SERINADE 1

GETTING STARTED

This section covers the following topics:

- Description
- System Requirements
- Installing SERINADE On Your Hard Drive
- Running SERINADE As a MONARCH Enhancement

Refer to the README file on the distribution disk for any documentation updates.

DESCRIPTION

SERINADE is being furnished as a stand alone development package for the Harris HSP43124 Serial I/O Filter. Alternatively, SERINADE can also be installed as an enhancement to The Athena Group, Inc. Monarch Version 2.0 or above Professional DSP software package. Monarch is a powerful filter design, signal synthesis and analysis package. To purchase Monarch contact:

The Athena Group, Inc.
3424 N.W. 31st Street
Gainesville, FL 32605
(904) 371-2567

SYSTEM REQUIREMENTS

To install and run SERINADE, you must have the following:

- An IBM PC/XT/AT, PS/2, or 100% compatible with a minimum of 640k of random-access memory (RAM) (SERINADE does not utilize extended memory).
- At least 400kB of free disk space on your hard disk.
- One of the following video adapters: CGA, MCGA, EGA, VGA, IBM 8514, Hercules, AT&T 400, or 3270 PC.
- DOS Version 3.0 or higher.
- For 286 and 386 PCs, a Math Coprocessor is strongly recommended for greatly enhanced performance.

INSTALLING SERINADE ON YOUR HARD DRIVE

The distribution diskette contains a program called INSTALL which you use to install the SERINADE system and tutorial files on your hard disk. NOTE: The steps in this section assume you are installing SERINADE from a diskette in drive A: onto a hard drive C:. If you are using a different configuration, substitute the letter of the drive where the diskette is located for drive A:. Substitute the letter for the hard drive for drive C:.

To start the installation program:

1. Insert the distribution disk into drive A: and from the DOS prompt, Type:

    A: <Enter>

    INSTALL <Enter>

The INSTALL program will then prompt the user for the name of the SERINADE system directory and for the printer configuration. Files will then be copied onto your hard drive from the distribution disk.

If the installation fails, the message, “Cannot create specified directory. Please try again. System error: Permission denied.” will appear on the screen. This usually indicates that: the directory already exists; there is not enough disk space to load the files; the user has entered a path for which he or she does not have write permission. If this error message appears, make sure that disk space/permission exists, then either use a different path name or delete the directory, and try again.

PRINTER CONFIGURATION

The printer configuration consists of the printer ID number, the printer port and the printer I/O method. By setting these values, the user can select the type of printer, the printer port, and whether the printer is to be physically connected to the PC printer port or if the connection is to be made through a network. The printer type is selected through the printer ID number. A list of supported printers and their ID numbers is given in the Printer Definition Table in Appendix A. The printer port is either LPT1, LPT2, LPT3, COM1, COM2 or a DOS file. Printer I/O is either through hardware, BIOS, or through an I/O stream. If the printer is to be physically connected to the PC, then option 1 (hardware) should be selected; If the PC and printer are connected together through a network, then 3 (stream I/O) should be selected. Option 2 goes through the BIOS printer driver. BIOS can be used for either directly connected printers or network printers. However, due to subtle variations in BIOS across the various brands of PCs, it is NOT the recommended selection. The default method is 1 (Hardware).

All printer configuration information may be changed at any time without re-installing SERINADE by editing the SERINADE configuration file, SER.CFG, which is an ASCII text file. See Appendix C for a complete description of this file and modifiable printer characteristics.

CONFIGURING YOUR SYSTEM

To enable your computer to run SERINADE, you must modify your CONFIG.SYS and your AUTOEXEC.BAT files. Typically, these files are located in the root directory of the disk drive you use to start your computer. Use an ASCII text editor to edit these files. The EDLIN line editor or the EDIT text editor are available with most versions of DOS (consult your DOS Reference Manual). If you prefer, use an ASCII text editor.

CONFIG.SYS

The CONFIG.SYS file must contain the following two lines:

files=20

buffers=40

If these lines are not in your CONFIG.SYS file, add these lines to the file. If you do not have a CONFIG.SYS file, one must be created.

AUTOEXEC.BAT

To start SERINADE, DOS must be able to find the SERINADE System files. To ensure that DOS can always find these files, modify your search path to include the location of the SERINADE System directory.

For example, if you installed SERINADE Systems files on drive C in a subdirectory called \SERINADE, add the following line to the end of the existing PATH command in your AUTOEXEC.BAT file:

;C:\SERINADE

If your AUTOEXEC.BAT file does not contain a PATH command, add the following command to the file:

PATH=C:\SERINADE

USING SERINADE

To begin using \SERINADE, at the DOS prompt type:

SERINADE <Enter>

all input and output files will use the current directory as their base path. To access files in other directories, use the standard DOS path nomenclature in specifying the file name.

RUNNING SERINADE AS A MONARCH ENHANCEMENT

Assuming that SERINADE and MONARCH are both installed and added to the system PATH environment variable, at the DOS prompt type:

MONARCH <Enter>

which accesses the MONARCH subdirectory, executes the MONARCH.BAT file, and produces the MONARCH animated logo. Press any key to enter the MONARCH Main Screen containing the Copyright Notice. Press <Enter> to continue.

Add the SERINADE program to the MONARCH menu system. Highlight CONFIG and press <Enter>. Highlight MENUS and press <Enter>. Toggle the MENU cell to ENHANCEMENTS (to toggle repeatedly press the <Enter> key). Add the text shown in the table below to the ENHANCEMENT MENU CONFIGURATION:

MENU OPTION	COMMAND	CLEAR SCREEN
SERINADE	SERINADE.EXE	NO

Note that the installation and configuration of SERINADE is as described above, whether or not it is run as a Monarch enhancement.

SERINADE 2

SERINADE TUTORIAL

The SERINADE tutorial assumes that SERINADE has been successfully installed and configured (see Installation).

This tutorial is designed to acquaint you with the SERINADE software package. The SERINADE software designs a HSP43124 Serial I/O Filter configuration including filter coefficients from a set of user specifications.

WORKING IN SERINADE

Movement within SERINADE follows standardized procedures. The table below lists the available editing options.

KEY	DESCRIPTION
Right/Left Arrow	Move the Cursor Right and Left
Up/Down Arrow	Move the Cursor Up and Down
<Home>	Puts Cursor at Start of Field
<End>	Puts Cursor at End of Field
<Del>	Deletes Character at Cursor
<Backspace>	Deletes Character Left of Cursor
<Ctrl>y	Deletes Entire Field, Positions Cursor at Beginning of Field
<Tab>	Moves Cursor from Column to Column
<Enter>	Moves Cursor From Row to Row
<Space>	Changes Value of a Toggle Field
<Insert>	Toggle Edit Mode Between Insert and Overwrite When in Insert Mode, the Cursor is Displayed as an Underline Character, While in Overwrite Mode it is Displayed as a Block Character.

To select a menu option, use the arrow, <Tab> or <Enter> keys to position the cursor in a selected field. If desired, clear the field by typing <Ctrl>y. Text may then be inserted or overwritten (use <Insert> key to toggle edit mode). Fields that do not require numerical data or file name entries may be toggled via the <Space> key through the available options. In fields that select one of several options, the new value is implemented immediately, whereas fields that require data or file names must be exited via the <Enter>, <Tab> or arrow keys before the new value is saved and utilized to alter the configuration.

Press the <F1> help key to access context-sensitive on-line help files. When the filter specification is complete and SERINADE has computed a valid filter configuration, the <F2> key may be pressed to design the programmable FIR filter coefficients; save report, frequency, and coefficient files; and display the FIR and system frequency responses graphically.

To begin the tutorial, go to the SERINADE directory (C:\SERINADE) and type:

SERINADE <Enter>

Lesson 1: Decimating Filter Design Using SERINADE

The HSP43124 SERIAL I/O FILTER SPECIFICATION screen accepts the following user-supplied design specifications:

1. Input Sample Rate
2. Decimation Factor
3. Passband
4. Transition Band
5. Passband Attenuation
6. Stopband Attenuation (or FIR Order)
7. Input Bits
8. Output Bits
9. FCLK Rate
10. FIR Type
11. User Options

When the program starts, the cursor is in the Filter File field. Clear the field by pressing <Ctrl>y, then type:

SER1.SER <Enter>

The HSP43124 SERIAL I/O FILTER SPECIFICATION screen shown in Figure 1 appears.

The data specifies a filter with the following attributes:

LESSON 1: FILTER ATTRIBUTES

SPECIFICATION	VALUE	UNIT
Input Sample Rate:	60.0	kHz
Decimation Factor:	24	
Passband:	500.0	Hz
Transition Band:	250.0	Hz
Passband Atten:	1.01	dB
Stopband Atten:	100.0	dB
The I/O specifications are:		
Input Bits:	24	
Output Bits:	32	
FCLK	5.0	MHz
The FIR Type is selected to be:		
FIR Type:	LOWPASS	
The user options are selected to be:		
Design Mode:	AUTO	
Generate Report:	NO	
Display Response:	LOG	
Save Frequency Responses:	NO	
Save FIR Response:	NO	
FIR Order:	119	
A valid solution was found for the given specifications and is reported to be:		
Output Data Rate:	2.5 kHz	
Max FCLKS/CLKOUT:	32	
Min SCLK:	1.44 MHz	
Min FCLK:	840.0 kHz	
HB Decimation:	8	
FIR Decimation:	3	
HB Order:	3	

When satisfied with the specification, Press <F2> to start the design. The screen displays the design status and, when complete, displays the Frequency response screen shown in Figure 2.

