

FUMO – DSP Toolbox

Version 0.25

A. WHAT IS FUMO LIBRARY FOR

FUMO contains functions that enable digital signal processing. By it's means one can probe typical signals, window it, apply FFT (or DFT) to it, convolute it (linearly or circularly), lengthen it with zeros or cut down, or even obtain frequency characteristics (amplitude, phase, group delay).

B. LICENSE

FUMO is a freeware. It is permissible to spread FUMO library further on condition that no changes are going to be introduced to library itself, nor to the packet in which it is distributed, as well as it will be distributed without taking any charge for it's use.

Author is not responsible for any damages arising from using the program.

C. REGISTRATION

Just send e-mail entitled „FUMO-registration” to the address:
przemhb@wp.pl

D. REQUIREMENTS

HP48G(X) or HP49 calculator with about 7kB of free memory.

E. INSTALLATION

It is done in a standard fashion for self-attaching libraries.

- Set HP49 in `RPN` mode.
- Copy file containing the library into the calculator.
- Call the library to the stack by pressing the corresponding button.
- Purge the library, leaving only it's copy in the stack.
- Insert into the stack `:0: 1001` and then press `STO`
- Turn off and on the calculator.
- Make sure flags 2 and 3 are set to `Constant→num` and `Function→num`

From now on the library shall be available after pressing → `LIBRARY`

F. USING BUILT-IN FUNCTIONS

F1. → PL

Purpose: Drawing graphs for the sequence given on the 1st level of stack.

Parameters: Level 1: Sequence to be drawn.

Results: Required graph drawn.

Note: Function enables to choose 2 graph modes: BAR and SCATTER. These are standard graph types, although for point mode (second from above ones) ordinate axis spreads from 1 to the value responding to number of elements on list or input vector.

F2. ZRPL

Purpose: Calculating chosen characteristics (amplitude, phase, group delay) in section $[-\pi, \pi]$.

Parameters:

Level 1: List containing transmittance zeros

Level 2: List containing transmittance poles

Results:

Level 1: List containing the characteristic's magnitude

Level 2: List containing the transmittance's complex magnitude-phase characteristic.

Note:

It is possible to instantly draw the result thanks to built-in function → PL. Also, because of retaining the lists with complex magnitudes it is possible to draw the remaining two characteristics without repeated evaluation of transmittance's magnitudes in whole section.

F3. SMPL

Purpose: Samples chosen signal.

Parameters:

Level 4: δ

Level 3: χ

Level 2: β

Level 1: α

Results:

Level 1: List containing samples of the chosen signal.

| Signal type | Course | α | β | χ | δ | Equation ¹ |
|-------------|-----------------------------|-----------------|-----------------------------|--|----------|---|
| Imp | Factual rectangular impulse | Impulse length. | Number of non-zero samples. | Position of first non-zero element. ² | - | If number of current element (c) is of section $[\chi, \chi + \beta]$ then the introduced |

¹ C is the loop's numerator.

² Numbering from 0.

| | | | | | | |
|------|----------------------|---------------------|-----------------------------|-------------------------------------|------------------------------|---|
| | | | | | | magnitude is 1, otherwise 0. |
| Ramp | Factual ramp impulse | Ramp length. | Number of non-zero samples. | Position of first non-zero element. | - | If number of current element (c) is of section $[\chi, \chi + \beta]$ then the introduced magnitude is c, otherwise 0.. |
| Rsin | Factual Sinus | Total probe number. | Phase. | Number of samples per period. | Number of periods in signal. | $\sin\left(\frac{2\pi\delta C}{\chi} + \beta\right)$ |
| Csin | Complex Sinus | Total probe number. | Phase. | Number of samples per period. | Number of periods in signal. | $\exp\left(\frac{j2\pi\delta C}{\chi}\right)$ |

| | | | | | | |
|------|----------------------|--------------------------------|-------------------------------|------------------------------|---|---|
| Sinc | Sinc | Total probe number. | Number of samples per period. | Number of periods in signal. | - | $\frac{\sin\left(\frac{C\pi\chi}{\beta}\right)}{\sin\left(\frac{C\pi}{\beta}\right)}$ |
| User | Defined by the user. | Total signal's samples number. | - | - | - | Program named UDS ³ in current catalogue. |

F4. WND

Purpose: Generates a sequence of samples of chosen windowing function.

