8 different time vs. amplitude curves for filter data in 4 HIRES colors. RT60MON manages the curves by creating an 8 element buffer that holds the indices to the filters (from 0 to 31) currently on the screen. When RT60MON is first called (coldstarted) it calls RTAXES to clear this buffer and to set up the screen for the display. It then begins polling the keyboard for valid command keys. On subsequent entries RT60MON checks to see if the FRSPEC or NOSPEC parameters have

been altered or the screen erased since it was last exited, and coldstarts itself if they have; otherwise it continues from the state in which it was left when "ESC" was pressed. After calling CALC, RT60MON checks the VALIDFLAG returned be CALC, and prints an error message if CALC couldn't determine the RT60. If it was successful, RT60MON prints the RT60 and draws a white line over the data curve that shows the decay slope extrapolated by CALC from the data.

RTAXES calls ROM routines to set up the selected HIRES page and draws and labels the RT60 axes. It divides the horizontal axis into at least NOSPEC-1 divisions (usually more, due to limited horizontal screen resolution), and uses the buffer header corresponding to the INTRVL to label the axis with milliseconds per division as well as the full scale duration. RANGE is not active here- the data is always scaled to its full range (although the bottom 3 dB are truncated because of the analyzer's limited resolution).

The CALC subroutine takes the data from a particular filter that has been "windowed" with FRSPEC and NOSPEC and, MAKING THE ASSUMPTION THAT THE DATA IS DERIVED FROM A REVERBERATION DECAY, estimates the time it would take the level to fall 60 dB. This process necessarily involves an estimate, since the dynamic range of the spectrum analyzer is less than 60 dB. CALC takes the data, finds two "valid" data points, and uses the slope (in dB/msec) of a straight line connecting them as the decay rate, extrapolating this rate over 60 dB to calculate the RT60. Most of the "work" in CALC is finding two good endpoints for the estimated data slope. CALC first finds the maximum amplitude of the given data, and then finds the minimum subsequent to this, and assumes this is the noise floor either of the analyzer or of the space being measured. If these maxima and minima are not at least 10 dB and 4 samples apart, then CALC sets VALIDFLAG =255, and returns to its caller, indicating that the given data did not cover a wide enough level or time interval to make a valid slope estimate. If the two points do meet these criteria, CALC checks the intermediate points, evaluating the smoothness of the decay slope. If there is a "bump" on this slope of more than 2 dB then one of the two existing endpoints is discarded and a new maximum or minimum is found. The evaluation process is repeated with new points until a valid data range is found or there are no more points, causing VALIDFLAG to be set. If the search is successful CALC divides 60 dB by the difference in dB between the endpoints, and multiplies this value by the time interval between the two, giving the RT60. The time is then printed and VALIDFLAG is cleared to 0.

CALC may be called on its own from a user program to calculate RT60 without the graphic output by passing the filter channel number (0 to 31) in CURFILT and retrieving the RT60, in milliseconds, in 3 hex bytes from the RAM locations TEMP through TEMP+2, LSB through MSB (see Appendix #4 for the location of TEMP).

APPENDIX #1: SOME COMMON ERRORS

Here are some errors commonly encountered using the SPECSYSTEM:

Problem: No bargraph response at all in RTA mode, at any gain setting.
Cause: Make sure you have an audio signal at the proper voltage applied to the analyzer input. The analyzer is not designed for microphone level inputs. Check your audio cabling and connections, and refer to the analyzer manual if necessary.

Problem: You get a "LANGUAGE NOT AVAILABLE" message when trying to LOAD or RUN the SPECSYSTEM driver.
Cause: Use the other version of the SPECSYSTEM driver to match the language in your machine or type "FP" or "INT" if you have the ROM Card. Also, when using the Language Card you must boot DOS from a disk that contains a copy of the language you're using.

Problem: You get a "FILE NOT FOUND" message after attempting to RUN the BASIC driver.
Cause: Either the BASIC driver program or the binary file of machine language routines is not on the disk that's in the drive. Make sure you copied ALL the files from the SPECSYSTEM disk onto your work disk and that it's inserted in the default drive.

Problem: You get a "FILE NOT FOUND" message when attempting to load a data buffer or a screen image from the disk.
Cause: You probably typed in an incorrect filename for the desired file. Unfortunately, the Integer BASIC driver cannot recover errors like this. Make sure you have the name spelled as it appears in the catalog. It is NOT necessary, however, to type the ".BUF" or ".SCR" which is added to the filename. Restart the program with RUN.

Problem: The Applesoft driver crashes after having created a spectral buffer.
Cause: The Applesoft loader program GETDRIVER.SFT was not used to load the driver, so DOS loaded it into memory at Applesoft's default load point where it conflicts with the area of RAM assigned to the data buffer. Re-boot the disk and type "RUN GETDRIVER.SFT" to use the loader to load and run the driver.

Problem: The computer crashes any time a SPECSYSTEM command is executed (in immediate mode OR from the BASIC driver).
Cause: The APX card may not be initialized or may no longer be "hooked into" BASIC. This can happen if the computer is RESET or the disk is re-booted. Execute the PR#n command (where n is the slot with the APX card) and then execute the APX command INIT to reinitialize the analyzer and integrate it into DOS's input/ output structure. This also rebuilds the APX vectors which must be active in RAM Page 3.

There may, of course, be instances when the above descriptions don't fit the problem you're experiencing, or the suggested fixes won't relieve the problem If the problem seems disk or DOS-related, try running a program from another disk that you know is good. If the good disk DOESN'T work there may be a problem with your drive or controller card, in which case you should contact your Apple dealer for further help. Success with the known disk isolates the problem to a

bad SPECSYSTEM disk. In the case of a bad workdisk, try making a new copy (preferably on a fresh disk). If the problem seems to be analyzer-related then try executing any of the built-in analyzer commands such as INIT or RTA. If these commands fail then there is probably a hardware problem with the spectrum analyzer card. If the problem seems to point to the original SPECSYSTEM disk or to the analyzer hardware itself, then it's time to call Eventide. Before you contact us, make a note of the EXACT symptoms and the conditions under which the problem occurs- an accurate description may make it possible to remedy the problem over the phone.

