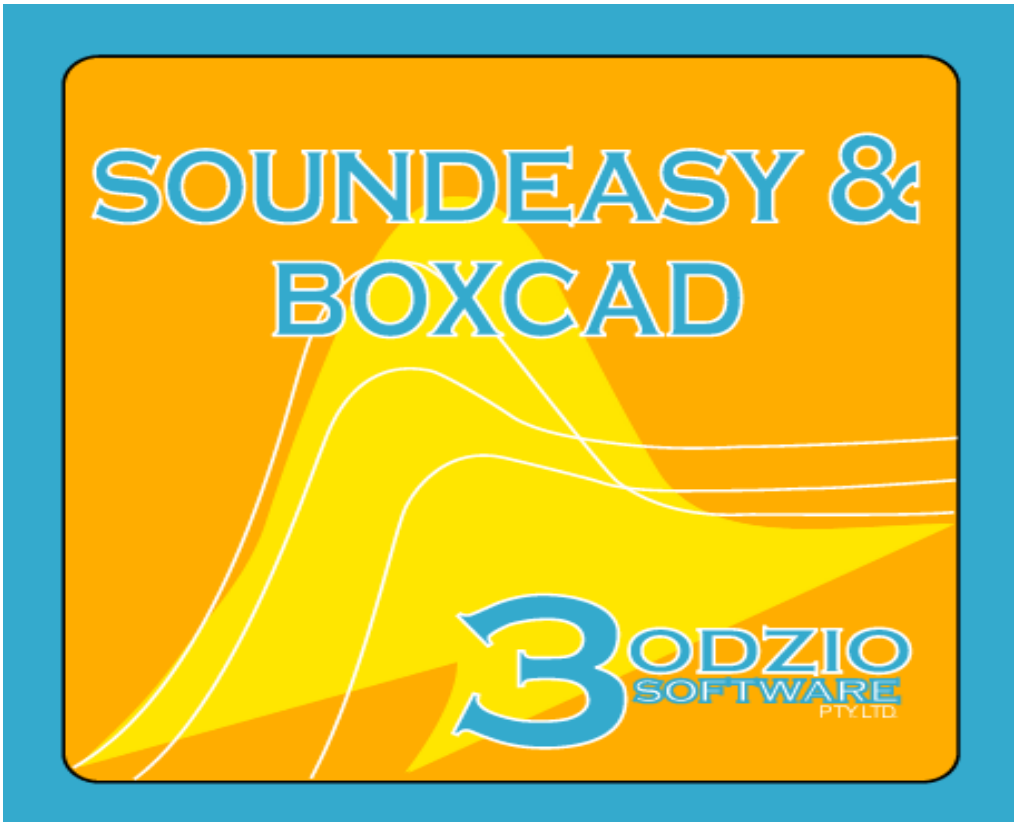


Reference Manual

Version 31.0

Recommended system: Windows 7-11/64-bit

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Part 1

SoundEasy Fundamentals

Chapter 1. Introduction

The theory of the electrodynamic loudspeakers has advanced a great deal over the last four decades. Because of the popularity of multi-driver speaker systems (and their attendant design difficulties) this subject has been the focus of engineering and academic research. As a result, the advantages and limitations of the multi-driver speaker systems (and the various crossover types) have been exhaustively debated and published. Loudspeaker manufacturers, recognising these scientific advances, now provide their products with rather detailed driver specifications. Mathematical models which approximate real drivers and the various types of enclosures have been developed and confirmed in practical applications. **SoundEasy** computer program was developed to consolidate the accumulated knowledge. The resulting computer simulation deals with low, mid and high frequency electrodynamic drivers mounted in a suitable enclosures (one which provides optimum loading for the drivers across the required frequency range). Individual drivers may need to be compensated in time and frequency domains and the selected units eventually mounted in an enclosure to operate as a system. **SoundEasy** offers the designer a set of powerful tools, covering all aspects of system design in one convenient package. Advances in Computational Acoustics enabled us to implement powerful Finite Element Method for the purpose of evaluating room acoustics. We have incorporated two measurement techniques: analog and digital to assist you with data acquisition. **SoundEasy** is aimed at more advanced range of users, but beginners will be surprised how easy it is to evaluate drivers, enclosures and crossovers and produce a working speaker system from them. Professional designers and advanced hobbyists will benefit from the ability to explore the various alternative designs and as a result be able to more quickly choose and optimize both the enclosures and crossovers.