The two plots represent:

1. FIR Frequency Response: Shows equi-ripple passband and stopband behavior over the frequency range 0.0 to $F_{SAMPLE}/(2*DEC_{HB})$ Hz (the Nyquist frequency of the FIR input). The curve entering the graph on the right side represents the aliasing due to the halfband filter stages. The additional line at $F_{OUT}/2$ indicates the FIR folding frequency.
2. System Frequency Response: Shows the end-to-end frequency response of the designed filter and verifies the 100 dB attenuation in the stopband out to $F_{OUT}/2$Hz (the Nyquist frequency of system output). The dashed line indicates the desired frequency response that was entered in the SPECIFICATION screen.

Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

User Options

In the HSP43124 SERIAL I/O FILTER SPECIFICATION screen, position the cursor on the “Generate Report” field; using the <Space> bar, toggle “Generate Report” to YES. In a similar manner, set “Display Response” to LINEAR, “Save Freq Responses” to YES, and “Save FIR Response” to YES. Press <F2> to design the filter. Following computations, the screen shown in Figure 3 appears.The interpretation of the data is the same as presented above, except the responses are displayed on a linear scale, rather than log.

In the linear scale it is readily apparent that the FIR response is equi-ripple with a maximum gain of unity. Also note, in the system frequency response, the equi-ripple profile falls off near the end of the passband limit (i.e., 500.0Hz). This effect is caused by cascading the FIR and Halfband sections.

Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

Press <F10> to exit the program. Answer NO to the “SAVE FILE?” prompt before exiting SERINADE. (This will ignore all changes to SER1.SER.) Use a text editor or the DOS type command to view the data and report files generated by SERINADE. The report file SER1.RPT contains the user defined filter specifications as well as the hexadecimal values needed to load the HSP43124 Serial I/O Filter's control registers. The frequency files, SER1H.FRQ, SER1F.FRQ, and SER1S.FRQ contain the magnitudes of the frequency responses of the halfband filters, the FIR filter and the end-to-end frequency response in log units. The SER1.IMP file contains the FIR impulse response data.

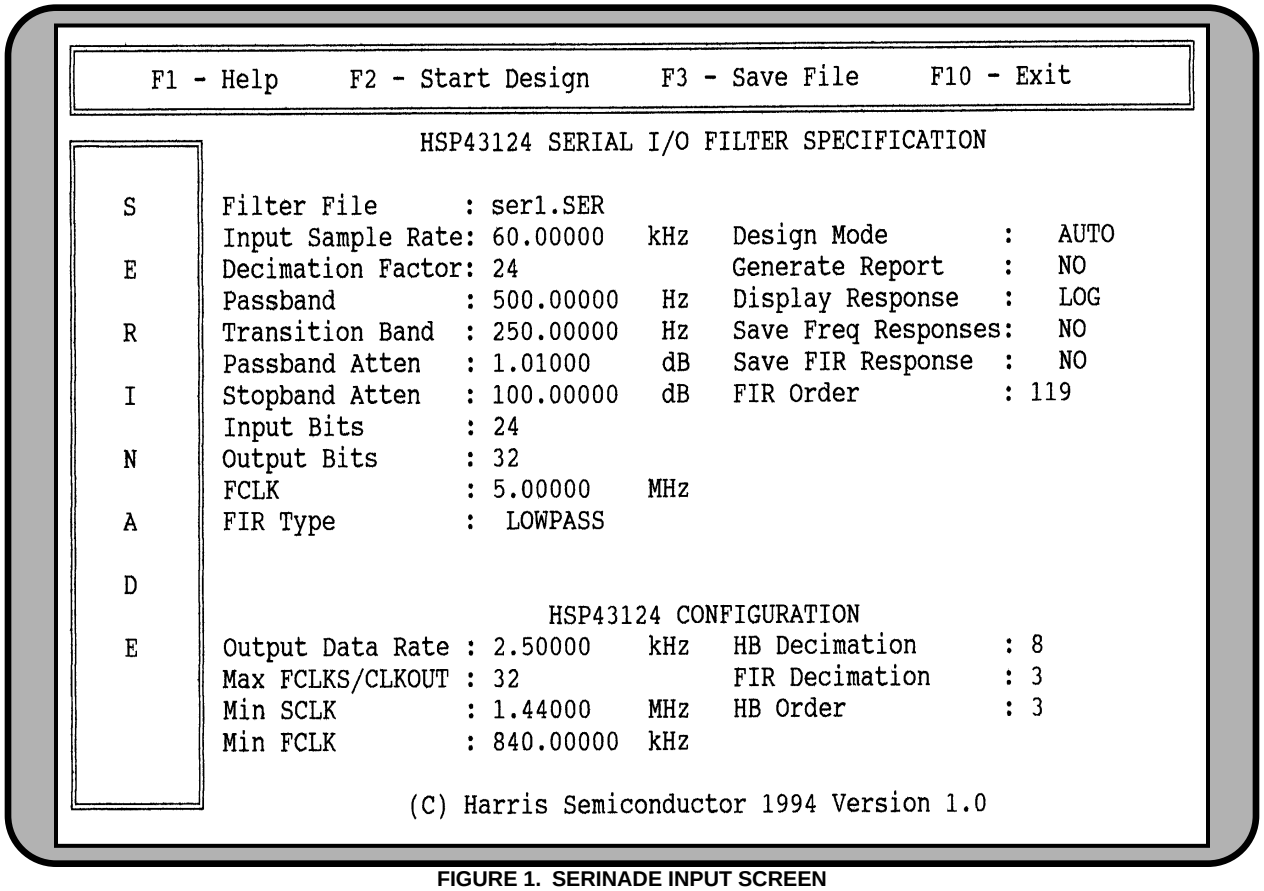
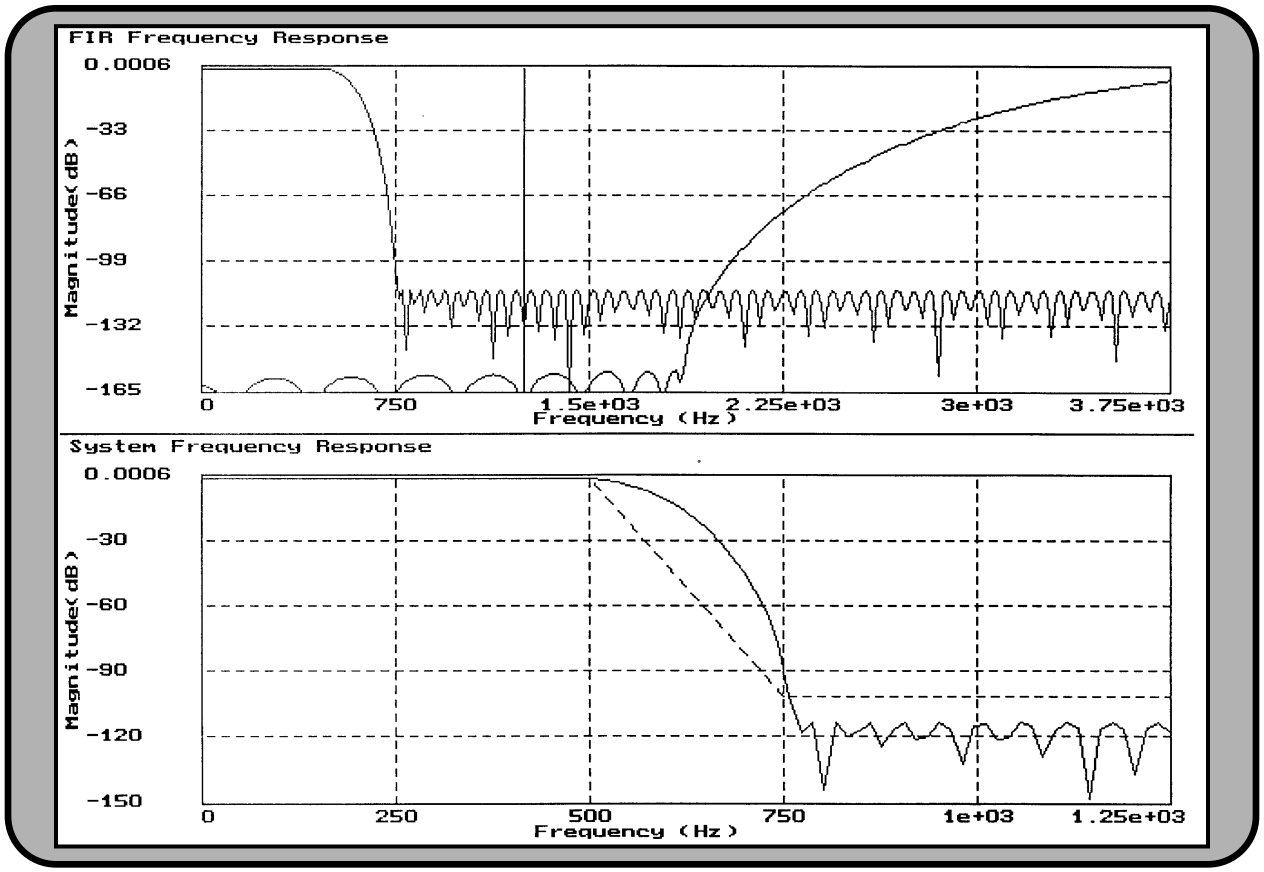


FIGURE 1. SERINADE INPUT SCREEN



Lesson 2: FIR Only Design

The Halfband filter section may be bypassed to create a SERIAL I/O filter as an FIR section only. For filters using no decimation, this is accomplished by setting the Decimation Factor to 1. (For a decimating filter using only the FIR, enter MANUAL Design Mode and enter a 0 for the HB Order - see Lesson 3). After restarting the program, change the Filter File to SER2 and press <Enter>.