APPENDIX #2: INTEGER BASIC DRIVER PROGRAM LISTING

This listing is included to show examples of parameter passing and control techniques you might use to write your own BASIC driver. This listing is NOT an exact copy of the program provided on disk: comments have been added and variable names expanded here to facilitate your understanding. Due to the space available for BASIC programs (see memory map, Appendix #4,) these explanatory features have been removed from the actual program code to conserve memory space.

```
   0 REM                    SPDRIVER.INT
   1 REM     BASIC DRIVER PROGRAM FOR SPECSYSTEM 2.0 FOR THE
   2 REM EVENTIDE APX252 SPECTRUM ANALYZER FOR APPLE II COMPUTERS
   3 REM        COPYRIGHT(C) 1982 EVENTIDE CLOCKWORKS NYC
   4 REM
  10 REM          INITIALIZE D$=CTRL-D, R$=CTRL-R
  15 REM          AND LOAD MACHINE CODE FROM DISC
  18 REM
  20 D$= "": R$= "" : TEXT : CALL-936 : VTAB 10 : PRINT "SPECSYSTEM 2.0 / HANG ON-INTIALIZING..."
  25 PRINT D$;"BLOAD SPCODE"
  90 REM
  95 REM          EQUATE LABELS TO ADDRESSES OF
  96 REM          USER VARIABLES
  98 REM
 100 DIM U$(22),A$(25),P$(4),C$(5),B$(25),L$(7),CH$(36):C$= "BLOAD":L$= "":P$= ".SCR":B$= "BUFFER DOESN'T EXIST YET "
 110 G$= "" : U$= "USE '( )' KEYS TO SET " : CH$= "   CHOOSE ONE FROM THE ABOVE OPTIONS"
 115 VAR= 24746
 120 NOSCANS= VAR : INTRVL= VAR+1 : NOSPEC= VAR+2 : SCAL= VAR+3 : FRSPEC= VAR+5 : TOFF= VAR+7 : RTFLAG= VAR+35 : THRSH= 3
 130 PKFLAG= 768 : PLTPAGE= 780 : RANG= 770 : BGBF= 4350 : CURBUF= 8 : XMEM= 1 : XSCRN= 1 : RET= 1 : INC= 1 : KEYBRD= 1 : FALL= 1
 140 KPR= 10000 : RSET= 11000 : BMP= 13000 : TOP= 500 : KBD= -16384 : KSTB= -16368 : DIR= 1
 150 REM
 160 REM          INITIALIZE THE ANALYZER CARD
 180 REM
 200 CALL -936 : VTAB 10 : INPUT "WHICH ANALYZER SLOT (1-7)",K : IF K>8 OR K<1 THEN GOTO 200
 210 PR#K : PRINT R$;"INIT" : PRINT R$;"PAGE= 2" : POKE -16297,0 : POKE -16302,0
 480 REM
 490 REM          PRINT THE MAIN MENU CHOICES HERE
 495 REM
 500 CALL -936 : VTAB 1
 501 PRINT "\\\\\\\\\\\\\\\\\\\\//////////////////////";
 502 PRINT "\" : VTAB 2 : TAB 40 : PRINT              "/";
 505 PRINT "\       EVENTIDE SPECTRUM ANALYZER     /";
 510 PRINT "/              SPECSYSTEM 2.0          \";
 512 PRINT "/" : VTAB 5 : TAB 40 : PRINT              "\";
 515 PRINT "////////////////////\\\\\\\\\\\\\\\\\\\\" ;
 520 VTAB 8 : PRINT "   1    REAL TIME SPECTRUM ANALYSIS" : VTAB 10 : PRINT "   2    CREATE A SPECTRAL DATA BUFFER"
 530 VTAB 12 : PRINT "   3    PLOT A SPECTRAL SURFACE" : VTAB 14 : PRINT "   4    RT60 REVERBERATION DISPLAY"
 535 VTAB 16 : PRINT "   5    DISPLAY HIRES SCREENS" : VTAB 18 : PRINT "   6    SCREEN/BUFFER/DISK TRANSFER"
 541 REM
 542 REM          PROMPT FOR CHOICE AND GO TO KEY
 543 REM          DETECTION SUBROUTINE AT KC
 544 REM          ON KEY, GOTO THE DESIRED SECTION
 549 REM
 550 POKE 34,20 : CALL -936 : VTAB 22 : PRINT CH$ : KLM= 6 : GOSUB KPR
 560 POKE 34,0 : IF K= 1 THEN GOTO 800 : GOTO 1000*(K-1)
 793 REM
 794 REM          CALL THE SUBROUTINE FOR
 795 REM          REAL TIME ANALYSIS,
 797 REM          RETURNING TO MAIN MENU
 799 REM
 800 POKE CURBUF,176 : POKE CURBUF+1,3 : PRINT R$;"PAGE= 1" : PRINT R$;"WARMRTA"
 810 PRINT R$;"PAGE= 2" : GOSUB RSET
 990 REM
 995 REM          PRINT THE BUFFER CREATION MENU
 998 REM
1000 CALL -936 : VTAB 2 : PRINT ">>>  SPECTRAL DATA BUFFER CREATION  <<<<"
1020 VTAB 5 : PRINT "1     # OF SCANS" : VTAB 7 : PRINT "2    SAMPLE INTERVAL"
1030 VTAB 9 : PRINT "3     TRIGGER SOURCE" : VTAB 11 : PRINT "4     THRESHOLD SLOPE" : VTAB 13 : PRINT "5     THRESHOLD LEVEL"
1040 VTAB 15 : PRINT "6     TRIGGER OFFSET" : VTAB 17 : PRINT "7     ENABLE TRIGGER" : VTAB 19 : PRINT "8     RETURN TO MAIN MENU"
1042 VTAB 5 : TAB 32 : PRINT "SAMPLES" : VTAB 7 : TAB 32 : PRINT "MSECS" : VTAB 13 : TAB 32 : PRINT "DB" : VTAB 15 : TAB 32
     : PRINT "SCANS"
```

```
1045 IF PEEK(PKFLAG)#0 AND PEEK(INTRVL)= 1 THEN POKE (INTRVL),2
1046 REM
1046 REM          PROMPT FOR A CHOICE
1047 REM          POKE 34,21 PUTS TEXT WINDOW AT
1048 REM          THE BOTTOM OF THE SCREEN
1049 REM
1050 GOSUB 1950 : POKE 34,21 : CALL -936 : PRINT CH$
1060 KLN= 8 : GOSUB KPR : CALL-936 : GOSUB K#100+1000 : CALL -936 : IF PEEK(KBD)>128 THEN GOTO 1060 : GOTO 1050
1090 REM
1095 REM          CHANGE # OF SCANS
1098 REM
1100 PRINT U$;"DESIRED # OF SCANS" : ULIM= 120 : LLIM= 1 : INC= 1 : RET= PEEK(NOSCANS)
1110 GOSUB BMP : PRINT R$;"#SCANS= ";RET : GOSUB 1650
1120 IF NOT FIN THEN GOTO 1110 : RETURN
1180 REM
1190 REM          CHANGE SAMPLING INTERVAL
1195 REM
1200 PRINT " ";U$;"INTERVAL IN MSEC" : POKE 50,63
1210 ULIM= 100 : LLIM= 1 : INC= 1 : RET= PEEK(INTRVL)
1220 GOSUB BMP : VTAB 7 : TAB 24 : PRINT " ";RET#10; : A$= " " : IF RET(100 THEN A$= "  " : PRINT A$
1230 IF NOT FIN THEN GOTO 1220 : POKE 50,255 : PRINT R$;"INTERVAL= ";RET : RETURN
1280 REM
1290 REM          SET TRIGGER MODE HERE
1295 REM
1300 KEYBRD= NOT KEYBRD : A$= "KEYBRD" : IF NOT KEYBRD THEN A$= "AUTO" : PRINT R$;A$ : RETURN
1380 REM
1385 REM          IN AUTO MODE, SET THRESHOLD SLOPE
1390 REM
1400 FALL= NOT FALL : A$= "F" : IF NOT FALL THEN A$= "R" : PRINT R$;"SLOPE= ";A$ : RETURN
1470 REM
1480 REM          IN AUTO MODE, SET THRESHOLD LEVEL
1490 REM
1500 PRINT " ";U$;"THRESHOLD LEVEL" : ULIM= 47 : LLIM= 1 : INC= 1 : RET= THRSH : POKE 50,63
1510 GOSUB BMP : VTAB 13 : TAB 24 : PRINT " ";RET;" " : IF NOT FIN THEN GOTO 1510
1520 THRSH= RET : PRINT R$;"THRESH= ";THRSH : POKE 50,255 : RETURN
1510 REM
1590 REM          SET THE TRIGGER OFFSET FROM +63
1595 REM          TO -(# OF SCANS IN BUFFER)