Parameters:

Level 2: Window's parameters (only for Kaiser's and Tschebyshev's windows).

Level 1: Window length.

Results:

Level 1: List of given length containing magnitudes of windowing function.

F5. DFT

Purpose: Evaluates DFT of given sequence.

Parameters:

Level 1: Sequence to be processed

Results:

Level 1: DFT of given sequence

F6. iDFT

Purpose: Evaluates iDFT of given sequence.

Parameters:

Level 1: Sequence to be processed

Results:

³ Program in form of «→ C 'equation' »; C is the loop's numerator is contained in section $[0, \alpha-1]$

Level 1: iDFT of given sequence

F7. CCNV

Purpose: Evaluates circular convolution of two given sequences.

Parameters:

Level 2: Sequence to be processed

Level 1: Sequence to be processed

Results:

Level 1: Circular convolution of given sequences.

F8. LCNV

Purpose: Evaluates linear convolution of two given sequences.

Parameters:

Level 2: Sequence to be processed

Level 1: Sequence to be processed

Results:

Level 1: Linear convolution of given sequences.

F9. ZINS

Purpose: Puts N-1 zero-samples between any two neighbouring samples of the original list..

Parameters:

Level 2: List to be processed

Level 1: N

Results:

Level 1: List with zero-samples put in.

F10. ZPAD

Purpose: Adds N zero-samples at the end of the list or removes last N of it's samples.

Parameters:

Level 2: List to be processed

Level 1: N

Results:

Level 1: List with added N zero-samples or (if N<0) with last N of samples removed.

F11. ODD

Purpose: Returns odd part of given sequence.

Parameters:

Level 1: Sequence to be processed

Results:

Level 1: Processed sequence

F12. EVN

Purpose: Returns even part of given sequence.

Parameters:

Level 1: Sequence to be processed

Results:

Level 1: Processed sequence

F13. $M \leftrightarrow L$

Purpose: Changes the standard notation of matrix to notation with use of square brackets and inversly.

Parameters:

Level 1: Matrix to be converted

Results:

Level 1: Converted matrix

F14. $V \leftrightarrow L$

Purpose: Changes the standard notation of vector to notation in form of list and inversly.

Parameters:

Level 1: Vector or list to be converted

Results:

Level 1: Converted vector or list

F15. $V \rightarrow C$

Purpose: Changes form of line vector to column vector.

Parameters:

Level 1: Vector to be converted

Results:

Level 1: Converted vector

F16. VMLT

Purpose: Multiplies appropriate elements of two vectors

Parameters:

Level 2: N-element vector

Level 1: N-element vector

Results:

Level 1: N-element vector which is result of the multiplying

Note: It is not checked whether or not the vectors are of the same size

F17. VABS

Purpose: Evaluates modulus of each element of complex vector

Parameters:

Level 1: N-element complex vector

Results:

Level 1: N-element vector of real values

F18. SHIFT

Purpose: Shifts elements of the sequence by a given value in a chosen direction.

Parameters:

Level 2: N-element sequence

Level 1: S – shifting value

Results:

Level 1: Transformed N-element sequence

Note:

Shift is circular, which means that in evaluated list there are always all the elements that were in the given list.

F19. VREV

Purpose: Inverses sequence.

Parameters:

Level 1: Sequence to be inversed

Results:

Level 1: Inversed sequence

F20. NRML

Purpose: Sequence's normalization.

Parameters:

Level 1: Sequence to be normalized.

Results:

Level 1: Transformed sequence.

Effect: Subtracts the highest value in the sequence from every values from the sequence.

F21. RNDL

Purpose: Makes even to 0 these elements from list, which are lower than given K value.

Parameters:

Level 2: Complex sequence to treatment.

Level 1: Real cut-off value K.

Results:

Level 1: Transformed sequence.

F22. FLTR

Purpose: Removes from the sequence points of incontinuity, i.e. very high values.

Parameters:

Level 1: Sequence to treatment.

Level 1: Saturation coefficient $K \in \langle 0, 1 \rangle$.

Results:

Level 1: Transformed sequence.

