FIR

COLLABORATORS

	TITLE : FIR	

ACTION	*NAME*	*DATE*	*SIGNATURE*
WRITTEN BY		February 12, 2023	

REVISION HISTORY

NUMBER	DATE	DESCRIPTION	NAME

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Chapter 1

FIR

1.1 Contents

```
                The Finite Impulse Response Filter Designer V1.1


 Contents


                1. Installation

                2. Purpose

                3. How to use

                4. Future Enhancements

                5. Copyright

                6. Thanks

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                9. Filter Library
```

1.2 Installation

```
 1. Installation


 This is the third Aminet Release of the FilterDesigner.
 To install the FIR Filter Designer V1.1, use
 the installer script in this directory.

 AmigaOS 2.x or up is required.
```

1.3 Purpose

2. Purpose

The problem of designing finite impulse response (FIR) digital filters experienced great activity in the early 1970's. Most of this work was directed at the problem of optimal filter design, in the weighted Chebyshev sense. The algorithm for this program, by McClellan, Parks and Rabiner, will design the optimal Chebyshev approximation for linear phase filters. The Chebyshev optimization is done very efficiently by means of the Remez exchange algorithm, and this particular FIR filter design program has found wide use.

1.4 How to use

3. How to use

Select the filter parameters or load a filter specification file (#?.FIR). Click on the design button and wait until the filter is designed. This can take up to a minute if you use a standard Amiga. With an A4000/40 however it takes only a few seconds.

The resulting filter parameters will be stored in an ASCII-file, located in:

T:FIR.OUTPUT

Please use one of the standard text viewers to have a look at this file.

If you select invalid filter parameters, the program will not do anything, except display a flashing screen.

Parameter Description

Filter-Type:	Bandpass Differentiator Hilbert Transformator
Filter-Length	3 to 128
Grid-Density	1 to 64
Bands	1 to 10
From	lower frequency of the specified Band
To	upper frequency of the specified Band

```
Value           0.0 to 1.0
                0.0 means stopband
                1.0 means passband

weight          weight for optimization

                Note that the the frequency value is relative to the
                sampling frequency. Load
               example
                files (#?.FIR) for
                better understanding. The bands have to be sorted in
                ascending order.
```

1.5 Example

```
                Example of a
               Bandpass
                Filter-Type     Bandpass
Filter-Length   55
Grid-Density    16
Bands           5

          From   To     Value   Weight
Band 01   0      0.05   0       10
Band 02   0.1    0.15   1       1
Band 03   0.18   0.25   0       3
Band 04   0.3    0.36   1       1
Band 05   0.41   0.5    0       20



Example of a
               Differentiator
                Filter-Type     Differentiator
Filter-Length   32
Grid-Density    16
Bands           1

          From   To     Value   Weight
Band 01   0      0.5    1       1



Example of a
               Hilbert
                Transformator

Filter-Type     Hilbert Transformator
Filter-Length   20
Grid-Density    16
Bands           1
```

```
          From   To     Value   Weight
Band 01   0.05   0.5    1       1
```

1.6 Future Enhancements

```
                4. Future Enhancements


If enough Amiga users are interested in the FIRDesigner,
i will add the following enhancements to this program:

  - filtering of sound samples
  - 1 dimensional and 2 dimensional filtering of pictures
  - improved online help
  - filter
              library
               Feel free to send me suggestions, bug reports and your
wish list.
```

1.7 Copyright

```
5. Copyright


This program is SHAREWARE !
If you use it, send me US$ 15 or DM 20.

  Harald Zottmann
  Friedenstraße 27
  63743 Aschaffenburg (Germany)

  Harald Zottmann
  Am Altenbruch 43
  40822 Mettmann (Germany)

  Internet: harald.zottmann@ntc.nokia.com
```

1.8 Thanks

```
6. Thanks



   James H. McClellan
   Thomas W. Parks
   Lawrence R. Rabiner
```

for the development of a powerful FORTRAN-Program which is able to design
"Optimum Finite Impulse Response Linear Phase Digital Filters"

1.9 References

7. References

Below is a small collection of related books and articles on
Finite Impulse Response Filters:

W. Hess
Digitale Filter
Teubner Studienbücher
ISBN 3-519-16121-4

J.H. McClellan
Programs for Digital Signal Processing
Edited by the DSP Committee IEEE ASSPS
IEEE Press NY 1979

J.H. McClellan, T.W. Parks, L.R. Rabiner
A Computer Program for Designing Optimum FIR Linear Phase Digital Filters
IEEE Transactions on Audio and Electroacoustics
Vol. AU-21, No.6, December 1973

Oppenheim/Schafer
Zeitdiskrete Signalverarbeitung
R.Oldenbourg Verlag 1992
ISBN 3-486-21544-2