The data specifies a filter with the following attributes:

LESSON 2: FILTER ATTRIBUTES

SPECIFICATIONS	VALUE	UNIT
Input Sample Rate:	1.0	MHz
Decimation Factor:	1	
Passband:	60.0	kHz
Transition Band:	30.0	kHz
Passband Atten:	0.50	dB
Stopband Atten:	50.0	dB
The I/O specifications are:		
Input Bits:	24	
Output Bits:	32	
FCLK	45.0	MHz
The FIR Type is selected to be:		
FIR Type:	LOWPASS	
The user options are the same as in Lesson 1, except:		
FIR Order:	77	
A valid solution was found for the given specifications and is reported to be:		
Output Data Rate:	1.0	MHz
Max FCLKS/CLKOUT:	1	
Min SCLK:	24.0	MHz
Min FCLK:	39.5	MHz
HB Decimation:	1	
FIR Decimation:	1	
HB Order:	0	

Note that SERINADE automatically bypassed the Halfband filter stage by setting the HB Order to 0. This was necessary to meet the Decimation Factor of 1, since each Halfband stage decimates by a minimum of two. Press <F2> to design the filter. The screen displays the design status and, when complete, displays the frequency response screen shown in Figure 4. Note that the FIR section alone meets the current design specifications. The top plot shows no halfband aliasing, since the half bands are bypassed. Also note that the FIR and system plots are identical due to the Decimation Factor of 1 through the FIR filter. Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

Lesson 3: Manual Design

In the HSP43124 SERIAL I/O FILTER SPECIFICATION screen, change the Decimation Factor to 4 and toggle the Design Mode to MANUAL mode. Note that the display changes with the FIR Decimation and HB Order now showing up as input fields editable by the user. The computed FIR Order is 43 taps. Press <F2> and observe the results, especially the system stopband attenuation of -63dB (Figure 5). Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen. Save the file by changing the Filter File name to SER3.SER and pressing the <Enter> key. Answer “NO” to the “SAVE FILE” prompt and “YES” to the “NEW FILE” prompt. Then press <F3> to save the file.

Change the FIR Decimation to 1 and the HB Order to 2. Note that an error will result as long as the Decimation Factor field does not match the decimation that would result from the current FIR decimation and the number of halfband filters that are enabled. This error will prevent a filter from being designed while the entries in the fields are inconsistent. The results are similar to those produced from the first design, but a lower order FIR is required: 27 taps. This is due to the fact that more filtering is being done by the Halfband filters. Press <F2> and observe the frequency response screen shown in Figure 6. Observe that the stopband attenuation has improved somewhat to -70dB. In this design, the Halfband stage alias overlaps the FIR transition band. To prevent novice users from getting unintended results, this condition is not allowed in AUTO Design Mode. In MANUAL Design Mode, SERINADE performs less checking on the input parameters, which allows the user to have more freedom. MANUAL Design Mode allows the FIR transition band to overlap the Halfband aliasing, and allows the FIR transition band to alias on itself by allowing the output rate to be less than 2 * (passband + transition band). Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

Change the FIR Decimation to 4 and the HB Order to 0 (Bypassing the Halfband filters completely). Again the results are similar to those produced from the first and second designs, but a higher order FIR is required: 77 taps. Press <F2> and observe that the stopband attenuation is now -56dB. Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

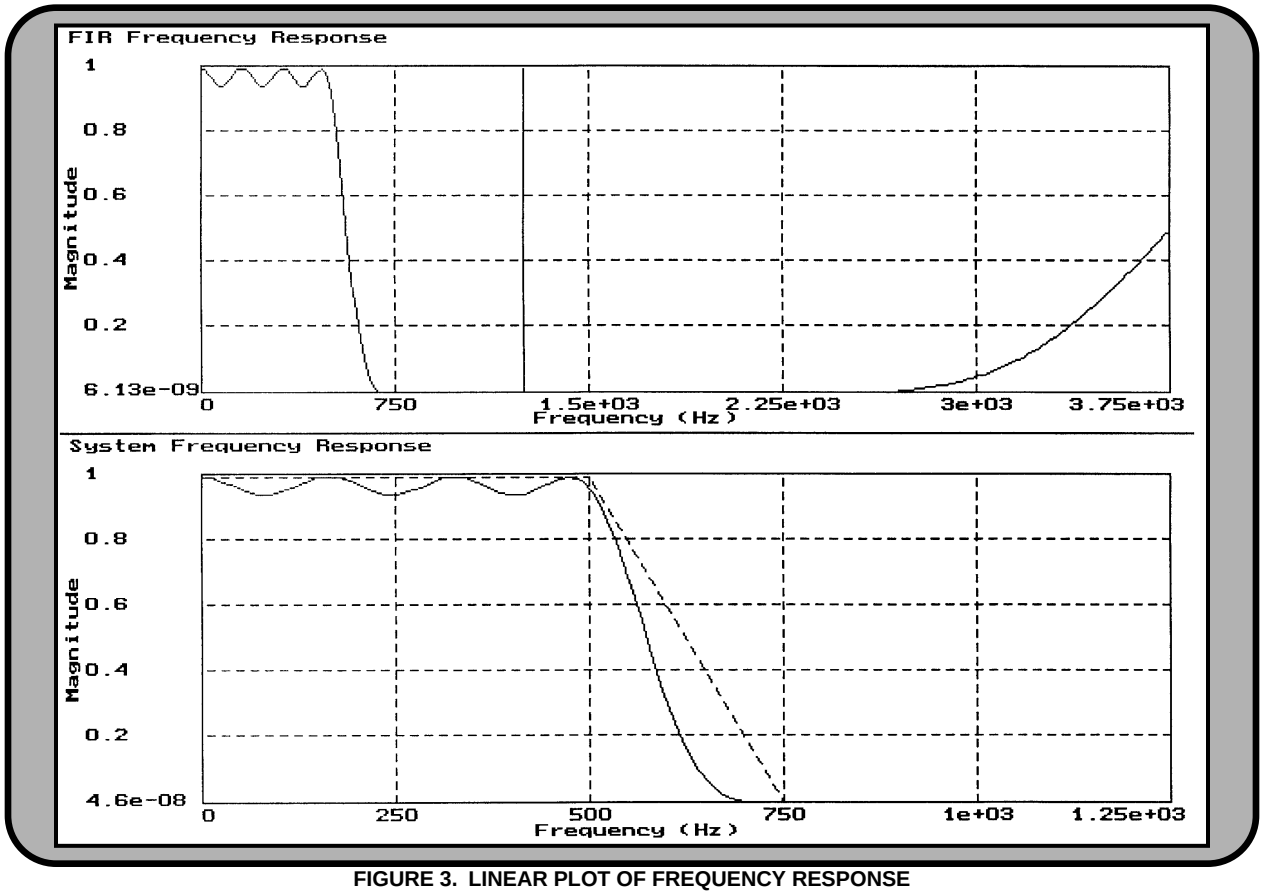
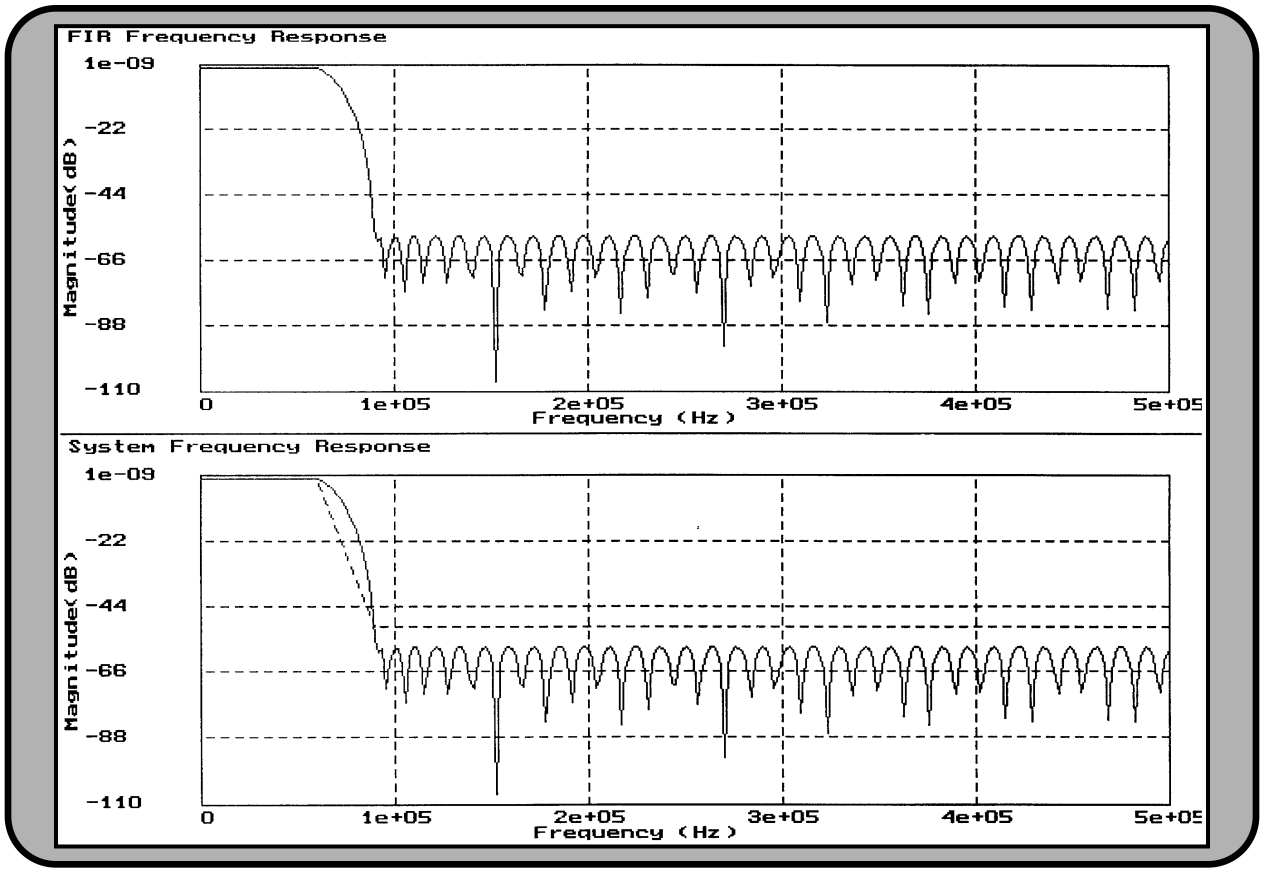