1596 REM
1600 X= PEEK(NOSCANS)-1 : IF X)63 THEN X= 63
1605 PRINT U$;"A POSITIVE OR NEG-ATIVE OFFSET FROM THE TRIGGER, IN SCANS"
1610 ULIM= 63 : LLIM= -X : INC= 1 : GOSUB 1650 : RET= T
1620 GOSUB BMP : PRINT R$; "TRIGOFF= ";RET : GOSUB 1650
1630 IF NOT FIN THEN GOTO 1620 : RETURN
1640 REM
1650 POKE 50,63 : VTAB 5 : TAB 24 : PRINT " "; PEEK (NOSCANS);"  " : T= PEEK(TOFF) : VTAB 15 : TAB 24
1660 A$= "" : IF T(128 THEN A$= "+" : IF T)127 THEN T= -(T-128) : PRINT A$;T;" " : POKE 50,255 : RETURN
1680 REM
1690 REM          START TAKING SAMPLES
1695 REM
1700 VTAB 22 : PRINT "        TRIGGER IS ENABLED" : VTAB 23 : IF NOT KEYBRD THEN GOTO 1730
1710 PRINT "  HIT ANY KEY TO BEGIN TAKING SAMPLES" : GOTO 1750
1730 PRINT "SAMPLING WILL BEGIN WHEN THE AMPLITUDE       CROSSES THE TRIGGER THRESHOLD";
1740 REM          HERE WE CALL BUFFMAKER
1750 BUFFLAG= 1 : PRINT R$; "BUFFER"
1790 REM
1795 REM          RETURN TO MAIN MENU
1800 GOTO RSET
1900 REM
1910 REM          THIS SECTION PRINTS THE
1915 REM          CURRENT VARIABLE VALUES IN
1920 REM          INVERSE VIDEO ON THE MENU PAGE
1925 REM
```

```
1950 POKE 50,63 : VTAB 7 : TAB 24 : X= PEEK(INTRVL)*10 : PRINT " ";X;" "; : IF X<1000 THEN PRINT " "
1970 VTAB 9 : TAB 24 : IF KEYBRD THEN PRINT "KEYBRD" : IF NOT KEYBRD THEN PRINT " AUTO "
1975 VTAB 11 : TAB 24 : A$= "FALLING" : IF NOT FALL THEN A$= " RISING" : PRINT A$
1980 VTAB 13 : TAB 24 : PRINT " ";THRSH;" " : GOSUB 1650
1985 POKE 50,255 : RETURN
1990 REM
1992 REM          PRINT THE MENU FOR DRAWING
1994 REM          SPECTRAL SURFACES
1995 REM
2000 IF NOT BUFFLAG THEN GOTO 3000 : X= PEEK(4347) : POKE 34,0 : CALL -936 : VTAB 2 : PRINT ") SPECTRAL DATA PLOTTING ("
2030 VTAB 5 : PRINT "1    # SPECTRA TO PLOT" : TAB 32 : VTAB 5 : PRINT "SPECTRA" : VTAB 7 : PRINT "2    PLOT OFFSET";
2040 TAB 32 : PRINT "SPECTRA" : VTAB 9 : PRINT "3    RANGE";
2042 TAB 32 : PRINT "DB" : VTAB 11 : PRINT "4    VERTICAL SCALE";
2045 TAB 32 : PRINT "LINES/DB" : VTAB 13 : PRINT "5    PLOT DIRECTION" : VTAB 15 : PRINT "6    CURRENT PLOT PAGE"
2050 VTAB 17 : PRINT "7    BEGIN PLOTTING" : VTAB 19 : PRINT "8    RETURN TO MAIN MENU"
2056 REM
2057 REM          PROMPT FOR CHOICES, CHECK KEY
2058 REM          AND GO TO APPROPRIATE SUBROUTINE
2059 REM
2060 GOSUB 2950 : POKE 34,21 : CALL -936 : PRINT CH$
2070 KLM= 8 : GOSUB KPR : CALL-936 : GOSUB K*100+2000 : IF PEEK(KBD)<128 THEN GOTO 2060 : GOTO 2070
2080 REM
2090 REM          SPECIFY THE # OF SPECTRA TO DISP
2092 REM          FROM 0 UP TO THE # IN THE BUFFER
2095 REM
2100 PRINT "  ";U$;"THE NUMBER OF " : TAB 8 : PRINT"SPECTRA TO BE DISPLAYED"
2110 LLIM= 1 : ULIM= PEEK(NOSCANS) : INC= 1 : RET= PEEK(NOSPEC)
2120 GOSUB BMP : PRINT R$;"#SPECTRA= ";RET : GOSUB 2250
2130 IF NOT FIN THEN GOTO 2120 : RETURN
2190 REM
2195 REM          ADD AN OFFSET FROM THE FIRST
2196 REM          SPEC. SAVED TO THE FIRST SPEC.
2197 REM          TO BE DISPLAYED
2198 REM
2200 PRINT U$;"AN OFFSET FROM THEFIRST SPECTRUM SAVED TO THE FIRST TO BE" :
2205 TAB 15 : PRINT "DISPLAYED";
2210 ULIM= PEEK(NOSCANS)-1 : LLIM= 0 : INC= 1 : RET= PEEK(FRSPEC)
2220 GOSUB BMP : PRINT R$;"PLOTOFF= ";RET : GOSUB 2250
2230 IF NOT FIN THEN GOTO 2220 : RETURN
2240 REM
2250 POKE 50,63 : VTAB 5 : TAB 25 : PRINT " "; PEEK (NOSPEC);"  " : VTAB 7 : TAB 25 : PRINT " "; PEEK (FRSPEC);"  "
     : POKE 50,255 : RETURN
2295 REM
2298 REM          SET THE DISPLAY RANGE IN DB
2299 REM
2300 T= PEEK (RANG ) : IF T= 48 THEN PRINT R$;"RANGE= 12" : IF T#48 THEN PRINT R$;"RANGE= ";T*2 : RETURN
2389 REM
2390 REM          SET THE DISPLAY VERTICAL SCALING
2392 REM
2400 T= PEEK (SCAL ) : IF T= 4 THEN X= 1 : IF T#4 THEN X= T*2 : PRINT R$;"SCALE= ";X : RETURN
2490 REM
2495 REM          SPECIFY THE RELATIVE PERSPECTIVE
2496 REM
2500 DIR= NOT DIR : A$= "R" : IF NOT DIR THEN A$= "L" : PRINT R$;"DIRECTION= ";A$ : RETURN
2590 REM
2595 REM          SELECT THE HIRES PAGE FOR PLOTTING
2598 REM
2600 PRINT R$;"PAGE= ";ABS(PEEK(PLTPAGE)-2)+1 : RETURN
2690 REM
2695 REM          CALL THE PLOTTING SUBROUTINE, SETTING
2696 REM          THE RT60 COLDSTART FLAG IF WE'RE PLOTTING
2697 REM          ON PAGE 1 (RT60'S PLOT PAGE)
2698 REM
2700 PRINT R$;"SPECSURF"
```

```
2701 REM
2705 REM          ON RETURN, ALLOW EITHER HIRES PAGE
2706 REM          TO BE VIEWED, RETURN TO MAIN MENU ON ESC
2707 REM
2710 IF PEEK(KBD)= 27 THEN GOTO 2740
2720 IF PEEK(KBD)<128 THEN GOTO 2720 : POKE KSTB,0
2730 K= PEEK(KBD) : IF (K<49) AND (K>50) THEN GOTO 2740 : POKE -16301+(K-48),0 : GOTO 2710
2740 POKE -16300,0 : POKE-16303,0 : RETURN
2790 REM
2795 REM          RETURN TO MAIN MENU
2800 GOTO RSET
2900 REM
2910 REM          THIS SECTION WILL PRINT THE
2915 REM          CURRENT VARIABLE VALUES
2920 REM          IN INVERSE ON THE MENU PAGE
2930 REM
2950 POKE 50,63
2955 VTAB 9 : TAB 25 : PRINT " "; PEEK (RANG );" " : VTAB 11 : TAB 25 : PRINT " "; PEEK (SCAL );" "
2960 VTAB 13 : TAB 25 : IF NOT DIR THEN PRINT "RIGHT" : IF DIR THEN PRINT " LEFT"
2965 VTAB 15 : TAB 25 : PRINT " "; PEEK (PLTPAGE);" "
2990 GOSUB 2250 : POKE 50,255 : RETURN
2991 REM
2992 REM          THIS SECTION CALLS THE RT60
2993 REM          ROUTINE. ON EXIT, RETURN TO
2994 REM          MAIN MENU
2996 REM
2997 REM          IF NO BUFFER YET (BUFFLAG= 0)
2998 REM          THEN PRINT ERR MESS AND RETURN
2999 REM
3000 IF BUFFLAG THEN GOTO 3200 : POKE 34,20 : POKE 50,127 : CALL -936 : VTAB 22 : TAB 4 : PRINT C$;" SORRY, ";B$
3005 FOR X= 0 TO 500 : NEXT X : CALL -936 : POKE 34,0 : POKE 50,255 : GOTO TOP
3100 REM
3110 REM          PLOT RT60 ALWAYS ON PG1
3120 REM          IF COLD, THEN SET WARMSTART