This software release reflects our continual effort to provide you, the User, with a friendly tool and a lot of enjoyment during your design/experimentation effort and is recommended as an upgrade for all **SoundEasy** users.

Program Overview

SoundEasy V31 is our latest release of the Windows7/11 64-bit version of the program. List of Version 31 enhancements over Version 30 is shown below:

1. HBT/IHBT Functionality moved to a separate dialogue box selectable from “EasyLab” menu as “Minimum Phase” option.
2. **HBT Method now includes a high frequency attachment point search** within -7/+7 frequency bins from selected Low-Pass Frequency.
3. Numerical Display Field Summary in the HBT/IHBT Methods retains the data of the last performed Method.
4. Fixed a bug in the “Preferences” Windows.
5. Added “Count Down” counter in the HBT/IHBT Methods to show the algorithmic progress.
6. Bin frequency is displayed in the box title bar, as the mouse is moved within the SPL/Phase display area.
7. Added time display to the “Acoustic Distance” display field in MLS and ESS systems.
8. The Acoustic Distance field now responds to sampling rate selection changes.
9. Time scale in IR display window updates automatically when Sampling Rate is changed in MSL and ESS Measurement Methods.
10. **SoundEasy imports “Balloon Measurements” data file**. All ANSI-CSI-2034 curves are calculated and displayed.
11. The SPL level of imported balloon data can be adjusted from MLS Turntable dialog box.
12. “Balloon Measurement”, the advanced companion program V2, now implements scaled colour map.
13. Decibel scale in Balloon Measurement program has been adjusted to match SoundEasy 50dB dynamic range scale.
14. Added “Zoom” function to the balloon display..
15. Fixed Automatic Exit error inBalloon Measurement program, when dongle is not present.
16. Update User Manual and website.

SoundEasy is a menu driven software, which requires Windows (TM) to be installed on your computer. The program takes advantage of the SVGA graphics capabilities of your computer (min. screen size is 1940x1080 pixels) and enables you, the designer, to create, evaluate and then optimize 2, 3, 4 or 5 way loudspeaker systems **prior** to starting the assembly of the enclosure. Most errors or problems can be intercepted and corrected at a very early stage of the design, without cost penalties!. Greater speed and design accuracy can be achieved when designing the enclosure, filters, and complete crossover.

A **Hilbert-Bode Transform** technique is employed which re-creates complex transfer function from the frequency response of a driver. Using this method, the magnitude and phase response of a driver across the desired frequency range can be obtained. You can now take into account phase errors introduced by the driver or drivers at the crossover point. The data imported from the measurement system may be in error. One of the **sources of data errors** can be the noise level in your measurement system (sound cards). This problem may manifest itself as amplitude errors and particularly **phase errors at lower signal levels**. SoundEasy allows you to add small time delay to somewhat compensate for the measurement system errors. Comparison of the imported phase with no acoustic delay with the phase generated by the built-in Hilbert-Bode Transform will tell you if your measured data is correct. One of the most significant sources of errors in speaker system design is **the loading of the crossover** by the complex input impedance of the driver. (Crossover design can be a formidable task when "ideal" loads are replaced by "real" drivers).

Non-Coherence Distortion analysis is a **dual-channel method of analysis** of non-coherence between the reference signal (stimulus) and the response of the system under test. Interestingly, the NCD method, provides continuous distortion curve versus frequency and can provide single number, as the Total Non-Coherent Distortion figure. Most importantly, the preferred stimulus signal can be noise, music or speech. This is where the NCD method is most useful. **Inverse Hilbert-Bode Transform (**IHBT) requires **asymptotic phase slopes** to be attached to the phase response at selected frequency points. This combined phase response constitutes input data into the IHBT algorithm.

