

GENERAL PROGRAM GUIDE

This program is a combination of the "AC" Circuit Analysis program and an "FFT" (Fast Fourier Transform) facility. Circuits can be analysed and test waveforms, window & filter functions can be created, using standard algebraic expressions.

Initially the program is in Time domain and can be toggled between Waveform and Window modes using the **M**ode command. The only difference between these 2 modes is that the FFT Transform acts only on the Waveform values and the **C**onvolution option causes the Window to be used as multiplier with effect on the Waveform. (Convolution is useful for modulation as well as windowing non-repetitive data) The **T**ransform command toggles the program between Time and Frequency domains.

In the Frequency domain, the waveform's frequency components and phase are seen and can be **C**onvolved with the results of a circuit analysis or with a filter. Reversion to the Time domain shows the system's effect on the chosen waveform.

A Waveform analysis option allows the zero time point to be at left or centre. This has effect only on the phase of the frequency components after a transform with the centre zero giving minimum phase for any centred symmetrical waveform. Change of horizontal scale is allowed in both the Time and the Frequency domain with automatic coupling ensuring correct transfer of scale between the domains. The inevitable linking of these two scales must be remembered with any changes.

EDITOR GUIDE

The Editor provided is a simple text editor which can be used on any text files such as CONFIG.SYS and AUTOEXEC.BAT, as well as the various files needed here. The only restrictions are the maximum of 100 lines and 79 characters per line.

Most normal cursor movement commands are implemented, including:
"Home" and "End" move the cursor to the start and end of the line respectively.
CONTROL + "Home" and "End" move the cursor to the top and bottom of the screen.
"PgUp" and "PgDn" act as expected. With CONTROL they move to start/end of file.

The action of the editing commands depends on the insert mode which is toggled by pressing the "Insert" key, and indicated by a block rather than line cursor.
"Tab" moves over the text or inserts spaces to the next position (8 columns).
"Del" deletes the character at the cursor and moves the rest of the line left.
"Back" deletes the character to the left of the cursor but otherwise as above.
"Return" inserts a carriage return or just moves cursor to start of next line.
CONTROL+Y deletes the whole line containing the cursor, moving lines below up.

Pressing "Escape" ends an editing session but the cursor position is remembered as an aid to rapid optimisation of a new design. The only exception to this is if an error is found when attempting to analyse a text file, in which case the cursor is left at the erroneous parameter as an indication for your correction.

FILE SAVING GUIDE

Files are normally saved with the file extensions listed below, as only files with the appropriate extension are listed in the "File Load" option directory. If a filename without an extension is entered then one is added automatically, however, filenames with any other extension can be used if entered explicitly.

The "Insert" key may be used to toggle between the insert and overwrite modes.

By default the current filename will be offered, however if this or any new filename entered already exists then the message "Replace Y/N" is displayed. This arrangement allows the user to avoid overwriting a wanted current file:

Pressing the "Y" key will cause the file to be overwritten.

Pressing the "N" key will allow re-entry of the filename.

Change of Directory or File Mask is by a suitable entry in place of a filename: Directory names are entered as for DOS CD, but must end with "\" so they do not look like file names. Simple drive changes should be entered as normal eg "D:". File Masks can use "*" and "?" as usual. Initial Directory will be current one.

FFT.EXE must be in the same directory or in one specified by the "PATH" command (This may be put in your AUTOEXEC.BAT file. See the MS-DOS Manual for details.)

FILE LOADING GUIDE

All filenames in the current directory with the current extension are displayed but this may be changed as described below. Initial extensions as listed below. The current extension is added automatically to filenames entered without one. Any new extension will become the automatic default for the "File Save" option. Alternatively any other text file in the current directory may be loaded simply by entering a full filename. (Remember 100 line / 79 characters per line limit)

The "Insert" key may be used to toggle between the insert and overwrite modes.

If the name of a Waveform file is entered as a parameter, on the command line, when the Fast Fourier Transform program "FFT" is run, then it will be loaded. If the program is run under Windows and the file extension .WAV is associated with FFT.EXE then clicking on a .WAV file will run the program & load the file.

Change of Directory or File Mask is by a suitable entry in place of a filename: Directory names are entered as for DOS CD, but must end with "\" so they do not look like file names. Simple drive changes should be entered as normal eg "D:". File Masks can use "*" and "?" as usual. Initial Directory will be current one.