1.10 History

8. History

Date	Version	Type	Comments
01/05/96	V1.10	Release	Third AMINET Release - Versions for: MC 68000 MC 68020 MC 68040 - Updated the installer script - Now compatible with AudioLab16 (AudioLab16 copyright by Maurizio Ciccione) - Grids in the Prism window - Some redesigns and optimizations

```
                                - Fixed Bug with too small workbench

  15/04/96  V1.01    Release   ScientificAmigan Disk Library
                               (Selected by Robert Pigford)

  29/11/95  V1.01    Release   Second AMINET Release
                               - Fixed several Enforcer Hits
                                 (Reported by Jukka Marin)
                               - Fixed Bug with not updating gadgets
                               - Recompiled with SAS/C V6.56
                               - Less Shareware Requesters
                               - Installer Script
                               - Added Pattern in Filerequester
                               - More Examples

  21/07/95  V1.00    Release   First AMINET Release
```

1.11 Output for Bandpass.FIR

```
DEVIATION =   0.000734
DEVIATION =   0.006316
DEVIATION =   0.021567
DEVIATION =   0.026203
DEVIATION =  -0.032680
DEVIATION =  -0.034435
DEVIATION =  -0.034448
DEVIATION =  -0.034448


FINITE IMPULSE RESPONSE (FIR)
LINEAR PHASE DIGITAL FILTER DESIGN
FILTER TYPE: BANDPASS FILTER
FILTER LENGTH = 55


******* IMPULSE RESPONSE *******

H(  1) =  1.066267E-03 = H( 55)
H(  2) =  6.377732E-03 = H( 54)
H(  3) =  3.575602E-03 = H( 53)
H(  4) = -9.067776E-03 = H( 52)
H(  5) = -9.090722E-03 = H( 51)
H(  6) =  2.915573E-03 = H( 50)
H(  7) =  3.963771E-03 = H( 49)
H(  8) =  1.117204E-02 = H( 48)
H(  9) =  1.164679E-02 = H( 47)
H( 10) = -9.963073E-03 = H( 46)
H( 11) = -9.238414E-03 = H( 45)
H( 12) = -2.040640E-02 = H( 44)
H( 13) = -1.946051E-02 = H( 43)
H( 14) =  3.124302E-02 = H( 42)
H( 15) =  6.304561E-03 = H( 41)
H( 16) = -2.048280E-02 = H( 40)
H( 17) =  6.574080E-03 = H( 39)
H( 18) = -1.120240E-03 = H( 38)
```

```
H( 19) =  4.195695E-02 = H( 37)
H( 20) =  3.578428E-02 = H( 36)
H( 21) =  3.474480E-02 = H( 35)
H( 22) =  7.149640E-02 = H( 34)
H( 23) = -1.713883E-01 = H( 33)
H( 24) = -1.825505E-01 = H( 32)
H( 25) =  7.405902E-02 = H( 31)
H( 26) = -1.031742E-01 = H( 30)
H( 27) =  2.571671E-02 = H( 29)
H( 28) =  3.781355E-01 = H( 28)
```

	BAND 1	BAND 2	BAND 3	BAND 4
LOWER BAND EDGE	0.000000	0.100000	0.180000	0.300000
UPPER BAND EDGE	0.050000	0.150000	0.250000	0.360000
DESIRED VALUE	0.000000	1.000000	0.000000	1.000000
WEIGHTING	10.000000	1.000000	3.000000	1.000000
DEVIATION	0.003444	0.034448	0.011482	0.034448
DEVIATION IN DB	-49.256573	0.294179	-38.798996	0.294179

	BAND 5
LOWER BAND EDGE	0.410000
UPPER BAND EDGE	0.500000
DESIRED VALUE	0.000000
WEIGHTING	20.000000
DEVIATION	0.001722
DEVIATION IN DB	-55.277172

EXTREMAL FREQUENCIES--MAXIMA OF THE ERROR CURVE

0	0.243616	0.032366	0.044642
0.1	0.108929	0.126786	0.142411
0.18	0.18558	0.197857	0.213482
0.243616	0.25	0.3	0.312277
0.350223	0.36	0.41	0.41558
0.445714	0.463571	0.481428	0.5

```
################################################

 1.066267E-03
 6.377732E-03
 3.575602E-03
-9.067776E-03
-9.090722E-03
 2.915573E-03
 3.963771E-03
 1.117204E-02
 1.164679E-02
-9.963073E-03
-9.238414E-03
-2.040640E-02
-1.946051E-02
 3.124302E-02
 6.304561E-03
-2.048280E-02
```

```
 6.574080E-03
-1.120240E-03
 4.195695E-02
 3.578428E-02
 3.474480E-02
 7.149640E-02
-1.713883E-01
-1.825505E-01
 7.405902E-02
-1.031742E-01
 2.571671E-02
 3.781355E-01
 2.571671E-02
-1.031742E-01
 7.405902E-02
-1.825505E-01
-1.713883E-01
 7.149640E-02
 3.474480E-02
 3.578428E-02
 4.195695E-02
-1.120240E-03
 6.574080E-03
-2.048280E-02
 6.304561E-03
 3.124302E-02
-1.946051E-02
-2.040640E-02
-9.238414E-03
-9.963073E-03
 1.164679E-02
 1.117204E-02
 3.963771E-03
 2.915573E-03
-9.090722E-03
-9.067776E-03
 3.575602E-03
 6.377732E-03
 1.066267E-03
```