Using the built-in **electronic CAD system,** SoundEasy enables you to model the behavior of the crossover when loaded by the driver in an enclosure and observe the dramatic effect on the frequency response curve of the crossover that the driver may have. A suitable design compensation network can be also created on the same screen and the effect on the crossover re-examined. The program allows you to pin-point problems and test possible solutions so that the frequency response of the crossover is as close to the "ideal" as possible. The effect of the statistical spread (variations within a specific model) of loudspeaker parameters can be quickly evaluated using **parametric family plots**. (This will be of great assistance to loudspeaker manufacturers when setting their quality tolerance levels). In order to provide you with a high degree of flexibility, a **schematic capture** module is provided as one of the SoundEasy tools.

The process supports a 'pick-and-place' technique for creating schematics and is based on **powerful 'Nodal Analysis'** (matrices of complex numbers) techniques, employed by most world-recognized electronic CAD systems. An advanced numerical optimization method called the **'Method of Rotating Coordinates'** is used throughout the program to optimize the enclosure parameters, the individual filters and the complete crossover. The Method of Rotating Coordinates was selected for its speed and accuracy. **Box, crossover** and **system** response to a rectangular pulse can be evaluated in **time domain** and correlated with its frequency response. SoundEasy offers here several tools such as DSP techniques (1024 point **FFT & IFFT**), Lattice Network Calculator, and Network Analysis in Time using Runge-Kutta methods.

The final consideration (prior to the commencement of listening tests) is usually the question of enclosure positioning within your listening environment. This problem can be very complex if all the influencing factors are considered. SoundEasy offers a solid, engineering approach to improve the overall sound quality of the system **in the testing position** using **Ray Summation, Image Summation** and most importantly**, the accurate FEM** methods (see Chapter 15). Current SoundEasy release allows you to actually plot “room contribution” effect vs. frequency for any position of two subwoofers in a **non-rectangular room**. When a high power is applied to the driver for a prolonged period of time, the voice coil heats-up and the performance of the driver deteriorates. **Enclosure Modes are also calculated using the FEM**.

The effects of the **voice coil temperature** on the frequency response of the high power drivers can be evaluated at all power levels. Also, the temperature of the magnetic structure can be calculated if the thermal resistances of the driver are known. Detailed analysis can now be performed on all eleven types of enclosures for any power level between 1mW to 1000W. Current version of the program incorporates **Large-Signal Analysis** based on BL(x) and Cas(x) non-linearities. Both parameters are approximated as a set of curves, which can be edited for the best fit with a known parameters of the driver. A **Total Harmonic Distortion** (THD) estimator is also built-in. To top it all, **port non-linearities** are also simulated. A complete **off-axis analysis** can be performed in the program and horizontal and vertical SPL plots are available. **Titling drivers** is available and this will come very handy when attempting to design an enclosure with the **front baffle of a complex shape**.

Digital Equalizer provided with the CAD section of the program is capable of "non-minimum phase" equalization of the loudspeaker system, and therefore, correcting amplitude and time domain delays of 5-way loudspeaker system. An extension of this concept is equalization of the "speaker-to-ear" room transfer function – the **Digital Room Equalizer (DRE).** The DRE is a "minimum-phase" equalizer, which in addition, includes a delay function as well. This new feature has been implemented to allow you to "deconvolve" or "equalize" areas of your listening room. The issue of room equalization has been described in many publications, and seven of them are listed below to start your creative thinking process flowing.

SoundEasy also incorporates a measurement system – **EasyLab**. The system has been designed and optimised for analogue and digital loudspeaker and room acoustics measurements. Two measurement systems: **MLS and ESS measurement systems** have been incorporated with **Cepstral Deconvolution and Matching Filter technique. STFT Spectrograms**, **Wavelet Analysis** are implemented and Non-Coherence Distortion analysis is the latest addition to EasyLab.

ANSI-CTA-2034 automated measurement system, capable of controlling a turntable, is now built-in.