FIGURE 3. LINEAR PLOT OF FREQUENCY RESPONSE



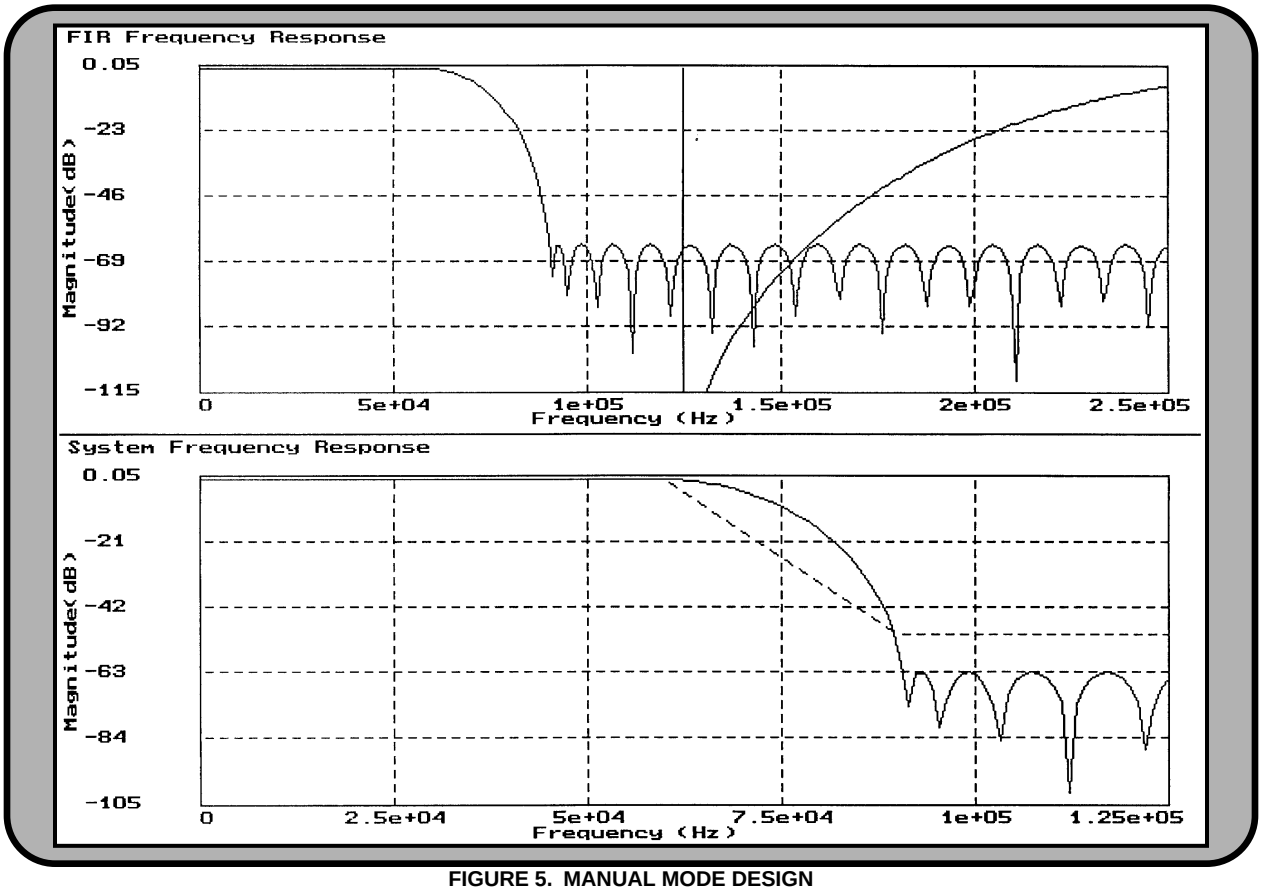
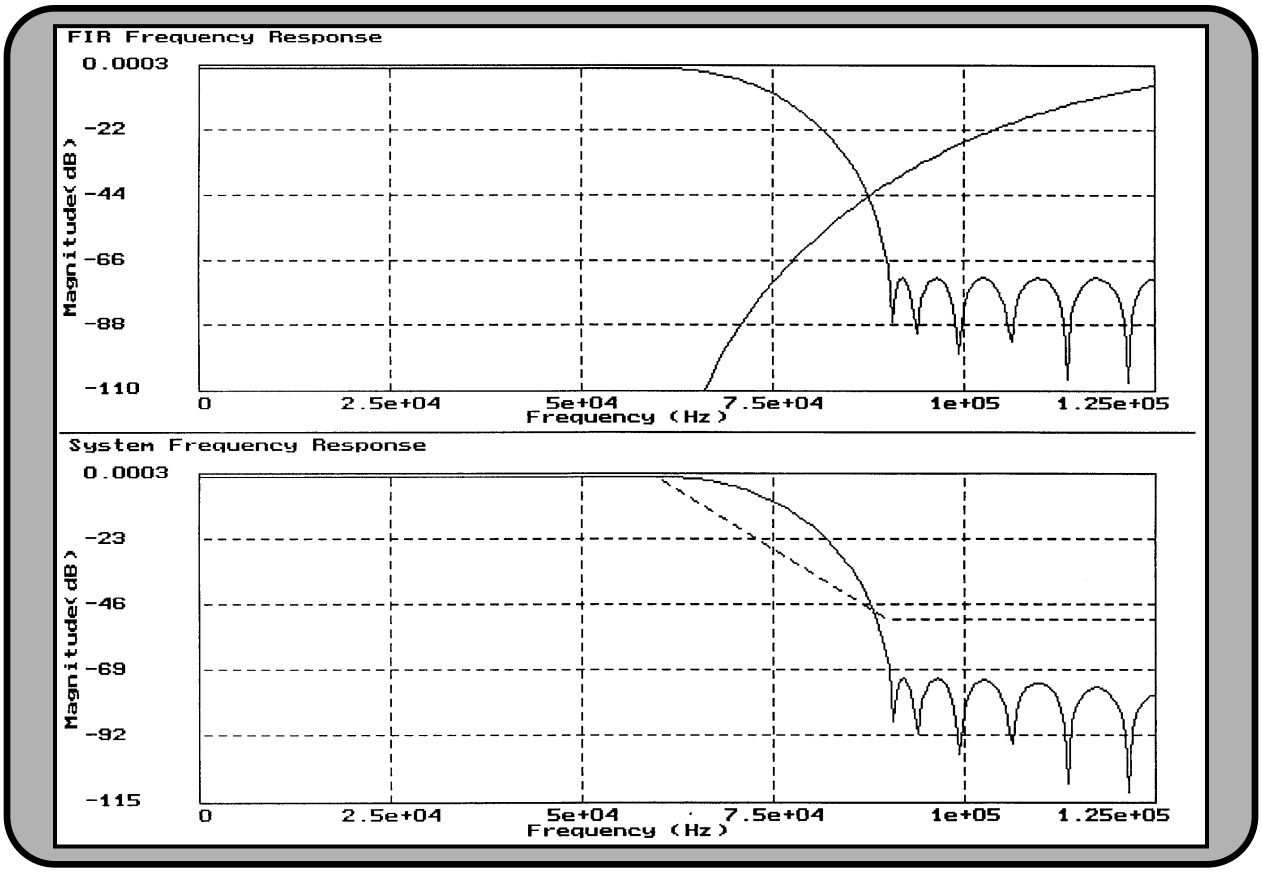


FIGURE 5. MANUAL MODE DESIGN



Lesson 4: Half Band Filter Only Design

The Halfband filter section may be bypassed to create a SERIAL I/O filter configuration using only the halfband filters. This is accomplished by setting the FIR type to BYPASS. In the HSP43124 SERIAL I/O FILTER SPECIFICATION screen, change the Filter File to SER4.SER and press <Enter>. Answer NO to the “SAVE FILE?” prompt to prevent overwriting SER3.SER.

The data specifies a filter with the following attributes:

LESSON 4: FILTER ATTRIBUTES

SPECIFICATIONS	VALUE	UNIT
Input Sample Rate:	1.0	MHz
Decimation Factor:	4	
Passband:	36.0	kHz
Transition Band:	30.0	kHz
Passband Atten:	0.50	dB
Stopband Atten:	144.0	dB
The I/O specifications are:		
Input Bits:	24	
Output Bits:	32	
FCLK	40.0	MHz
The FIR Type is selected to be:		
FIR Type:	BYPASS	
The user options are the same as before, except:		
FIR Order:	0	
A valid solution was found for the given specifications and is reported to be:		
Output Data Rate:	250.0	kHz
Max FCLKS/CLKOUT:	5	
Min SCLK:	24.0	MHz
Min FCLK:	14.0	MHz
HB Decimation:	4	
FIR Decimation	1	
HB Order	2	

Press <F2> to design the filter. The screen displays the design status and, when the design is complete, displays the frequency response screen shown in Figure 7. Note that the Halfband filter section does not meet the current design specifications. When using the FIR type of BYPASS, the SERINADE software only attempts to meet the Decimation Factor specification by calculating the necessary number of halfband filters to enable. In addition, the FIR Order and Stopband Attenuation fields may not be modified by the user: they will always be 0 and 144dB respectively. Note that the halfband aliasing overlaps the halfband frequency response so that the two curves intersect at their -6dB point.

Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

Lesson 5: User-Supplied FIR Design

In the HSP43124 SERIAL I/O FILTER SPECIFICATION screen, use the <Space> bar to select the FIR Type to be IMPORTED. At the FIR File field, press <Ctrl>y to delete the default file name, then type SER5.IMP and press <Enter>. The FIR symmetry should remain set to EVEN, which specifies that the IMPORTED FIR is an even symmetric FIR. See the HSP43124 data sheet for an explanation of even symmetry.

SER5.IMP is a 117 tap FIR filter with a stopband attenuation of 45dB. When using an imported FIR, SERINADE estimates the Stopband Attenuation using the FIR order it reads from the impulse response file and the current filter design specifications. (Note that the filter specifications are entered by the user and do not necessarily match the characteristics of the imported filter.) The maximum value is 198.0dB.

The user may not modify the FIR Order or Stopband Attenuation fields, since SERINADE will simply recompute these values using the imported FIR order. All other input fields may be modified, but the only filter specification SERINADE will attempt to meet is the decimation factor.

Press <F2> to design the filter. The screen displays the design status and, when complete, displays the frequency response screen shown in Figure 8. Note that the IMPORTED FIR does not meet the current design specifications indicated by the dotted line. When using the FIR type of IMPORTED, the SERINADE software only attempts to meet the Decimation Factor specification by calculating the necessary number of halfband filters to cascade and the FIR decimation. In this mode it is up to the user to design the FIR to meet the desired design specifications.

Press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

Press <F10> to exit the SERINADE program. Respond “NO” to the “SAVE FILE?” prompt to preserve the original version of SER4.SER.

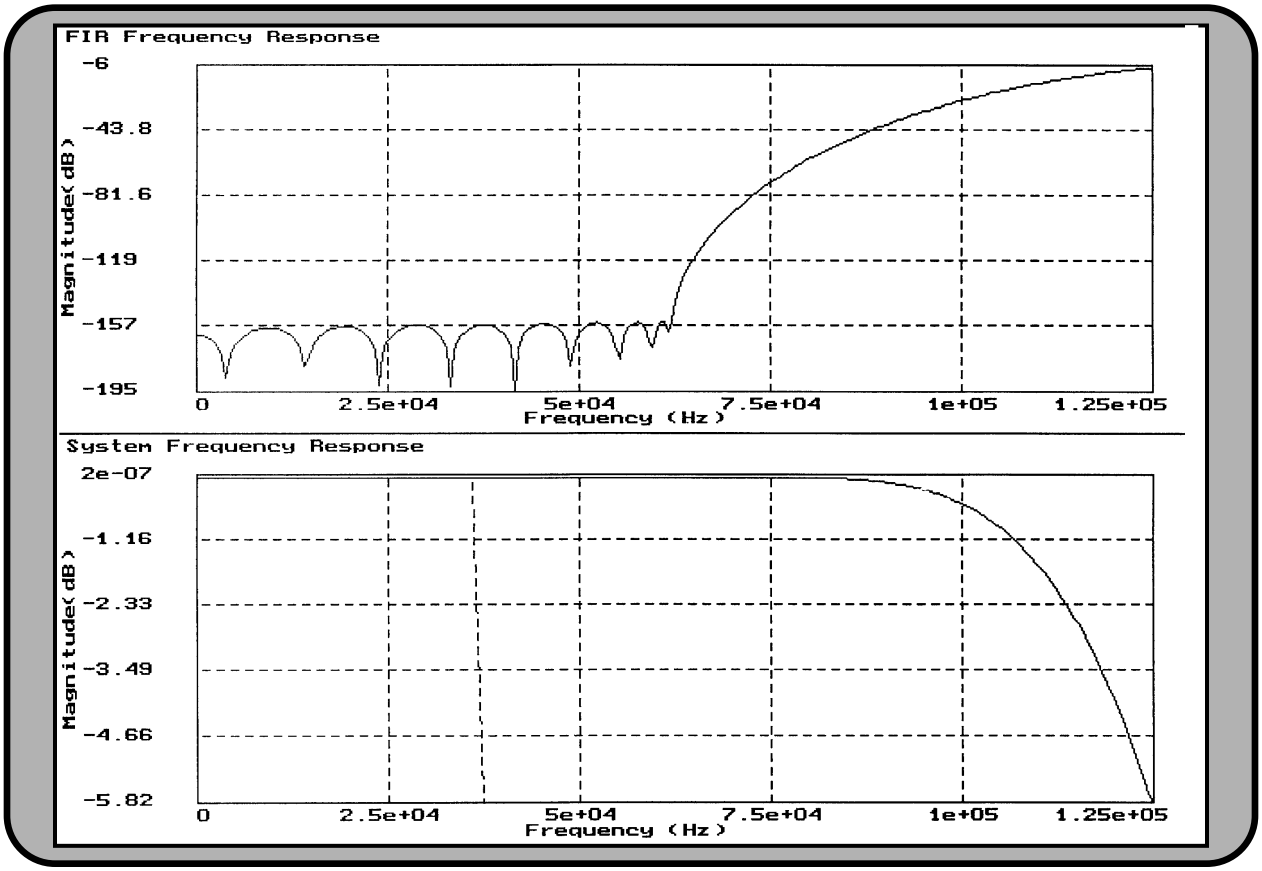
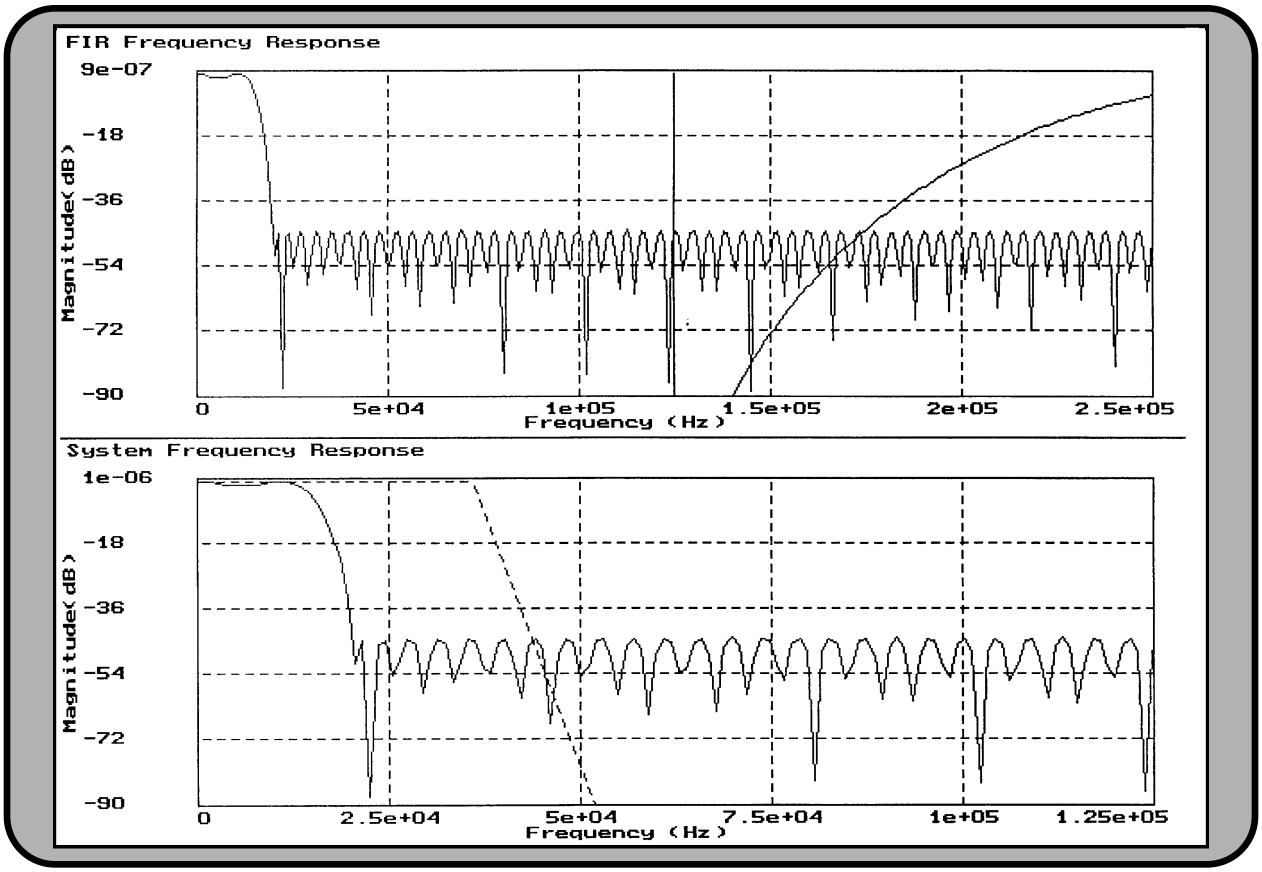


FIGURE 7. RESPONSE OF HALFBAND FILTERS



SERINADE 3

SERINADE USER'S GUIDE

INTRODUCTION

SERINADE was developed by Harris specifically to design filter configurations for the HSP43124 Serial I/O Filter. Design specifications are supplied by the user in terms of frequencies and gains. SERINADE automatically computes the optimum configuration of the Serial I/O Filter's cascadable halfband filters and programmable finite impulse response (FIR) filter; it also allows the user to manually design his or her own configuration.