1.12 Output for Differentiator.FIR

```
DEVIATION =   0.001310
DEVIATION =   0.005829
DEVIATION =   0.006130
DEVIATION =   0.006202


FINITE IMPULSE RESPONSE (FIR)
LINEAR PHASE DIGITAL FILTER DESIGN
FILTER TYPE: DIFFERENTIATOR
FILTER LENGTH = 32


******* IMPULSE RESPONSE *******
```

```
H(  1) = -6.271307E-04 = -H( 32)
H(  2) =  8.563357E-04 = -H( 31)
H(  3) = -4.241865E-04 = -H( 30)
H(  4) =  3.990139E-04 = -H( 29)
H(  5) = -4.343722E-04 = -H( 28)
H(  6) =  4.996944E-04 = -H( 27)
H(  7) = -5.963505E-04 = -H( 26)
H(  8) =  7.327703E-04 = -H( 25)
H(  9) = -9.300249E-04 = -H( 24)
H( 10) =  1.227003E-03 = -H( 23)
H( 11) = -1.701281E-03 = -H( 22)
H( 12) =  2.527233E-03 = -H( 21)
H( 13) = -4.160115E-03 = -H( 20)
H( 14) =  8.129457E-03 = -H( 19)
H( 15) = -2.253910E-02 = -H( 18)
H( 16) =  2.026653E-01 = -H( 17)


                    BAND 1
LOWER BAND EDGE     0.000000
UPPER BAND EDGE     0.500000
DESIRED SLOPE       1.000000
WEIGHTING           1.000000
DEVIATION           0.006202

EXTREMAL FREQUENCIES--MAXIMA OF THE ERROR CURVE

        0.001953        0.5             0.066406        0.099609
        0.164063        0.197266        0.230469        0.263672
        0.330078        0.363281        0.394531        0.427734
        0.486328        0.5



################################################

-6.271307E-04
 8.563357E-04
-4.241865E-04
 3.990139E-04
-4.343722E-04
 4.996944E-04
-5.963505E-04
 7.327703E-04
-9.300249E-04
 1.227003E-03
-1.701281E-03
 2.527233E-03
-4.160115E-03
 8.129457E-03
-2.253910E-02
 2.026653E-01
-2.026653E-01
 2.253910E-02
-8.129457E-03
 4.160115E-03
```

```
-2.527233E-03
 1.701281E-03
-1.227003E-03
 9.300249E-04
-7.327703E-04
 5.963505E-04
-4.996944E-04
 4.343722E-04
-3.990139E-04
 4.241865E-04
-8.563357E-04
 6.271307E-04
```

1.13 Output for Hilbert.FIR

```
DEVIATION =   0.004165
DEVIATION =   0.016426
DEVIATION =   0.020038
DEVIATION =   0.020556


FINITE IMPULSE RESPONSE (FIR)
LINEAR PHASE DIGITAL FILTER DESIGN
FILTER TYPE: HILBERT TRANSFORMATOR
FILTER LENGTH = 20


******* IMPULSE RESPONSE *******

H(  1) =  1.602632E-02 = -H( 20)
H(  2) =  1.417333E-02 = -H( 19)
H(  3) =  2.045249E-02 = -H( 18)
H(  4) =  2.873692E-02 = -H( 17)
H(  5) =  3.985263E-02 = -H( 16)
H(  6) =  5.533331E-02 = -H( 15)
H(  7) =  7.854278E-02 = -H( 14)
H(  8) =  1.182376E-01 = -H( 13)
H(  9) =  2.066413E-01 = -H( 12)
H( 10) =  6.347561E-01 = -H( 11)


                    BAND 1
LOWER BAND EDGE     0.050000
UPPER BAND EDGE     0.500000
DESIRED VALUE       1.000000
WEIGHTING           1.000000
DEVIATION           0.020556

EXTREMAL FREQUENCIES--MAXIMA OF THE ERROR CURVE

        0.05            0.24375         0.103125        0.146875
        0.24375         0.29375         0.346875        0.396875
        0.5
```

```
################################################

 1.602632E-02
 1.417333E-02
 2.045249E-02
 2.873692E-02
 3.985263E-02
 5.533331E-02
 7.854278E-02
 1.182376E-01
 2.066413E-01
 6.347561E-01
-6.347561E-01
-2.066413E-01
-1.182376E-01
-7.854278E-02
-5.533331E-02
-3.985263E-02
-2.873692E-02
-2.045249E-02
-1.417333E-02
-1.602632E-02
```

1.14 Filter Library

```
  9. Filter Library


  If you  have designed  good filters for special purposes,
  you  can send  them to  me via e-mail,  including a short
  description, for  example about  the  application you use
  them in, or special characteristics. I  will then include
  them in a  filter library and  distribute  them  together
  with the program. Remember to send only the #?.FIR files,
  saved by this  program, so  other people  can modify your
  filters.



  Thanks...(e-mail: harald.zottmann@ntc.nokia.com)
```