General Program Specifications.
Environment.....…: Windows 7/64-bit.
User interface.....: Mouse, Keyboard, Windows.
Program control.....: Mouse, Menus, Buttons.
Hard copy.....: Graphics Printer, e.g.: LaserJet 5L.
Screen output.....: 1980x1080 pixels min, 256 colours
Processor.....: i7-960, 2.8GHz or better is recommended.
RAM.....: 1Gb Mb **MINIMUM REQUIRED for SoundEasy**.
Hard Disk required.....: 40.0 Mb min.

Short Summary of the Main Software functions performed

1. Loudspeaker driver reference library creation.
The program will accept the electro-mechanical (including acoustical center offset) and frequency response parameters of each driver. These parameters can be saved to disk for later editing. Frequency response is entered as SPL (1 meter, 1 watt) for 750 discrete frequencies, separately selected for woofer, upper base, midrange, tweeter and super tweeter. Complex transfer function of each driver is then re-created by the user. Program facilitates importing frequency response and impedance data and manual editing of the imported files. Two **accurate impedance models** are provided.

2. Loudspeaker enclosure design.
The function is implemented by means of entering vital parameters of the enclosure: volume, Q-factor, tuning frequency or TL line length and so on. The software will then plot the frequency response, relative cone excursion, the system (driver + enclosure) impedance for a specified driver, system phase response and group delay (and more curves in total, depending on the enclosure type).

Sealed, vented, double-chamber and triple-chamber, sealed-vented, vented-vented, passive radiator, transmission line, horn enclosures, vented/TL subwoofers, U-Diploes and H-Dipoles (total of 13 enclosures) are supported (both sealed and vented enclosure design functions are provided for midrange and upper bass drivers). Parametric family curves can be obtained by incrementing (within a predetermined range) one of the enclosure parameters. This automatic process will plot the changes in frequency response, cone excursion and system impedance. Isobaric extension is available for sub-woofer system. 'Multiple drivers' variations are also modeled. **BL(x) , Cas(x) , temperature and port non-linearity** and compression modeling are included. You can also print **detailed dimensions of a rectangular enclosure** with bracing and all parasitic elements inside the box accounted for.

3. Loudspeaker enclosure optimization.
This advanced feature also takes advantage of the "Method of Rotating Coordinates". All three enclosure parameters: Fp, Ob and Vb are optimized at the same time as the program attempts to obtain the "optimally flat" alignment for a given loudspeaker. Sealed, vented and band-pass type 2 enclosures can be optimized for the bass driver, upper bass and the midrange driver. Several reference alignments are provided.

4. Compensation of the driver impedance, amplitude peaks or time delays.
This function enables you to :
- Cancel voice coil inductance
- Compensate for the upper bass/midrange/tweeter/super tweeter resonant impedance peak.
- Reduce amplitude irregularities.
- Adjust sensitivities of the higher frequency drivers.
- Insert a time delay network, such as Lattice Network to offset the acoustic center of the driver.

Driver compensation can result in an improvement in the performance of the crossover. The resulting amplitude/phase/impedance/group delay plots are available for all three drivers. Full examination can allow the designer to model the behavior of the designed network. L-type attenuation pads and the interaction of the woofer and midrange drivers with their enclosures can also be evaluated. Active components (OPAMPS) are provided.

5. Crossover filter design.
SoundEasy provides you with a full electronic **CAD GUI for the schematic capture** process. This allows you to design ANY type of circuit or crossover (parallel, series, cascaded and so on…).

There are also several types of circuits and many types of pre-built crossover filters provided**: Bullock, Butterworth, All-Pass, Linkwitz-Riley and Bessel** filters. You can also select four rates of rollover for low-pass, high-pass and band-pass configurations. Amplitude/phase/impedance/group delay plots are available to enable full evaluation of the design. Bullock coefficients for all filter orders are dynamically calculated. As a result, the effect of the crossover on the real driver frequency response can be readily observed. Active filters (OPAMPS) are also provided. The **Add Network function** allows you to quickly put together complex, uneven order crossovers.