FILE I/O

The SERINADE input and output files are text files. The formats are listed in Appendix C.

The input files are:

Filename.SER — Filter design parameters. This file is automatically created by SERINADE with the SER extension.

Filename.XXX — An imported file which lists the impulse response of a filter.

The output files are:

Filename.FRQ — The magnitude of the frequency responses of the Halfband filters, FIR filter, and System saved in log units. The frequency scale of the Halfband filter response is from 0 to the input Nyquist frequency of the first halfband filter. The frequency scales of the FIR and System responses are from 0 to the FIR input Nyquist frequency.

Filename.IMP — The impulse response of the programmable FIR filter.

Filename.RPT — Report file: lists the configuration of the HSP43124.

DATA ENTRY

Filter parameters are entered using the menu screen shown in Figure 1. This is the screen that appears when the program is invoked.

The data fields located on the top portion of the screen (the Specification menu) require user input. The user enters the parameters of the target system. As each value is entered, SERINADE attempts to design a valid system configuration. If the data is not in the legal range of values for that field, or if it results in an invalid configuration, SERINADE reports the error at the bottom of the screen. All numeric values can be entered in either decimal or scientific notation. Values are stored in memory at full precision up to the sixth decimal place. Displayed values are rounded to six decimal places.

The FIR Order and Stopband Attenuation fields are unique in that they operate both as input and output. If the user enters data in the Stopband Attenuation field, SERINADE calculates and displays the FIR Order. If the user enters data in the FIR Order field case SERINADE calculates and displays the corresponding Stopband Attenuation value.

When a set of valid parameters has been entered, SERINADE computes the configuration parameters and reports them at the bottom of the menu screen under HSP43124 Configuration. The bottom portion of the screen remains blank until all of the input field contain valid data. If the input parameters are invalid, the bottom line on the screen displays an error message indicating which design rule is being broken. If more than one design rule is being violated, the message reflects the first violation encountered during checking.

The specification parameters are as follows:

- Filter File: a new or existing filter specification (*.SER) file. For a new file, the "New File? YES/NO" prompt is displayed. If you create a new file and have not saved your previous file, the "Save File? YES/NO" prompt is also displayed. Note that this file name may be any acceptable DOS file name, thus the *.SER, *.IMP, *.RPT, and *.FRQ files may be rerouted to an alternate directory by specifying the directory name as part of the file name.
- Input Sample Rate: the sample rate of the input data, denoted F_S, where F_S is in [1Hz:100MHz]. The input sample rate can be entered in scientific notation (to enter 2MHz, type 2e6). The maximum sample rate of the HSP43124 is dependent on the configuration (See Decimation Factor, FIR Order).
- Decimation Factor: the total system decimation from input to output; denoted D_f. This is the product of the Halfband decimation, which is a power of two from 1 to 32, and the FIR decimation, which is an integer from 1 to 8. The lowest possible decimation factor is 1 (no decimation) and the highest possible value is 256. Decimation Factor = Input Sample Rate/Output Data Rate
- Passband: the maximum frequency of the filter passband (F_P). The passband can be entered in scientific notation. In AUTO mode (see Design Mode below), F_P must satisfy the Nyquist condition: $(F_P + F_T) < (F_{OUT}/2)$. The range of F_P is from 1Hz to 100MHz.

- Transition Band: the width of the filter transition band, denoted F_T. The transition band can be entered in scientific notation. In AUTO mode (see Design Mode below), the value of F_T must satisfy the Nyquist condition (F_P + F_T) < $F_{OUT}/2$. The range of (F_P + F_T) is from 1Hz to 100MHz.
- Passband Atten: Specify the maximum acceptable passband attenuation (peak-to-peak passband ripple/2), denoted A_p, where A_p is from 0.0001dB to 5dB.
- Stopband Atten: Specify the acceptable minimum stopband attenuation, denoted A_s, where A_s is from 0.01dB to 198dB. Entering a number in this field causes the estimated number of coefficients in the FIR filter stage to be displayed in the FIR Order field.
- Input Bits: Specify the number of bits in the input data word, an integer from 8 to 24.
- Output Bits: Specify the number of bits in the output data word, an integer from 8 to 32.
- FCLK: Specify the clock rate of the Filter Compute Engine, denoted F_c, where F_c can be calculated from the minimum FCLK equation in the HSP43124 data sheet. Note that for configurations in which the halfband filters are used, F_c must exceed 14*F_S.
- FIR Type: Toggle between three FIR filter types (LOWPASS, BYPASS, and IMPORTED).
- LOWPASS: An FIR is designed of order N, where N is odd, which satisfies the user specifications established by F_P, F_T, D_f, A_p and A_s. The FIR is designed using the Parks-McClellan with Remez exchange method to compute the coefficients of an equi-ripple Chebyshev filter. The derived FIR has even symmetry and is scaled so that the end to end gain of the Serial I/O Filter = 1.0.
- BYPASS: SERINADE uses the Decimation Factor to determine the number of Halfband filters to enable. The Decimation Factor must be a power of two from 2 to 32. The FIR decimation factor is automatically set to 1. while the FIR Enable bit is set to 0 in the Filter Configuration Register. SERINADE will automatically display the FIR Order as 0 and the Stopband Attenuation as 144 dB. The user may not modify these input fields. All other input fields may be modified as in LOWPASS mode, but the filter specification fields are not meaningful in BYPASS mode since SERINADE does not attempt to meet these specifications when designing a filter.
- IMPORTED: The FIR coefficients are read from a disk file. The format of this file is shown in Appendix C. The sum of the FIR coefficients must be $\leq$ 1.0. In this mode, SERINADE estimates the Stopband Attenuation using the number of coefficients in this file and the filter design specifications. Note that this may not reflect the actual stopband attenuation. The user may not modify the FIR Order or Stopband Attenuation fields as SERINADE will simply recompute these values using the IMPORTED FIR order. All other input fields may be modified; however, just as in BYPASS mode, the only filter specification SERINADE uses is the decimation factor. All other filter specifications are meaningless in this mode.
- FIR File: Applicable to IMPORTED FIR Type designs only. Specify the name of a file which contains FIR filter coefficients. The format of this file must be compatible to the format shown in Appendix C, with a maximum order of 256 taps. The FIR can be of even or odd symmetry with an even or odd number of taps.
- FIR Symmetry: Applicable to IMPORTED FIR Type designs only. Toggle between EVEN and ODD to specify the symmetry of the imported FIR. An FIR designed in SERINADE is always EVEN. Note that symmetry is independent of the number of coefficients. See the HSP43124 data sheet for a complete explanation.
- Design Mode: Toggle between AUTO and MANUAL. In the AUTO mode, SERINADE generates valid filter configurations with the maximum number of Halfband filters and the minimum order FIR filter. In the MANUAL mode, the user can alter the FIR Decimation and HB Order independently. In MANUAL mode, SERINADE does not check for aliasing by the Halfband or FIR stages; the user is expected to detect these conditions by viewing the generated frequency responses. Harris recommends that a filter be designed using the AUTO mode first; if the filter design is not acceptable, then the MANUAL mode can be used to fine-tune the design.
- FIR Decimation: Applicable to MANUAL Design Mode only. Specify the FIR Decimation where the admissible range is an integer from 1 to 8.
- HB Order: Applicable to MANUAL Design Mode only. Specify the number of Halfband filters to be enabled. The admissable range is an integer from 0 to 5. If the order is 0, the Halfband section is effectively bypassed.
- Generate Report: Toggle between NO and YES. If enabled, the design report (*.RPT) file contains file identification information: HSP43124 Serial I/O Filter design parameters, design statistics, control register contents and FIR coefficient information. This information is provided for use when configuring the HSP43124 Serial I/O Filter.
- Display Response: Toggle between LINEAR, LOG, and NONE. If LINEAR is selected, the magnitude of the filter's frequency response is displayed on a linear scale immediately after the filter is generated. If LOG is selected, the display is in dB. If NONE is selected, then no response is displayed.
- Save Frequency Responses: Toggle between NO and YES. If enabled, the magnitude of the Halfband, FIR, and System frequency responses are saved as FilenameH.FRQ, FilenameF.FRQ, and FilenameS.FRQ, respectively. To conduct further analysis these files may be read into any software that can read numerical signal files (see File Format in Appendix C).
- Save FIR Response: Toggle between NO and YES. This saves the generated FIR impulse response as FileName.IMP. This file can be used as an imported FIR at a later date.
- FIR Order: Specify the number of coefficients in the FIR filter. For LOWPASS and IMPORTED filters, this is an integer in the range 4 to 256. For FIR BYPASS mode, it is

always 0. Entering a value in this field causes the estimated Stopband Attenuation to be displayed in the Stopband Attenuation field. Harris strongly recommends that the minimum acceptable FIR order be used: this will minimize the group delay of the filter and, since the HSP43124 is a fixed-point digital filter, this will decrease its susceptibility to round-off errors.