3150 REM
3200 PRINT R$;"PAGE= 1" : PRINT R$;"RT60"
3300 PRINT R$;"PAGE= 2" : GOSUB RSET
3990 REM
3995 REM          HERE WE CAN TOGGLE BETWEEN
3996 REM          VIEWING HIRES PG1 OR PG2
3997 REM          WITH THE "1" AND "2" KEYS
3999 REM
4000 POKE -16304,0 : POKE -16297,0 : POKE -16300,0
4010 KLM= 2 : GOSUB KPR : POKE -16301+K,0 : GOTO 4010
4994 REM
5994 REM
5992 REM          PRINT BUFFER/SCREEN/DISK TRANSFER MENU
5993 REM
5994 REM
5000 CALL -936 : VTAB 3 : PRINT "))))  SCREEN/BUFFER/DISK TRANSFER  ((((("
5010 VTAB 7 : PRINT "1    TRANSFER DIRECTION : FROM" : VTAB 9 : TAB 28 : PRINT "TO"
5020 VTAB 11 : PRINT "2    TRANSFER DATA" : VTAB 13 : PRINT "3    HIRES TRANSFER PAGE"
5030 VTAB 15 : PRINT "4    CATALOG/TRANSFER" : VTAB 17 : PRINT "5    RETURN TO MAIN MENU"
5040 GOSUB 5900 : POKE 34,21 : CALL -936 : PRINT CH$
5050 KLM= 5 : GOSUB 10000 : GOSUB 5000+K*100 : GOTO 5000
5070 REM
5080 REM
5090 REM          CHANGE TRANSFER DIRECTION HERE
5092 REM
5094 REM
5100 XMEM= NOT XMEM : GOSUB 5900 : GOSUB 5970 : RETURN
5195 REM
5196 REM
```

```
5197 REM          CHANGE FROM SCREEN TO BUFFER
5198 REM
5199 REM
5200 XSCRN= NOT XSCRN : GOSUB 5900 : GOSUB 5970 : RETURN
5295 REM
5296 REM
5297 REM          SWITCH SCREEN PAGES FOR TRANSFER
5298 REM
5299 REM
5300 XPAGE= NOT XPAGE : GOSUB 5900
5310 FOR X= 0 TO 15 : NEXT X : POKE-16297,0 : POKE -16304,0 : POKE -16300+XPAGE,0
5320 CALL -936 : TAB 6 : POKE 50,127 : PRINT "PAGE ";XPAGE+1;" SELECTED FOR TRANSFER" : POKE 50,255 : FOR X= 0 TO 300 : NEXT X
5330 POKE -16302,0 : POKE-16300,0 : POKE-16303,0 : FOR X= 0 TO 400 : NEXT X : RETURN
5395 REM
5396 REM
5397 REM          DO THE TRANSFER
5398 REM
5399 REM
5400 IF (XSCRN OR BUFFLAG OR XMEM) THEN GOTO 5404 : CALL -936 : POKE 50,127
5402 PRINT "CAN'T TRANSFER-";B$;G$ : POKE 50,255 : FOR X= 0 TO 1000 : NEXT X : RETURN
5404 POKE 34,1 : CALL -936 : PRINT D$;"CATALOG"
5406 PRINT " " : PRINT "ENTER THE FILENAME TO BE" : PRINT "USED FOR THE TRANSFER : "; :
5410 IF PEEK(KBD)<128 THEN GOTO 5410
5415 IF PEEK(KBD)>192 AND PEEK(KBD)<219 THEN GOTO 5420 : POKE KSTB,0 : RETURN
5420 INPUT A$ : T= LEN(A$) : IF T<5 THEN A$(T+1)= P$ : T= LEN(A$)
5430 IF A$(T-3,T)$ P$ THEN A$(T+1)= P$
5440 IF XSCRN THEN GOTO 5480
5442 REM
5446 REM          HERE IF BUFFER TRANSFER
5447 REM          STRINGS HOLD CMD,FILENAME,ADDRESS
5448 REM
5450 PRINT "" : POKE 50,127 : TAB 4 : PRINT " TRANSFERRING SPECTRAL DATA BUFFER " : POKE 50,255
5455 PRINT D$;C$;A$;",A4345";L$ : IF NOT XMEM THEN RETURN
5456 REM
5457 REM          IF TRANSFERING IN NEW BUFFER, SET NEW
5458 REM          VARIABLES, CLEAR RT60 FLAG, SET BUFFER FLAG
5459 REM
5460 POKE NOSCANS, PEEK (4349) : POKE NOSPEC,PEEK(4349) : POKE ITRVL, PEEK (4348)
5465 POKE PKFLAG, PEEK (4347) : PRINT R$;"PERIOD= ";PEEK (4346)+1
5470 POKE RTFLAG,0 : BUFFLAG= 1 : RETURN
5472 REM
5474 REM
5476 REM          HERE IF SCREEN TRANSFER
5478 REM
5479 REM
5480 IF NOT XMEM THEN GOTO 5490 : POKE -16304,0 : POKE -16300+XPAGE,0 : GOTO 5492
5490 PRINT " " : POKE 50,127 : TAB 5 : PRINT " TRANSFERRING HIRES SCREEN IMAGE " : POKE 50,255
5492 PRINT D$;C$;A$;",A";8192+(XPAGE*8192);L$ : IF NOT XMEM THEN RETURN
5495 FOR X= 0 TO 1000 : NEXT X : POKE -16303,0 : POKE -16300,0 : IF NOT XPAGE THEN POKE RTFLAG,0 : RETURN
5496 REM
5497 REM          HERE ON EXIT
5498 REM
5500 GOTO RSET
5890 REM
5890 REM          THIS PRINTS THE MENU VARIABLES
5890 REM          IN INVERSE VIDEO AND UPDATES STRINGS
5890 REM
5900 POKE 50,63 : VTAB (7+2*XMEM) : TAB 31 : PRINT "MEMORY" : VTAB (9-2*XMEM) : TAB 31 : PRINT " DISK "
5910 VTAB 11 : TAB 22 : IF NOT XSCRN THEN PRINT "  SPECTRAL BUFFER " : IF XSCRN THEN PRINT "HIRES SCREEN IMAGE"
5930 VTAB 13 : TAB 32 : PRINT " ";XPAGE+1;" " : POKE 50,255
5940 IF XSCRN THEN L$= ",L8192" : IF XSCRN THEN P$= ".SCR"
5950 IF NOT XSCRN THEN L$= ",L3847" : IF NOT XSCRN THEN P$= ".BUF"
5960 IF XMEM THEN C$= "BLOAD" : IF XMEM THEN L$= "" : IF NOT XMEM THEN C$= "BSAVE" : RETURN
```

```
 5962 REM
 5962 REM           PRINT CAUTION MESSAGE
 5962 REM
 5970 IF XMEM OR XSCRN OR BUFFLAG THEN RETURN : CALL-936 : TAB 6 : POKE 50,127 : PRINT "CAUTION"
 5980 POKE 50,255 : VTAB 22 : TAB 13 : PRINT "- ";B$ : FOR X= 0 TO 500 : NEXT X : RETURN
 9990 REM
 9991 REM          THIS SUBROUTINE CHECKS FOR
 9992 REM          A NUMERICAL KEY PRESSED
 9993 REM          AND RETURNS IS THE KEY IS
 9994 REM          WITHIN THE LIMIT OF KLM
 9995 REM
10000 K= PEEK (KBD) : IF K<177 AND K#155 THEN GOTO KPR : POKE KSTB,0 : K= K-176 : IF K>KLM AND K#-21 THEN GOTO KPR
10010 IF K#-21 THEN RETURN
10990 REM
10991 REM          AN ESCAPE KEY PRESSED
10992 REM          WILL FALL INTO THIS
10993 REM          SUBROUTINE WHICH POPS
10994 REM          THE RETURN ADDRESS AND
10995 REM          JUMPS BACK TO THE MENU
10996 REM
11000 POKE 34,0 : POKE -16300,0 : POKE -16303,0 : POP : GOTO TOP
12990 REM
12992 REM           THIS SECTION RECEIVES UPPER AND LOWER LIMITS,
12994 REM           AN INCREMENT VALUE, AND RETURNS A "FINISHED" FLAG
12996 REM           AND A RETURN VARIABLE.
12998 REM
13000 FIN= 0 : K= PEEK(KBD) : IF K<128 THEN RETURN
13020 IF K#172 THEN GOTO 13030 : RET= RET-INC : IF RET<LLIM THEN RET= ULIM : GOTO 13080
13030 IF K#174 THEN GOTO 13040 : RET= RET+INC : IF RET>ULIM THEN RET= LLIM : GOTO 13080
13040 IF K#188 THEN GOTO 13050 : RET= RET-(5*INC) : IF RET<LLIM THEN RET= ULIM : GOTO 13080
13050 IF K#190 THEN GOTO 13060 : RET= RET+(5*INC) : IF RET>ULIM THEN RET= LLIM : GOTO 13080
13060 IF K#172 AND K#174 AND K#188 AND K#190 THEN FIN= 1
13070 IF FIN AND K>176 AND K<186 THEN RETURN
13080 POKE KSTB,0 : RETURN
IN#0
```