The program also includes extensive support for **Transient-Perfect** crossovers and **Digital Equalizer and Filtering** option. The processing power of the CAD system is enhanced by Super-Components and Mega-Components. Finally**, Cut-and-Paste** method combined with the ability to have 3 Projects opened at the same time, allows you to create extremely complex crossover systems. In the concept of Modular Crossover, the filters are defined in terms of cut-off frequencies and slopes. There is also an array of shaping circuitry available. SoundEasy now includes 18 CAD processing functions:

1. **Draw** – For "pick-and-place" components and drawing connections
2. **Erase** – For erasing single connection or component
3. **Overlap** – Changing components without disconnecting or moving them
4. **Undo / Redo -** For "undoing" the last 4 steps, and cancelling the last Undo operation
5. **Wipe** – For disconnecting and erasing the component
6. **Wipe Wire** – For erasing wires
7. **Move** – For disconnecting and moving component around
8. **Group** – For grouping components
9. **Add** – For adding a complete, pre-calculated filter or even a complete crossover to your schematic
10. **Cut** – For cutting a section of the schematic

11. **Cut To Hard Disk** – For cutting a section of the schematic and saving it to HD
12. **Copy** – For duplicating a section of the schematic
13. **Copy To Hrd Disk** – For duplicating a section of the schematic and saving it to HD
14. **Paste** – For pasting the Cut section
15. **Paste From Hard Disk** – For pasting the Cut section from HD.
16. **Cad Nodes** – For switching ON/OFF dots (nodes) on CAD area.
17. **Schematic Nodes** – For switching ON/OFF node numbering on CAD area.
18. In addition, there are over 100 **in-built filters and crossovers** to choose from.

6. Crossover filter optimization.
The optimization process takes into account the driver's complex transfer function, the effect of the enclosure, the input impedance and the compensation network characteristics. As a result of the optimization, alternative low-pass, high-pass or band-pass filter components are calculated. This feature employs the Rotating Coordinates Method and can optimize complete crossover. Target curves can be extensively modified by tilting, stepping, and **adding ripples**.

7. System frequency response evaluation.
This feature enables you to plot the combined frequency response of the complete speaker system taking into account all driver, crossover and enclosure related parameters. SPL amplitude plots are provided, together with number of impedance/phase and delay plots. As well phase reversal effects for all drivers can be observed.

8. System frequency response optimization.
A number of approaches can be tried using this tool. The filter components of any driver can be optimized over a selected frequency range in order to obtain the flattest possible system response. Alternatively, the target frequency response can be heavily distorted, thanks to the **new "Add Ripples" feature**. Once again, the Method of Rotating Coordinates is used in this tool. Optimization can be performed for SPL, phase and Zin constraints.

9. Frequency response of the system "in-room".
The effects of placing the enclosure in the corner of a room on the frequency response can be estimated with this feature. Another screen allows for frequency response evaluation within 10-200Hz in a fully enclosed room of ANY shape.

10. Calculators.
L-pad calculator, Series LRC calculator, Zobel Network calculator, Impedance peak suppressor, Lattice Network Calculator, Vent Calculator, Rectangular Enclosure Details and Enclosure Shapes calculators.

11. Large-Signal analysis.
The program accepts thermal resistances of the driver's voice coil and magnetic structure and enables you to examine all modeling curves and structure temperatures at all input power levels from 1mW to 1000W. Power compression" effect can be clearly observed on the frequency response and all other plots. In addition, **port non-linearities** and non-linearities of the suspension system can be modeled and editing of **BL(x) and Cas(x)** curves is provided. Finally, **Total Harmonic Distortion (THD)** of the driver+enclosure can be estimated over 5Hz-2kHZ frequency range of interest.

12. Polar and "Straight Line" vertical and horizontal plots.
Horizontal, vertical and tilted location of the drivers on the front baffle can be varied and the interaction of the complete system examined at any frequency. This is particularly important at the crossover points. There are three dialogue boxes the implement calculators and plotting functions for "off-axis" response.