FFT.EXE must be in the same directory or in one specified by the "PATH" command (This may be put in your AUTOEXEC.BAT file. See the MS-DOS Manual for details.)

WAVEFORM & WINDOW GUIDE

This program Analyses Waveforms and Window functions using standard algebraic expressions. Maximum value expected is ± 1 with limiting enforced at this level. Valid Point range is 0-512, but Point 512 values ignored & copied from Point 0. This makes it easy to fit cyclic functions, eg Sin(X), to the 512 cycle length. Analysed values are added to a precleared array to allow addition of functions. Entries can thus exceed a line length, or "noise" added using the RND function. Formulae must be entered using the built in Editor or another as follows:

0 128 Sin(PI*X/I)

Start Point End Point Value Expression

Parameters may be separated by Spaces, Tabs or One Comma, in any combination. Permitted functions are Sin(x), Cos(x), Tan(x) (radians); Log(x), Ln(x), Exp(x) and Rnd(x), with the latter returning values between $\pm x$. PI is also available.

Formulae may use the predefined variable "I" where I = End Point - Start Point.

Formulae may also use the variable "X" where X=0 at Start Point and X=I at End.

Upper case or Lower case may be used for any of the variable or function names.

Comments may be added in place of, or at the end of a line, pre-fixed by " ' ".

Component Values ($\pm 1E-18$ to $\pm 1E18$) may include standard suffixes as follows:

f/F=1E-15, p/P=1E-12, n/N=1E-9, u/U=1E-6, m=1E-3,
k/K=1E3, M=1E6, g/G=1E9, t/T=1E12

NOTE: Evaluation is strictly Left to Right, ie there is NO Operator Precedence. Brackets are however treated correctly, and can thus ensure correct evaluation.

PASSIVE CIRCUIT GUIDE

This program Analyses Circuits with Resistors, Capacitors & Inductors, as well as Active components modelled as Voltage controlled Voltage or Current sources. Circuit nodes (32 Max.) must be numbered consecutively from 1, Earth 0 or last. Then each component must be entered using either the built in Editor or another with Passive components in the following format:

1	R1	1	2	1M	R	1K	10
Optional] Component	First	Second	Component	[Optional	Parameter	Optional	
Line No.] Type/Ref.	Node	Node	Value	[Parameter	Value	Tolerance	

Parameters may be separated by Spaces, Tabs or One Comma, in any combination.

Passive Component Types are R, L, C. Optional Tolerance Ignored at present.

Optional Parameter/Value = Series/Parallel R for L/C also Ignored at present.

Comments may be added in place of, or at the end of a line, pre-fixed by " ' ".

Component Values ($\pm 1E-18$ to $\pm 1E18$) may include standard suffixes as follows:

f/F=1E-15, p/P=1E-12, n/N=1E-9, u/U=1E-6, m=1E-3,
k/K=1E3, M=1E6, g/G=1E9, t/T=1E12

Units (Ohms, Henries & Farads) must not be used, unless prefixed by the above.

Mutually coupled inductors with one end common may be modelled as a T network, where the arm inductors have values L1-M, L2-M and centre inductor value is M.

A 1:1 100% coupled inverting transformer has L1=L2=L, M=-L. Arms 2L, Centre -L.

Floating inputs can be modelled using a Voltage or Current source (Next Page).

ACTIVE CIRCUIT GUIDE

Active component entry requires two lines of data. The first line specifies the type of model as either the Voltage or Current source, both voltage controlled. The second line must be the normal passive definition of the output resistance. For Voltage sources the resistance is effectively in series with the output but for Current sources it is effectively in parallel:

1	V1	1	2	1000	10
Optional]	Amplifier	Input	Input	Amplifier	[Optional
Line No.]	Type/Ref.	+Node	-Node	Gain	[Gain Tolerance
2	Rout	3	4	10	10
Optional]	Resistor	Output	Output	Output	[Optional
Line No.]	Reference	+Node	-Node	Impedance	[Res. Tolerance

Active Component Types are V or I. Optional Tolerance Ignored at present. For Voltage sources such as Operational Amplifiers the Gain must be put in V/V, but for Current sources such as Transconductance Amplifiers it is given in A/V.