APPENDIX #3: APPLESOFT BASIC DRIVER PROGRAM LISTING

This listing is included to show examples of parameter passing and control techniques you might use to write your own BASIC driver. This listing is NOT an exact copy of the program provided on disk: comments have been added and variable names expanded here to facilitate your understanding. Due to the space available for BASIC programs (see memory map, Appendix #4,) these explanatory features have been removed from the actual program code to conserve memory space.

```
   0 REM                      SPDRIVER.SFT
   1 REM          APPLESOFT SPECSYSTEM 2.0 DRIVER FOR THE
   2 REM  EVENTIDE APX252 SPECTRUM ANALYZER FOR APPLE II COMPUTERS
   3 REM          COPYRIGHT(C) 1982 EVENTIDE CLOCKWORKS NYC
   4 REM
  10 REM           INITIALIZE D$=CTRL-D, R$=CTRL-R
  15 REM           AND LOAD MACHINE CODE FROM DISC
  18 REM
  20 D$="" : R$="" : HOME : VTAB 10 : PRINT "SPECSYSTEM 2.0 / HANG ON-INITIALIZING..."
  30 PRINT D$;"BLOAD SPCODE"
  90 REM
  95 REM           SET VARIABLES AND EQUATE ADDRESSES
  96 REM           OF USER VARIABLES
  98 REM
 100 G$="" : C$="BSAVE" : P$=".SCR" : B$="BUFFER DOESN'T EXIST YET"
 110 U$="USE '( )' KEYS TO SET " : CH$="   CHOOSE ONE FROM THE ABOVE OPTIONS"
 115 VAR=24746
 120 SCANS=VAR : ITRVL=VAR+1 : SPEC=VAR+2 : VSCAL=VAR+3 : FRSPEC=VAR+5 : TFFST=VAR+7 : RTFLAG=VAR+35 : THRSH=3
 130 PKFLAG=768 : RANG=770 : PLTPAGE=780 : BGBF=4350 : CURBUF=8 : XMEM=1 : XSCRN=1 : RET=1 : IV=1 : DIR=1 : KEYBRD=1 : FALL=1
 140 KBD=-16384 : KSTB=-16368
 150 ON ERR GOTO 14000
 155 REM
 160 REM           INITIALIZE THE ANALYZER CARD
 180 REM
 200 TEXT : HOME : VTAB 10 : INPUT "WHICH ANALYZER SLOT (1-7)? ";K : IF K>8 OR K<1 GOTO 200
 210 PR#K : PRINT R$;"INIT" : PRINT R$;"APSOFT=ON" : PRINT R$;"PAGE=2"
 220 POKE -16302,0 : POKE -16297,0
 480 REM
 490 REM           PRINT THE MAIN MENU CHOICES HERE
 495 REM
 500 X=FRE(0) : HOME : VTAB 1
 501 PRINT "\\\\\\\\\\\\\\\\\\\\///////////////////";
 502 PRINT "\" : VTAB 2 : HTAB 40 : PRINT               "/";
 505 PRINT "\       EVENTIDE SPECTRUM ANALYZER     /";
 510 PRINT "/              SPECSYSTEM 2.0          \";
 512 PRINT "/" : VTAB 5 : HTAB 40 : PRINT               "\";
 515 PRINT "///////////////////\\\\\\\\\\\\\\\\\\\\" :
 520 VTAB 8 : PRINT "   1    REAL TIME SPECTRUM ANALYSIS" : VTAB 10 : PRINT "   2    CREATE A SPECTRAL DATA BUFFER"
 530 VTAB 12 : PRINT "   3    PLOT A SPECTRAL SURFACE" : VTAB 14 : PRINT "   4    RT60 REVERBERATION DISPLAY"
 535 VTAB 16 : PRINT "   5    DISPLAY HIRES SCREENS" : VTAB 18 : PRINT "   6    SCREEN/BUFFER/DISK TRANSFER"
 541 REM
 542 REM           PROMPT FOR CHOICE AND GO TO KEY
 543 REM           DETECTION SUBROUTINE AT 10000
 544 REM           ON KEY, GOTO THE DESIRED SECTION
 549 REM
 550 POKE 34,20 : HOME : VTAB 22 : PRINT CH$ : KLM=6 : GOSUB 10000
 560 POKE 34,0 : ON K GOTO 800,1000,2000,3000,4000,5000 : GOTO 500
 793 REM
 794 REM           CALL THE SUBROUTINE FOR
 795 REM           REAL TIME ANALYSIS,
 797 REM           RETURNING TO MAIN MENU
 799 REM
 800 POKE CURBUF,176 : POKE CURBUF+1,3 : PRINT R$;"PAGE=1" : PRINT R$;"WARMRTA"
 810 PRINT R$;"PAGE=2" : GOSUB 11000
 990 REM
 995 REM           PRINT THE BUFFER CREATION MENU
 998 REM
1000 HOME : VTAB 2 : PRINT ">>>> SPECTRAL DATA BUFFER CREATION <<<<"
1020 VTAB 5 : PRINT "1    # OF SCANS" : VTAB 7 : PRINT "2    SAMPLE INTERVAL"
1030 VTAB 9 : PRINT "3    TRIGGER SOURCE" : VTAB 11 : PRINT "4    THRESHOLD SLOPE" : VTAB 13 : PRINT "5    THRESHOLD LEVEL"
1040 VTAB 15 : PRINT "6    TRIGGER OFFSET" : VTAB 17 : PRINT "7    ENABLE TRIGGER" : VTAB 19 : PRINT "8    RETURN TO MAIN MENU"
1042 VTAB 5 : HTAB 32 : PRINT "SAMPLES" : VTAB 7 : HTAB 32 : PRINT "MSECS" : VTAB 13 : HTAB 32 : PRINT "DB" : VTAB 15 : HTAB 32
     : PRINT "SCANS"
```

```
1045 IF PEEK(PKFLAG)<>0 AND PEEK(ITRVL)=1 THEN POKE (ITRVL),2
1046 REM
1046 REM          PROMPT FOR A CHOICE
1047 REM          POKE 34,21 PUTS TEXT WINDOW AT
1048 REM          THE BOTTOM OF THE SCREEN
1049 REM
1050 GOSUB 1950 : POKE 34,21 : HOME : PRINT CH$
1060 KLM=8 : GOSUB 10000 : HOME : ON K GOSUB 1100,1200,1300,1400,1500,1600,1700,1800 : HOME : IF PEEK(KBD)>128 GOTO 1060
1070 GOTO 1050
1090 REM
1095 REM          CHANGE # OF SCANS
1098 REM
1100 PRINT U$;"DESIRED # OF SCANS" : ULIM=120 : LLIM=1 : IV=1 : RET=PEEK(SCANS) : INVERSE
1110 GOSUB 13000 : PRINT R$;"#SCANS=";RET : GOSUB 1650
1120 IF NOT (FIN) GOTO 1110
1130 RETURN
1180 REM
1190 REM          CHANGE SAMPLING INTERVAL
1195 REM
1200 PRINT " ";U$;"INTERVAL IN MSEC" : INVERSE
1210 ULIM=100 : LLIM=1 : IV=1 : RET=PEEK(ITRVL) : IF PEEK(PKFLAG)<>0 THEN LLIM=2
1220 GOSUB 13000 : VTAB 7 : HTAB 24 : PRINT " ";RET$10; : A$=" " : IF RET<100 THEN A$="  " : PRINT A$
1230 IF NOT (FIN) GOTO 1220
1240 NORMAL : PRINT R$; "INTERVAL=";RET : RETURN
1280 REM
1290 REM          SET TRIGGER MODE HERE
1295 REM
1300 KEYBRD= NOT KEYBRD : A$= "KEYBRD" : IF NOT KEYBRD THEN A$= "AUTO"
1310 PRINT R$;A$ : RETURN
1380 REM
1385 REM          IN AUTO MODE, SET THRESHOLD SLOPE
1390 REM
1400 FALL= NOT FALL : A$ ="F" : IF NOT FALL THEN A$="R"
1410 PRINT R$; "SLOPE=";A$ : RETURN
1470 REM
1480 REM          IN AUTO MODE, SET THRESHOLD LEVEL
1490 REM
1500 PRINT " ";U$;"THRESHOLD LEVEL" : ULIM=47 : LLIM=1 : IV=1 : RET=THRSH : INVERSE
1510 GOSUB 13000 : VTAB 13 : HTAB 24 : PRINT " ";RET;" " : IF NOT (FIN) GOTO 1510
1520 THRSH=RET : PRINT R$;"THRESH=";THRSH : NORMAL : RETURN
1580 REM
1590 REM          SET THE TRIGGER OFFSET FROM +63
1595 REM          TO -(# OF SCANS IN BUFFER)
1596 REM
1600 X=PEEK(SCANS)-1 : IF X>63 THEN X=63