Reported Values

- Output Data Rate: Reports the output sample rate (F_{OUT}); F_{OUT} = Input Sample Rate / Decimation Factor.
- Max FCLKS per CLKOUT: Reports the minimum number of filter clocks per output bit clock necessary to ensure that no data is missed at the output of the filter. Configuring the HSP43124 with this value in the FCLKs per CLKOUT field will result in the minimum acceptable output bit rate.
- Min SCLK: Reports the minimum Serial Input Clock Rate necessary to meet the specified Input Sample Rate for the given number of Input Bits.
- Min FCLK: Reports the minimum Filter clock calculated from the equation in the HSP43124 data sheet. The reported value also satisfies the requirement that the filter clock rate exceed 14 x (Input Sample Rate) if the halfband filters are enabled.
  Note: It is the user's responsibility to ensure that this value does not exceed the speed grade of the HSP43124. For some design specifications, the user may see FCLK rates higher than grades currently available.
- HB Decimation: Reports the value of the aggregate decimation rate of the enabled halfband filters, where halfband decimation rate = 2**(HB Order).
- FIR Decimation: Reports the FIR decimation rate. Not applicable in MANUAL design mode.
- HB Order: Reports the number of halfband filters needed to meet the specified filter design criteria. Not applicable in MANUAL design mode.

Function Keys

<F1> (Help): Press to receive context-sensitive on-line help. Use arrow and page keys to scroll through help screens. Press <Esc> key to exit the help screen.

<F2> (Filter Design): Generates the specified HSP43124 Serial I/O Filter. The design data is first tested for consistency. If any errors are detected, a message indicating the **first** detected design inconsistency is displayed at the bottom of the screen (see Error Messages). The filter design halts at that point.

If no errors are found, the design process is initiated. For the AUTO design mode, the number of Halfband filters to use is determined by dividing the Decimation Factor by two until the remainder is not a power of two. The number of halfband filters used is the number of iterations of the divide by two, and the FIR decimation is the remainder. This maximizes the number of Halfband filters used, which relaxes the constraints on the specification of the FIR.

In AUTO design mode, the filter specification is then checked to make sure that the transition band of the FIR does not overlap the aliasing caused by the Halfband filters. If overlap occurs, the number of Halfband filters is decreased until the overlap is eliminated. If the number of halfband filters is decremented to zero and the resulting FIR Decimation is greater than eight, the design process is halted and an error message is displayed on the bottom of the screen. In AUTO Design Mode, aliasing in the transition band of the FIR is prohibited by generating an error unless $F_{OUT} > 2 \times (F_P + F_T)$. The user may override both of these aliasing checks by changing to the MANUAL Design Mode. For the MANUAL Design Mode, the design process is similar, except that the FIR Decimation rate and Halfband Order are specified separately by the user and no aliasing checks are performed.

While SERINADE is designing the filter, the screen displays the iteration index for the Remez Exchange algorithm. The maximum iteration index is 50. To abort during generation, press the <Esc> key. When the current Remez iteration is complete, the "Interrupt Remez?" prompt appears. Select YES to interrupt or NO to continue.

Upon completion of the design and if enabled in the HSP43124 SERIAL I/O FILTER SPECIFICATION screen, the output files are saved. These files are the FIR impulse response (*.IMP), the report file (*.RPT) and the Halfband, FIR and System frequency response files (*.FRQ).

If Display Response is LINEAR or LOG, the magnitudes of the frequency response of the FIR and the system are displayed. The range of the frequency axis for the FIR screen is from DC to $F_S/(2*DEC_{HB})$ (the FIR Nyquist frequency), while the range for the System Response is from DC to $F_{OUT}/2$ (the System Nyquist frequency).

The graphics screen may be printed by pressing the <F3> key (see Appendix A for printer configuration information). To display the graphics screen on a white background, press the <F2> key. <F2> toggles the display between the black and white background. Press <F1> to display the context sensitive help or press <Esc> to return to the HSP43124 SERIAL I/O FILTER SPECIFICATION screen.

<F3> (Save File): Saves the filter specification (.SER) file under the file name specified in the Filter File field.

<F10> (Exit): Exits the SERINADE program. If you have not saved your filter specification (*.SER) file, the prompt, "Save File?" is displayed.

ERROR MESSAGES

Convergence Failure: Unable to calculate a valid FIR filter due to the passband and/or transition band being either too wide or too narrow. The user may continue generating the filter by answering "YES" to the "Cannot Converge, Continue?" prompt that appears on the design screen, but the filter will not meet the design specifications.

Error Calculating FIR Coefficients: A mathematical error occurred while trying to calculate the filter coefficients. Usually a result of the passband and/or transition band being either too wide or too narrow, or the number of coefficients specified being far too many for the given filter characteristics.

Design Limitations Exceeded: Design requirements exceed the HSP43124 SERIAL I/O's capabilities.

Data Out of Range [low:high]: The data entered in a numerical entry field is out of the acceptable range, which is indicated by the low and high limits. Use the edit keys to correctly enter an acceptable value.

Device Driver File Not Found: The graphics driver files (*.BGI) are not in the SERINADE system directory. These files may be copied directly from the installation disk.

Graphics Hardware Not Detected: No resident graphics card detected on the system.

Invalid Device Driver File: Your graphics adapter is not supported by SERINADE.

Not Enough Memory To Load Driver: There was not enough memory available to allocate for the dynamically loaded graphics driver. Eliminate all memory resident programs (TSRs) and try again, or toggle the Display Response field to NONE.

Insufficient Memory: There was not enough memory available to allocate for a dynamically created data type. Eliminate memory resident programs (TSRs) and try again, or reduce one or more of the following: the number of FIR coefficients; the pass band/(FIR input rate) ratio; or the transition band/(FIR input rate) ratio.

Filter File name Not Specified: A file name has not been specified in the Filter File field.

File name Cannot Be Opened: The file name cannot be opened for either a read or a write operation. Check available disk space and/or appropriateness of the file name or path.

File name Contains Invalid Data: The file name contains incompatible data or is lacking necessary data (see File Format in Appendix C). Check the file for data corruption using the DOS TYPE command.

DESIGN ERRORS:

FIR Order > 256: The maximum number of taps in the programmable FIR filter is 256. Reduce the stopband attenuation, or increase the transition band, passband, or passband attenuation.

FIR Decimation Rate > 8: The maximum FIR Decimation rate is 8. In AUTO mode, change the total decimation factor to a number which can be represented by the product of a power of two from one to 32 and an integer from one to eight. In MANUAL mode, reduce the FIR decimation; adjust the Halfband decimation and the total decimation as necessary.

FIR Decimation Rate > 1 in FIR Bypass Mode: The FIR Decimation rate must not exceed 1 in Bypass Mode, since the FIR is not active.

FCLK < Minimum FCLK: The specified frequency for the Filter Clock is less than is required by the HSP43124 filter section to complete operations without missing input data samples. Increase the FCLK rate to the maximum, then reduce the number of taps until SERINADE calculates and displays a value for the minimum FCLK. See the HSP43124 Data sheet for the equation used to calculate this minimum value.

FCLK < 14 * Input Sample Rate: The specified frequency for the Filter Clock is less than is required by the HSP43124 filter section when the configuration includes halfband filters.

HB Order = 0 And FIR Bypassed Not Allowed: The Halfband stages and the FIR filter may not be bypassed simultaneously.

HB Order > 5: The maximum number of cascaded halfband filters available for the HSP43124 SERIAL I/O Filter is 5.

Passband + Transition Band >= Input Sample Rate/ 2: The sum of the passband and transition band must be less than the input sample rate divided by two. [1, 2]

Output Rate > Input Sample Rate: The Output Rate may not be greater than the Input Sample Rate. [1,2]

Output Rate < 2 * (Passband + TransItion Band): In AUTO filter design mode, the output rate must be greater than two times the sum of the passband and transition bands to prohibit FIR filter aliasing into the passband. This is not checked in the MANUAL filter design mode. [1,2]

Passband >= Input Sample Rate: The specified passband may not be greater than the input sample rate. [1,2]

Stopband Atten <= Passband Atten: The stopband attenuation must be greater than the passband attenuation.

FIR File name Not Specified: A file name has not been specified in the FIR File field.

Help File SERI.HLP Cannot Be Found: The SERINADE Help Text file can not be found. Check to make sure this file is in the SERINADE system directory and that the PATH environment variable contains this directory (see the Getting Started section on proper installation procedures). This file may be copied directly from the installation disk if necessary.

Error Reading Halfband Frequency File: The Halfband Frequency Files can not be found, cannot be opened for read or contains corrupt data. Check to make sure the files HB1.COM through HB5.COM and HB1A.COM through HB5A.COM are in the SERINADE system directory, and that the PATH environment variable contains this directory (see the Getting Started section on proper installation procedures). Check the files for data corruption using the DOS TYPE command. These files may be copied directly from the installation disk if necessary.

Total Decimation not = HB Decimation * FIR Decimation: In MANUAL Design Mode, the total Decimation Factor must be the product of the HB Decimation * the FIR Decimation which are values entered by the user. In AUTO Design Mode SERINADE computes the HB and FIR Decimation and will never fail this design rule.

Transition Band Too Narrow: The minimum size of the transition band is 0.004 x passband.