Effect: If a given element L is $>$ than $\text{maximum} * K$ then in it's place instead of it is placed value $K * \text{max sequence's value}$.

F23. WNK

Purpose: Generates matrix W_N^{kn} sized $N \times N$.

Parameters:

Level 1: N – wanted matrix's size.

Results:

Level 1: Matrix W_N^{kn}

F24. ABOUT

Purpose: Gives info on program's name, version, author.

Parameters: None required.

Results: Window with info mentioned above.

G. Composition of input parameters' types and input data of each function.

| Function name | Purpose | Input parameters | | | | Output |
|---------------|--|------------------|-----------------|-----------------|-----------------|--------|
| | | Stack's Level 1 | Stack's Level 2 | Stack's Level 3 | Stack's Level 4 | |
| →PL | Graph drawing | L or V | | | | |
| ZRPL | Evaluating frequency characteristics of given transmittance. | L or CL | L or CL | | | L, L |
| SMPL | Generating sequences of sampled signals. | N: α | N: β | N: χ | N: δ | L |
| WND | Generating sequences of windowing functions. | N: α | | | | L |
| DFT | Evaluating DFT | L, CL or V | | | | V |
| IDFT | Evaluating iDFT | L, CL or V | | | | V |

| | | | | | | |
|-----------------------|---|---|------------|--|--|-----------------------------------|
| CCNV | Evaluating circular convolution | L or CL | L or CL | | | L or CL |
| LCNV | Evaluating linear convolution | L or CL | L or CL | | | L or CL |
| ZINS | Putting $\alpha-1$ zero-samples between following signal samples. | $N : \alpha$ | L | | | L |
| ZPAD | Adding α zero-samples or removing $-\alpha$ samples | $N: \alpha$ α positive – adds α negatives removes | L | | | L |
| ODD | Returns sequence's odd part. | CL or V | | | | CL for CL, V for V |
| EVN | Returns sequence's even part. | CL or V | | | | CL for CL, V for V |
| $M \leftrightarrow L$ | Matrix-to-list conversion. | M or L | | | | L for M, M for L |
| $V \leftrightarrow L$ | Vector-to-list conversion. | V or L, CL | | | | L or CL for V, V for L or CL |
| $V \rightarrow C$ | To-column vector conversion | V or L, CL | | | | cV |
| VMLT | Multiplication by elements | V | V | | | V |
| VABS | Modulus by elements | V | | | | V |
| SHIFT | Circular shift by α | α positive – right negative – left | V or L, CL | | | L for L, CL for CL, V for V |
| VREV | Inverts vector | V or L, CL | | | | V for V, L for L, CL for CL |
| NRML | Sequence's normalization | L | | | | L |
| RNDL | Makes even to 0 those elements from the list, which are smaller than given K value. | N | CL | | | CL |
| FLTR | Removes from sequence points of incontinuity i.e. very high values. | N | L | | | L |
| WNK | Generates matrix \mathbf{W}_N^{kn} | N | | | | M |
| ABOUT | Info | | | | | |

L – list, CL – complex list, V – vector, cV – column vector, N – number, M – matrix; α , β , χ , δ - function's input parameters.

H. FAQ

Q: I decompressed the lib files, but both files (fumo49vxxx.lib and FUMOxxx.lib) seems to be for HP48. How do I install in HP49G? I set RPN mode and transferred using HPComm PC Connectivity Kit software. It transferred the file as text because it didn't recognized as lib (ie "HHP48").

A: Probable cause of such behavior is truncated library file. This problem often occurs when files are transferred on calculator. Another reason is incorrect HPComm / calc / system setting. In HPComm you should have Translation= Mode 0, Checksum = Type 3 and Binary as Mode. Calc should be set in Binary mode too. System should be set to 8-N-1, but if this kind of problem doesn't occur often then you have this set OK. And one more - HPComm has a bug which may be source of this problem too. It transfers only as many bytes of transferred file as it displays in a window. So if the file size does changed, or is read incorrectly the file may be truncated.

The "HHP48" is a valid header for both 48 and 49 files.

I. Plans

- Code's speed optimalization.
- Adding Tschebyshev's window.

J. From Author:

I will be grateful for any remarks and suggestions. I wish you satisfaction from using FUMO.

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