1605 PRINT U$;"A POSITIVE OR NEG-ATIVE OFFSET FROM THE TRIGGER, IN SCANS"
1610 ULIM=63 : LLIM=-X : IV=1 : GOSUB 1650 : RET=T
1620 GOSUB 13000 : T=RET : PRINT R$;"TRIGOFF=";T : GOSUB 1650 : IF NOT (FIN) GOTO 1620
1630 RETURN
1640 REM
1650 INVERSE : VTAB 5 : HTAB 24 : PRINT " ";PEEK(SCANS);"  " : VTAB 15 : HTAB 24
1660 A$="+" : T=PEEK(TFFST) : IF T>127 THEN T=-(T-128) : A$=""
1670 PRINT A$;T;" " : NORMAL :  RETURN
1680 REM
1690 REM          START TAKING SAMPLES
1695 REM
1700 VTAB 22 : PRINT "        TRIGGER IS ENABLED" : VTAB 23 : IF NOT KEYBRD GOTO 1730
1710 PRINT "  HIT ANY KEY TO BEGIN TAKING SAMPLES" : GOTO 1750
1730 PRINT "SAMPLING WILL BEGIN WHEN THE AMPLITUDE       CROSSES THE TRIGGER THRESHOLD";
1740 REM          HERE WE CALL BUFFMAKER
1750 BUFFLAG=1 : PRINT R$;"BUFFER"
1790 REM
1795 REM          RETURN TO MAIN MENU
```

```
1800 GOTO 11000
1900 REM
1910 REM          THIS SECTION PRINTS THE
1915 REM          CURRENT VARIABLE VALUES IN
1920 REM          INVERSE VIDEO ON THE MENU PAGE
1925 REM
1950 INVERSE : VTAB 7 : HTAB 24 : X= PEEK(ITRVL)%10 : PRINT " ";X;" "; : IF X(100 PRINT " "
1955 VTAB 9 : HTAB 24 : A$="KEYBRD" : IF NOT KEYBRD THEN A$=" AUTO "
1960 PRINT A$ : VTAB 11 : HTAB 24 : A$= "FALLING" : IF NOT FALL THEN A$=" RISING"
1970 PRINT A$ : VTAB 13 : HTAB 24 : PRINT " ";THRSH;" " : GOSUB 1650
1980 NORMAL : RETURN
1996 REM
1997 REM          PRINT THE MENU FOR DRAWING
1998 REM          SPECTRAL SURFACES
1999 REM
2000 IF NOT BUFFLAG GOTO 3000
2020 X=PEEK(4347) : POKE 34,0 : HOME : VTAB 2 : PRINT "))))))  SPECTRAL DATA PLOTTING  ((((((("
2030 VTAB 5 : PRINT "1    # SPECTRA TO PLOT" : HTAB 32 : VTAB 5 : PRINT "SPECTRA" : VTAB 7 : PRINT "2    PLOT OFFSET";
2040 HTAB 32 : PRINT "SPECTRA" : VTAB 9 : PRINT "3    RANGE";
2042 HTAB 32 : PRINT "DB" : VTAB 11 : PRINT "4    VERTICAL SCALE";
2045 HTAB 32 : PRINT "LINES/DB" : VTAB 13 : PRINT "5    PLOT DIRECTION" : VTAB 15 : PRINT "6    CURRENT PLOT PAGE"
2050 VTAB 17 : PRINT "7    BEGIN PLOTTING" : VTAB 19 : PRINT "8    RETURN TO MAIN MENU"
2056 REM
2057 REM          PROMPT FOR CHOICES, CHECK KEY
2058 REM          AND GO TO APPROPRIATE SUBROUTINE
2059 REM
2060 GOSUB 2950 : POKE 34,21 : HOME : PRINT CH$
2070 KLN=8 : GOSUB 10000 : HOME : ON K GOSUB 2100,2200,2300,2400,2500,2600,2700,2800 : IF PEEK(KBD)(128 GOTO 2060
2072 GOTO 2070
2080 REM
2090 REM          SPECIFY THE # OF SPECTRA TO DISP
2092 REM          FROM 0 UP TO THE # IN THE BUFFER
2095 REM
2100 PRINT "  ";U$;"THE NUMBER OF " : HTAB 8 : PRINT"SPECTRA TO BE DISPLAYED"
2110 LLIM=1 : ULIM=PEEK(SCANS) : IV=1 : RET=PEEK(SPEC)
2120 GOSUB 13000 : PRINT R$;"#SPECTRA=";RET : GOSUB 2250 : IF NOT (FIN) GOTO 2120
2130 RETURN
2190 REM
2195 REM          ADD AN OFFSET FROM THE FIRST
2196 REM          SPEC. SAVED TO THE FIRST SPEC.
2197 REM          TO BE DISPLAYED
2198 REM
2200 PRINT U$;"AN OFFSET FROM THEFIRST SPECTRUM SAVED TO THE FIRST TO BE" : HTAB 15 : PRINT "DISPLAYED."; :
2210 ULIM=PEEK(SCANS)-1 : LLIM=0 : IV=1 : RET=PEEK(FRSPEC)
2220 GOSUB 13000 : PRINT R$;"PLOTOFF="; RET : GOSUB 2250 : IF NOT FIN GOTO 2220
2230 RETURN
2240 REM
2250 INVERSE : VTAB 5 : HTAB 25 : PRINT " "; PEEK (SPEC);"  " : VTAB 7 : HTAB 25 : PRINT " "; PEEK (FRSPEC);"  " : NORMAL : RETURN
2295 REM
2298 REM          SET THE DISPLAY RANGE IN DB
2299 REM
2300 T= PEEK (RANG ) : IF T=48 THEN X=12
2310 IF T()48 THEN X=T%2
2320 PRINT R$;"RANGE=";X : RETURN
2389 REM
2390 REM          SET THE DISPLAY VERTICAL SCALING
2392 REM
2400 T= PEEK (VSCAL ) : IF T=4 THEN X=1
2410 IF T()4 THEN X=T%2
2420 PRINT R$;"SCALE=";X : RETURN
2490 REM
2495 REM          SPECIFY THE RELATIVE PERSPECTIVE
2496 REM
```

```
2500 DIR= NOT DIR : A$="R" : IF NOT DIR THEN A$="L"
2510 PRINT R$;"DIRECTION=";A$ : RETURN
2590 REM
2595 REM          SELECT THE HIRES PAGE FOR PLOTTING
2598 REM
2600 PRINT R$;"PAGE=";ABS(PEEK(PLTPAGE)-2)+1 : RETURN
2690 REM
2695 REM          CALL THE PLOTTING SUBROUTINE
2698 REM
2700 PRINT R$;"SPECSURF"
2701 REM
2705 REM          ON RETURN, ALLOW EITHER HIRES PAGE
2706 REM          TO BE VIEWED, RETURN TO MAIN MENU ON ESC
2707 REM
2710 IF PEEK (KBD)=27 THEN GOTO 2740
2720 IF PEEK (KBD)<128 THEN GOTO 2720
2730 POKE KSTB,0 : K=PEEK(KBD) : IF (K=49) OR (K=50) THEN POKE -16301+(K-48),0 : GOTO 2710
2740 POKE -16300,0 : POKE -16303,0 : RETURN
2790 REM
2795 REM          RETURN TO MAIN MENU
2800 GOTO 11000
2900 REM
2910 REM          THIS SECTION WILL PRINT THE
2915 REM          CURRENT VARIABLE VALUES
2920 REM          IN INVERSE ON THE MENU PAGE
2930 REM
2950 INVERSE : VTAB 9 : HTAB 25 : PRINT " "; PEEK (RANG );" " : VTAB 11 : HTAB 25 : PRINT " "; PEEK (VSCAL );" "
2960 VTAB 13 : HTAB 25 : A$=" LEFT" : IF NOT DIR THEN A$="RIGHT"
2970 PRINT A$ : VTAB 15 : HTAB 25 : PRINT " "; PEEK (PLTPAGE);" " : GOSUB 2250 : NORMAL : RETURN
2991 REM
2992 REM          THIS SECTION CALLS THE RT60
2993 REM          ROUTINE. ON EXIT, RETURN TO
2994 REM          MAIN MENU
2996 REM
2997 REM          IF NO BUFFER YET (BUFFLAG=0)
2998 REM          THEN PRINT ERR MESS AND RETURN
2999 REM
3000 IF BUFFLAG GOTO 3200
3010 POKE 34,20 : HOME : VTAB 22 : HTAB 5 : FLASH : PRINT G$;"SORRY, ";B$ : NORMAL
3020 FOR X=0 TO 2000 : NEXT : HOME : POKE 34,0 : GOTO 500
3100 REM
3110 REM          PLOT RT60 ALWAYS ON PG1
3120 REM          IF COLD, THEN SET WARMSTART
3150 REM
3200 PRINT R$;"PAGE=1" : PRINT R$;"RT60"
3300 PRINT R$;"PAGE=2" : GOSUB 11000
3990 REM
3995 REM          HERE WE CAN TOGGLE BETWEEN
3996 REM          VIEWING HIRES PG1 OR PG2
3997 REM          WITH THE "1" AND "2" KEYS
3999 REM