SERINADE 4

APPENDICES

Appendix A. Printer Definition Table

PRINTER ID	PRINTER TYPE
1	AEG Olympia 24 Pin Models (B/W)
2	AEG Olympia 8 Pin Models (B/W)
3	AEG Olympia Laserstar 6
4	ATT 495 Laser Printer
5	Acer LP-76
6	Acer IIIG Grayscale
7	Alps 24 Pin Models (B/W)
8	Alps 24 Pin Models (Color)
9	Alps 8 Pin Models (B/W)
10	Alps 8 Pin Models (Color)
11	Apple LaserWriter Series
12	Bezier BP404
13	Brother HL Series
14	Brother M-1000/1100 Series
15	Brother M-1909 (B/W)
16	Brother M-1909 (Color)
17	Brother M-1924L
18	Bull Compuprint Series (24 Pin)
19	Bull Compuprint Series (8 Pin)
20	C-Tech C-600 Series
21	C-Tech ProWriter Series
22	C. Itoh C-310 EP/CX
23	C. Itoh C-715F (24 Pin)
24	C. Itoh C715F (8 Pin)
25	C. Itoh Jet-Setter II
26	C. Itoh ProWriter CI-4
27	Canon BJ-10e
28	Canon BJ-300/330
29	Canon BJC 800/820 (B/W)
30	Canon BJC 800/820 (Color)
31	Canon BJC 600 (Color)
32	Canon LBP-8 Series X24E
33	Centronics PagePrinter 8
34	Citizen 120D/180D
35	Citizen MSP Series
36	Citizen Tribute 124/224
37	DEClaser Series
38	DataProducts LZR Series
39	Destiny LaserAct

PRINTER ID	PRINTER TYPE
40	Diconix 150 Series
41	Diconix Color 4
42	EGA Display
43	Epson EPL Series
44	Epson EX Series (B/W)
45	Epson EX Series (Color)
46	Epson FX Series
47	Epson JX Series (B/W)
48	Epson JX Series (Color)
49	Epson LQ Series (24 Pin, B/W)
50	Epson LQ Series (24 Pin, Color)
51	Epson LQ Series (8 Pin, B/W)
52	Epson LQ Series (8 Pin, Color)
53	Epson MX Series
54	Epson RX Series
55	Fortis DP-600S
56	Fortis/Dynax DM Series
57	Fujitsu DL2000 Series (B/W)
58	Fujitsu DL2000 Series (Color)
59	Fujitsu DX2000 Series (B/W)
60	Fujitsu DX2000 Series (Color)
61	Fujitsu RX7100
62	FutureLogic PMC-5000A
63	HP DeskJet Series (B/W)
64	HP DeskJet 500c (Color)
65	HP DeskJet 550c (Color)
66	HP DeskJet 1200c (Color)
67	HP LaserJet Series I
68	HP LaserJet Series II
69	HP LaserJet Series III
70	HP LaserJet Series IV
71	HP Laser IV 600 dpi
72	HP PaintJet Series (B/W)
73	HP PaintJet Series (Color)
74	HP PaintJet XL300(8.5in X 11in.)
75	HP PaintJet XL300 (11in. X 17in.)
76	Howtek Pixelmaster
77	IBM 3852-2 Jetprinter (B/W)
78	IBM 3852-2 Jetprinter (Color)

PRINTER ID	PRINTER TYPE
79	IBM Compact Printer
80	IBM LaserPrinter Series
81	IBM PC Color Printer (B/W)
82	IBM PC Color Printer (Color)
83	IBM PC Graphics Printer
84	IBM Proprinter Series
85	IBM Proprinter X24 Series
86	IBM QuietWriter Series
87	Juki 5510
88	Kodak Ektaplus 7008
89	Kyocera F-1010/2010/3010
90	LaserImage 1000
91	LaserMaster TrueTech Series
92	Mannesmann Tally MT911PS
93	Mannesmann Tally 130/24 Series
94	Mannesmann Tally MT910
95	MannesmannTally 130/9 Series
96	MicroTek TrueLaser
97	NEC Colormate PS
98	NEC LC-890 L
99	NEC Pinwriter P2/P3
100	NEC Pinwriter Series (24 Pin, B/W)
101	NEC Pinwriter Series (24 Pin, Color)
102	NEC SilentWrite2 990
103	NEC SilentWriter LC-860+
104	Okidata LaserLine6
105	Okidata ML Series (Color)
106	Okidata ML Series (IBM, B/W)
107	Okidata ML Series
108	Okidata OL830
109	Okidata OkiLaser Series
110	Panasonic KX-P1000/24 Series
111	Panasonic KX-P1000/8 Series
112	Panasonic KX-P14450 Series
113	PostScript Printer (B/W)
114	PostScript Printer (Color)
115	QMS PS Series
116	Qume LaserTen Plus
117	Roland RP-1100 Series
118	Roland Raven LP-1100
119	SGA Display
120	Seikosha SK-3000 Series (B/W)
121	Seikosha SK-3000 Series (Color)
122	Sharp JX-9500 Series
123	SpectriStar 400 Series
124	Star LaserPrinter Series
125	Star Micronix NX Series
126	Star Micronix NX-2400 Series
127	TI OmniLaser 2115
128	Tandy DMP 2130
129	Tandy DMP 240
130	Tandy LP-1000
131	Tandy LP-950
132	Tektronix 4696
133	Tektronix Colorquick
134	Tektronix Phaser Series
135	Toshiba 1350 Series
136	Toshiba P320 Series
137	Toshiba P350 Series
138	Toshiba PageLaser Series
139	VGA Display
140	Xerox 2700
141	Xerox 4045

Appendix B. References

[1] Oppenheim, Alan V. and Schafer, Ronald W., *Digital Signal Processing,* Prentice Hall, 1975.

[2] Crochiere, Ronald E. and Rabiner, Lawrence R. *Multirate Digital Signal Processing,* Prentice Hall, 1983.

Appendix C. File Formats

File Structure

File Formats Used by SERINADE

FORMAT	EXT	DESCRIPTION
Control	*.SER	Filter definition
Control	*.CFG	System Configuration file
RPT	*.RPT	Report file
Signal	*.xxx	Imported FIR file
Signal	*.IMP	Impulse response to designed FIR
Signal	F.FRQ	Frequency response of FIR stage
Signal	H.FRQ	Frequency response of Halfband stage
Signal	S.FRQ	Frequency response of entire system

NOTE: For Extensions, 'x' is any Character.

Control Files

The *.SER Control files are utilized to store information for use by SERINADE. These files do not require editing by the user.

The SER.CFG Control file is also utilized by SERINADE to store information concerning system configuration. This control file is an ASCII file containing configuration variables used by SERINADE. These variables are initialized at install time (see section 1.1) but may be altered by the user if necessary. The file takes on the following format:

FilterFile filename.SER
PrinterId 113
PrinterPort LPT1
XScale 0
YScale 0
Landscape 0
IoMode 1
PalletteInv 0

The user may use any text editor to modify these SERINADE variables but must adhere to the format shown above. The variables are described below:

FilterFile: The SERINADE filter specification file which may also be modified from within the SERINADE design screen.

PrinterId: The printer ID number corresponding to the configured printer (see Appendix A for the Printer Definition Table). In the example above, the printer ID of 113 corresponds to a Postscript printer.

PrinterPort: The printer port address or DOS file name to which the graphics print will be directed. Valid entries for this field are LPTn, COMn or a DOS file name. If a DOS file name is entered, the graphics screen is written to a binary file which may be printed via the DOS COPY /B file name LPT1: command.

XScale: The horizontal scaling factor which defaults to a value of zero. When zero is selected, auto-scaling is performed by SERINADE for both the horizontal and vertical factors. Auto-scaling attempts to provide scale factors such that the apparent image as seen on the display monitor is reproduced by the printer. If the auto-scaled image is not acceptable for your printer, this value may be adjusted. Scales are specified as a percentage, with 100 being a scale of 1:1, 200 being 2:1, and so on.

YScale: The vertical scaling factor which defaults to a value of zero. When zero is selected, auto-scaling is performed by SERINADE for both the horizontal and vertical factors. If the auto-scaled image is not acceptable for your printer, this value may be adjusted. Scales are specified as a percentage, with 100 being a scale of 1:1, 200 being 2:1, and so on.

Landscape: Print the frequency response in portrait (0) or landscape (1); the default is zero.

Note: auto-scaling does not work properly when landscape mode is selected; the user must specify the XScale and YScale factors.

IoMode: The printer I/O mode. The following values are valid:

1. Printer output via direct port hardware (default).
2. Printer output via BIOS (not recommended).
3. Printer output via stream (use this mode for networked printers or if output is directed to a file).

PalletteInv: Invert the color palette; On most printers, 0 = print black lines on a white background, 1 = white lines on a back background. The default is zero. The sense of this bit may be reversed on some printers. Set to 1 to invert the palette prior to printing. Does not affect screen display.

Report File

The *.RPT file generates a report of the filter design specifications for documenting the design. The first three lines are header information containing design dates and software information. The next seven lines define the filter requirements. The next three values define the minimum clocking requirements for the HSP43124. These are followed by the value of each of the control register in hexadecimal and each control word sub-field broken out in decimal representation. The hexadecimal values of the filter coefficients are also listed.

Signal Files

Signal files are used to store real or complex data for interchange between SERINADE and other signal analysis software. These data files conform to the file format used by MONARCH Digital Signal Processing Software, consisting of a seven line header followed by the data itself. The header section must follow this format:

Line 1: through 4 Comments

Line 5: X-Axis Label

Line 6: Y-Axis Label

Line 7: t c r

Where t = the letter “r” for real data or “c” for complex data, c = number of columns, and r = number of rows. Following the header section, the data is arranged according to the specified number of row and columns. Note: the real and imaginary parts of a complex number are listed as one row, with the real part first.

The frequency files H.FRQ, F.FRQ and S.FRQ are two dimensional files (t = c). Column 1 is the frequency and column 2 is the magnitude of the response for each respective stage.

The impulse response *.IMP is a one dimensional file (t = r). Column 1 is the FIR impulse response in floating point representation created by SERINADE.

The Imported FIR file *.xxx is created by the user using any filter design software, or may be a filter which was previously designed with SERINADE. This file format must be a one-dimensional (t = r, c = 1, r = #taps) SERINADE signal file. The FIR coefficients should be in floating point format; the sum of the coefficients must be <= 1.0. The number of coefficients must be from 4 to 256.