Transistors and FETs should be treated as Current sources. Both invert so have Collector or Drain as Output -Node, and Output +Node connected to Input -Node. Transistor gain=40mA/V * Collector current in mA. FET gains are quoted in mA/V. Transistors need an extra line for input impedance=25*hfe/Collector current mA.

TRANSMISSION LINE GUIDE

Transmission Line entry requires two lines of data. The first line specifies the Input Centre and Shield nodes of the line & its Effective Length in Metres. The second line specifies the Output Centre and Shield nodes and the Impedance. Open or Short circuit Stubs require the same data but Output nodes are ignored.

1	T1	1	2	10	10
Optional]	Line	Input	Input	Effective	[Optional
Line No.]	Type/Ref.	Centre	Shield	Length(M)	[Len. Tolerance
2	T1	3	4	50	10
Optional]	Line	Output	Output	Line	[Optional
Line No.]	Type/Ref.	Centre	Shield	Impedance	[Imp. Tolerance

T = Transmission Line. S = Shorted, O = Open Stub. Optional Tolerance Ignored. Although Stub Output Nodes are ignored they must still be in the range of 0-32. Effective Length (in Metres) equals Physical Length divided by Velocity Factor.

The algorithm used in this program is an improved version, rewritten in Pascal, of that given in the EDN magazine dated Feb 4th 1981, under the title "NET-80". (This algorithm, though vital, now forms less than 10% of the final program!)

CIRCUIT ANALYSIS PARAMETERS GUIDE

Certain natural Default Values are offered:

The Input Node defaults to the First Non-Ground Node and is thus always Node 1.
The Output Node is the Last Node if Ground=0, Next to Last Node if Ground=Last.
Logical numbering of a circuit will make these defaults correct in most cases.

The Up and Down cursor keys operate as expected, except during parameter entry.
"Home" moves the cursor to the top of the screen to the "Accept/Escape" block.
"End" moves the cursor to the bottom of the screen to the "Data Points" block.

During Analysis Parameter Entry the "Escape" key allows editing to be aborted and original values replaced. The "Enter" key is used to confirm a parameter.
Once entry of a parameter has started no other control or editing keys operate.
Parameter Values may be entered using normal suffixes as follows:

f/F=1E-15, p/P=1E-12, n/N=1E-9, u/U=1E-6, m=1E-3,
k/K=1E3, M=1E6, g/G=1E9, t/T=1E12

Units (deciBels, Seconds & Hertz) must not be used unless prefixed by the above.
On Analysis labelled options the "Space" bar is used to view the alternatives.
"Return" will confirm the new choice. "Escape" will leave the choice unchanged.

NOTE: The Editor "Insert" mode is not available on Analysis Parameter entry.

FILTER GUIDE

This program allows simulation of simple ideal filters using standard algebraic expressions. Maximum value expected is ± 1 with limiting enforced at this level.
Valid Point range is 0-256, but Point 256 values ignored & copied from Point 0.
This makes it easy to fit cyclic functions, eg Sin(X), to the 256 cycle length.
Analysed values are added to a precleared array to allow addition of functions.
All filters are linear phase, but future options may allow other possibilities.
Formulae must be entered using the built in Editor or another as follows:

0 128 Sin(PI*X/I)

Start Point End Point Value Expression

Parameters may be separated by Spaces, Tabs or One Comma, in any combination.
Permitted functions are Sin(x), Cos(x), Tan(x) (radians); Log(x), Ln(x), Exp(x) and Rnd(x), with the latter returning values between $\pm x$. PI is also available.

Formulae may use the predefined variable "I" where I = End Point - Start Point.
Formulae may also use the variable "X" where X=0 at Start Point and X=I at End.
Upper case or Lower case may be used for any of the variable or function names.
Comments may be added in place of, or at the end of a line, pre-fixed by " ' ".

Component Values ($\pm 1E-18$ to $\pm 1E18$) may include standard suffixes as follows:

f/F=1E-15, p/P=1E-12, n/N=1E-9, u/U=1E-6, m=1E-3,
k/K=1E3, M=1E6, g/G=1E9, t/T=1E12

NOTE: Evaluation is strictly Left to Right, ie there is NO Operator Precedence.
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