4000 POKE -16304,0 : POKE -16297,0 : POKE -16300,0
4010 KLM=2 : GOSUB 10000 : POKE -16301+K,0 : GOTO 4010
4994 REM
5994 REM
5992 REM          PRINT BUFFER/SCREEN/DISK TRANSFER MENU
5993 REM
5994 REM
5000 HOME : VTAB 3 : PRINT "))))  SCREEN/BUFFER/DISK TRANSFER  ((((("
5010 VTAB 7 : PRINT "1    TRANSFER DIRECTION : FROM" : VTAB 9 : HTAB 28 : PRINT "TO"
5020 VTAB 11 : PRINT "2    TRANSFER DATA" : VTAB 13 : PRINT "3    HIRES TRANSFER PAGE"
5030 VTAB 15 : PRINT "4    CATALOG/TRANSFER" : VTAB 17 : PRINT "5    RETURN TO MAIN MENU"
5040 GOSUB 5900 : POKE 34,21 : HOME : PRINT CH$
```

```
5050 KLM=5 : GOSUB 10000 : ON K GOSUB 5100,5200,5300,5400,5500 : GOTO 5001
5070 REM
5080 REM
5090 REM          CHANGE TRANSFER DIRECTION HERE
5092 REM
5094 REM
5100 XMEM= NOT XMEM : GOSUB 5900 : GOSUB 5990 : RETURN
5195 REM
5196 REM
5197 REM          CHANGE FROM SCREEN TO BUFFER
5198 REM
5199 REM
5200 XSCRN= NOT XSCRN : GOSUB 5900 : GOSUB 5990 : RETURN
5295 REM
5296 REM
5297 REM          SWITCH SCREEN PAGES FOR TRANSFER
5298 REM
5299 REM
5300 XPAGE= NOT XPAGE : GOSUB 5900
5310 FOR X=0 TO 500 : NEXT : POKE-16297,0 : POKE -16304,0 : POKE -16300+XPAGE,0
5320 HOME : HTAB 6 : FLASH : PRINT "PAGE ";XPAGE+1;" SELECTED FOR TRANSFER" : NORMAL : FOR X=0 TO 1800 : NEXT
5330 POKE -16302,0 : POKE-16300,0 : POKE-16303,0 : FOR X=0 TO 2000 : NEXT : RETURN
5395 REM
5396 REM
5397 REM          DO THE TRANSFER
5398 REM
5399 REM
5400 IF NOT (XSCRN OR BUFFLAG OR XMEM) THEN HOME : FLASH : PRINT G$;"CAN'T TRANSFER- ";B$ : NORMAL : FOR X=0 TO 1800 : NEXT : RETURN
5402 POKE 34,1 : HOME : PRINT D$;"CATALOG"
5406 PRINT "" : PRINT "ENTER A FILENAME TO BE" : PRINT "USED FOR THE TRANSFER : "; :
5410 IF PEEK(KBD)<128 GOTO 5410
5415 IF NOT (PEEK(KBD)>192 AND PEEK(KBD)<219) THEN POKE KSTB,0 : RETURN
5420 INPUT " ";A$ : IF LEN(A$)<5 THEN A$=A$+P$
5430 IF RIGHT$(A$,4)<>P$ THEN A$=A$+P$
5440 IF XSCRN GOTO 5480
5442 REM
5446 REM          HERE IF BUFFER TRANSFER
5447 REM          STRINGS HOLD CMD,FILENAME,ADDRESS
5448 REM
5450 PRINT "" : FLASH : HTAB 4 : PRINT " TRANSFERRING SPECTRAL DATA BUFFER " : NORMAL
5455 PRINT D$;C$;A$;",A4345";L$ : IF (NOT XMEM) OR XSCRN THEN RETURN
5456 REM
5457 REM          IF TRANSFERING IN NEW BUFFER, SET NEW
5458 REM          VARIABLES, CLEAR RT60 FLAG, SET BUFFER FLAG
5459 REM
5460 POKE SCANS, PEEK (4349) : POKE SPEC,PEEK(4349) : POKE ITRVL, PEEK (4348) : POKE PKFLAG, PEEK (4347)
5470 PRINT R$;"PERIOD=";PEEK(4346)+1 : POKE RTFLAG,0 : BUFFLAG=1 : RETURN
5595 REM
5596 REM
5597 REM           HERE IF SCREEN TRANSFER
5599 REM
5599 REM
5480 IF XMEM THEN L$="" : POKE -16304,0 : POKE -16300+XPAGE,0 : GOTO 5490
5485 L$=",L8192"
5490 IF NOT XMEM THEN PRINT " " : FLASH : HTAB 5 : PRINT " TRANSFERRING HIRES SCREEN IMAGE " : NORMAL
5492 PRINT D$;C$;A$;",A";8192+(XPAGE*8192);L$ : IF NOT XMEM THEN RETURN
5495 FOR X= 0 TO 2000 : NEXT : POKE -16303,0 : POKE -16300,0 : IF NOT (XPAGE) THEN POKE RTFLAG,0
5496 RETURN
5497 REM          HERE ON EXIT
5498 REM
5500 GOTO 11000
5890 REM
5890 REM          THIS PRINTS THE MENU VARIABLES
```

```
5890 REM           IN INVERSE VIDEO
5890 REM
5900 INVERSE : VTAB (7+2*XMEM) : HTAB 31 : PRINT "MEMORY" : VTAB (9-2*XMEM) : HTAB 31 : PRINT " DISK "
5910 VTAB 11 : HTAB 22 : IF NOT XSCRN THEN PRINT "  SPECTRAL BUFFER " : GOTO 5930
5920 PRINT "HIRES SCREEN IMAGE"
5930 VTAB 13 : HTAB 32 : PRINT " ";XPAGE+1;" " : NORMAL
5940 IF XSCRN THEN L$=",L8192" : P$=".SCR"
5950 IF NOT XSCRN THEN L$=",L3847" : P$=".BUF"
5960 IF XMEM THEN C$="BLOAD" : L$=""
5970 IF NOT XMEM THEN C$="BSAVE"
5980 RETURN
 5982 REM
 5984 REM           PRINT CAUTION MESSAGE
 5986 REM
5990 IF (XMEM OR XSCRN OR BUFFLAG) THEN RETURN
 5992 HOME : HTAB6 : FLASH : PRINT "CAUTION-" : NORMAL : VTAB 22 : HTAB14 : PRINT B$ : FOR X=0 TO 1800 : NEXT : RETURN
 9998 REM
 9990 REM
 9991 REM          THIS SUBROUTINE CHECKS FOR
 9992 REM          A NUMERICAL KEY PRESSED
 9993 REM          AND RETURNS IS THE KEY IS
 9994 REM          WITHIN THE LIMIT OF KLM
 9995 REM
10000 K= PEEK (KBD) : IF K(177 AND K()155 GOTO 10000
10005 POKE KSTB,0 : K=K-176 : IF K)KLM AND K()-21 GOTO 10000
10010 IF K()-21 THEN RETURN
10990 REM
10991 REM          AN ESCAPE KEY PRESSED
10992 REM          WILL FALL INTO THIS
10993 REM          SUBROUTINE WHICH POPS
10994 REM          THE RETURN ADDRESS AND
10995 REM          JUMPS BACK TO THE MENU
10996 REM
11000 POKE 34,0 : POKE -16300,0 : POKE -16303,0 : POP : GOTO 500
12990 REM
12992 REM           THIS SECTION RECEIVES UPPER AND LOWER LIMITS,
12994 REM           AN INCREMENT VALUE, AND RETURNS A "FINISHED" FLAG
12996 REM           AND A RETURN VARIABLE.
12998 REM
13000 FIN=0 : K=PEEK(KBD) : IF K(128 THEN RETURN
13020 IF K=172 THEN  RET=RET-IV : IF RET(LLIM THEN RET=ULIM
13030 IF K=174 THEN  RET=RET+IV : IF RET)ULIM THEN RET=LLIM
13040 IF K=188 THEN  RET=RET-(5*IV) : IF RET(LLIM THEN RET=ULIM
13050 IF K=190 THEN  RET=RET+(5*IV) : IF RET)ULIM THEN RET=LLIM
13060 IF K()172 AND K()174 AND K()188 AND K()190 THEN FIN=1
13070 IF FIN AND K)176 AND K(186 THEN RETURN
13080 POKE KSTB,0 : RETURN
13990 REM
13990 REM            ERROR HANDLING
13998 REM
14000 POKE-16303,0 : POKE-16300,0 : TEXT
14005 PRINT G$;" " : I=PEEK(222) : IF I(16 AND I()11 AND I()6 THEN HTAB 16 : FLASH : PRINT "DOS ERROR" : FOR X=0 TO 4000 : NEXT
      : NORMAL : GOTO 5000
14010 IF I=11 OR I=6 THEN HTAB 3 : FLASH : PRINT "UNRECOGNIZED FILENAME - TRY AGAIN" : NORMAL : FOR X=0 TO 4000 : NEXT : GOTO 5000
14020 IF I=16 THEN PRINT "SYNTAX ERROR AT ";PEEK(218)+PEEK(219)*256 : END
14030 IF I=255 THEN STOP : GOTO 500
14040 NORMAL : RESUME
IN$0
```

APPENDIX #4: RAM USAGE AND MEMORY MAP

CONTROL VARIABLES

Below is a list of control variables used by the SPECSYSTEM 2.0 routines. For a complete functional explanation of these variables, see the SUBROUTINE THEORY OF OPERATION.

VARIABLE NAME	ADDRESS HEX	ADDRESS DECIMAL	RANGE	DEFAULT VALUE	DESCRIPTION
NOSCANS	60AA	24746	1-120	25	# of SCANS performed by BUFFER
INTRVL	60AB	24747	1-100	1	# of 10 msec intervals between SCANS
SCALE	60AC	24748	1,2,4	2	Spectral surface vertical multiplier
XDIR	60AD	24749	0,1	0	Indicates perspective of SPECSURF plot
NOSPEC	60AE	24750	1-120	25	# of spectra to be displayed
FRSPEC	60AF	24751	0-119	0	Offset to first displayed spectrum
TRIGBYTE	60B0	24752	*	128	Signifies trigger type and threshold
TRIGOFF	60B1	24753	*	0	Offset to first spectrum after trigger
VALIDFLAG	60B3	24755	n.a	n.a.	Return flag indicating RT60 determination
APSFTFLAG	60B2	24754	0,255	0	Flags use of Applesoft graphic routines
TEMP,1,2	4078, 9,A	16504, 5,6	30 to 120,000	n.a.	These 3 locations hold the RT60 in msecs after a call to CALC

* See THEORY OF OPERATION.

SUBROUTINE ADDRESS TABLE

The major subroutines used in SPECSYSTEM 2.0 are accessed through a table of addresses at the locations shown below. See the THEORY OF OPERATION for description of these subroutines. The subroutines can be called by jumping indirectly to the location listed.

HEX ADDRESS	SUBROUTINE NAME	DESCRIPTION
608A	BUFFER	Create spectral data buffer
608C	SPECSURF	Plot spectral surface of buffer data
608E	RT60	Start interactive RT60 display
60A8	CALC	Calculate RT60 of buffer data (no graphics)

ZERO PAGE USAGE

SPECSYSTEM 2.0 uses several zero page locations for pointers into the spectral data buffer used by the BUFFER, SPECSURF and RT60 commands. These locations are in ADDITION to the ones normally used by the APX 252 system (a list of those locations can be found in the APX manual). In general, the content of these locations are only used internal to subroutines, so they may be used for temporary storage by other routines. Some locations are used in addition to these by the Applesoft graphics routines.

HEX ADDRESS	SOURCE NAME	DESCRIPTION
18, 19	PREBUF	Pointer to last SCAN block
1E, 1F	ENDBUF	Pointer to end block for RT60
CE, CF	STRTBUF	Pointer to start block for RT60
00, 01	DEVICE	Pointer to BUFFER trigger device location

SPECTRAL DATA BUFFER STRUCTURE

This map outlines the form of the spectral data buffer. 120 blocks of 32 bytes each are stored sequentially in memory. Byte 0 in each block is the 20 HZ amplitude, byte 1 is 25 HZ, etc. The buffer is preceded by a short header of status bytes. Because the buffer is circular, 2 of the header bytes hold the absolute address of the head of the buffer (first spectrum stored after the trigger). Spectra are stored in memory in increasing sequence starting at the head and wrapping around at the top boundary of the buffer.

HEX ADDRESS	DATA DESCRIPTION
$10F9	FLOAT flag (1 if in FLOAT mode)
10FA	Averaging period (0 if PEAK mode)
10FB	Mode- PEAK or AVERAGE (0 or 1)
10FC	Interval beween spectra, in 10 ms. increments
10FD	Number of valid spectra in buffer (1 to 120)
10FE	LSB Absolute address pointer to head of buffer
	MSB " " " " " " "
$1100	Spectral data buffer: 120 blocks - 3840 bytes.
1FFF	

MEMORY MAP

This memory map shows the location of the various SPECSYSTEM 2.0 code and buffer areas. Notice that the Applesoft BASIC driver is loaded starting at address $7500 instead of $800, as usual. This is why it's necessary to use a loader program when pulling it into memory.

HEX ADDRESS		DECIMAL ADDRESS
0	Zero pg- APPLE variables, APX and SPECSYSTEM pointers	0
100	System use- stack and GETLN buffer	256
300	APX variables and buffers	768
400	LORES and TEXT primary video page	1024
800	Integer BASIC variables (normal Applesoft load point)	2048
10FB	SPECSYSTEM spectral data buffer - 3845 bytes	4347
2000	HIRES PRIMARY PAGE	8192
4000	HIRES SECONDARY PAGE	16384
6000	SPECSYSTEM machine code- Address table Variable table Executable code	24576
7500	SPECSYSTEM BASIC DRIVERS- Applesoft loads up from here	29952
95FF	Integer loads down from here	-27137
9600	Apple DOS	-27136
C000	Apple I/O	-16384
Cn00	APX 2708 EPROM Peripheral ROM area (256 bytes)	-16128
C800	APX 2732 EPROM Expansion ROM area (2048 bytes)	-14336
D000	Apple ROMs	-12288
FFFF		-1

APPENDIX #5: A QUICK REFERENCE TO SPECSYSTEM COMMANDS AND RT60 FUNCTION KEYS

SPECSYSTEM 2.0

COMMAND	FUNCTION
BUFFER	Create a spectral data buffer
#SCANS=n	Specify the number of scans in the buffer, from 1 to 120
INTERVAL=n	Specify the interval between SCANs, from 1 to 100 (x10 ms)
KEYBD	Set the keyboard trigger mode
AUTO	Set automatic (threshold) trigger mode
THRESH=n	Specify the auto trigger threshold in dB, from 1 to 47
SLOPE=R/F	Set the auto trigger slope either Rising or Falling
TRIGOFF=n	Specify up to +/- 63 SCANs as a trigger offset
SPECSURF	Plot a spectral surface from the data in the buffer
#SPECTRA=n	Specify # of spectra for SPECSURF and RT60, 1 to the total #
PLTOFF=n	Specify # of the first spectrum to be plotted, 1 to total-1
SCALE=n	Set the vertical scale in SPECSURF 1, 2 or 4 lines/dB
DIRECTION=L/R	Set SPECSURF's plotting direction either leftward or right
RT60	Perform RT60 analysis with keyboard control of display
APSOFT=ON/OFF	Tell SPECSYSTEM you're using Applesoft rather than Integer

****

RT60 KEY	FUNCTION
"D"	Draw the curve of the frequency designated by the flashing "X"
"<-" (left arrow)	decrement the frequency pointed to by the flashing "X" OR decrement through the list of already plotted frequencies
"->" (right arrow)	increment the frequency pointed to by the "X" OR increment through the list of already plotted frequencies
"N"	find space to plot a New filter channel
"R"	Replace the current filter channel with a new one
"T"	calculate the RT60 of the currently selected filter channel
"1" "2"	display HIRES page 1 or 2

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