13. Time domain responses.
Enclosure response to a rectangular wave can be observed in time domain. This enables the designer to determine the amount of tolerable "ringing" generated by some specific alignments. This analysis is available for all seven enclosure types. Frequency of the rectangular wave can be adjusted between 1 and 500 Hz and FFT and IFFT techniques are employed. Finally, crossover response to a rectangular function can also be observed in time domain. This useful feature enables you to determine if the crossover is of the "constant voltage" type. This feature operates just like a "digital storage oscilloscope" and allows the designer to add up to 5 curves in time domain. Two methods are implemented: (1**)** **FFT Technique** and (2) **Modified Nodal Method** in Time Domain.

14. Importing data.
SoundEasy allows you to import amplitude/phase and impedance/phase from three measurement systems: (1) IMP, (2) LMS, (3) CLIO, (4) LAUD, (5) MLSSA and (6) DAAS32 . Some associated processing functions are also included, so that the imported data can be validated over 10Hz-40kHz frequency range. Small/Thiele parameters can also be imported from CLIO and DAAS32 systems.

15. Low-frequency room analysis.
The low-frequency analysis is performed using the FEM method. The FEM is now capable of analysing objects having irregular vertical shape such as arches and pyramids. 2D and 3D FEM screens are implemented.

16. Subwoofer design.
Active Equalization function is provided in the "Box" module. You can design the passive/active EQ circuit using "Crossover" module and then use the combined (box+EQ) frequency response optimize the subwoofer design and check it under Large-Signal conditions.

17. Enclosure Diffraction Analysis.
This feature allows the user to mount up to 4 drivers (quad-box) on the front panel and analyze resulting diffraction and mutual impedance effects. Diffraction distortion are best analyzed in an anechoic chamber, where the driver radiates into a full space.

18. Implemented Two Small-Signal Measurement Systems.
18.1 Measures SPL and Impedance
18.2 Impulse and Step responses
18.3 Two types of Waterfall analysis
18.4 Small/Thiele parameters
18.5 Enclosure stuffing Qb
18.6 Oscilloscope
18.7 Spectrum Analyser
Requires full duplex, 16/24-bit, stereo sound card.

19. Implemented Non-Linear Measurement / Modeller
19.1 Volterra Series Expansion Method Measurement System
19.2 Non-linear Differential equations Method Measurement System
19.3 Non-linear Differential equations Method Modeller

20. Implemented RLC Meter

21. Room Acoustics – RT60 measurements

22. Total Harmonic Distortion and **Intermodulation Distortion** measurement.

23. 6 Advanced DSP functions such as: Digital CAD Filter, Digital CAD Equalizer, Room Equalizer, Bass Synthesizer, Phase Equalisers, Phase/Amplitude Equalizers.

25. Cepstral deconvolution and Matching Filter Technique
Assist in removing room reflections from MLS measurements.

The above list is only intended to highlight many of the built-in features of SoundEasy. There is more to be found in the program, while you learn its true potential and flexibility. We suggest, you may want to start with Chapter 18 – which provides you with an overall direction and a “top level” set of hints to manage the program and your design process. Hopefully, you will find the manual informative enough to describe all functions incorporated in the program. We have also strived to provide you with numerous, easy to follow examples, that may provide an additional degree of confidence in your design activities with SoundEasy. Finally, four fully edited data files (3 driver files and one project file) have been provided with the program, so you can start using the program simply by loading any of the files and immediately exploring SoundEasy processing power.

Installation.

1. SoundEasy is distributed on CD-ROM for Windows7/64 as an executable code, without installation program. Manual installation would simply require you to create a directory, say, “SE” in the ProgramFiles on your C: drive, then copy all files from the CD-ROM and finally create “desktop icon” for the SoundEasy.exe code – as simple as this.

2. When run first time, the program will creat Preferences file, where the information about the size and location of windows and dialogue boxes is stored. You will need to adjust the sizes are your require.

3. For dongle driver installation please see "Dongle_Driver_Readme.txt" file.

4. User Manual may be update from time to time by Bodzio Software. For the latest version, please visit www.bodziosoftware.com.au

5. When finished with the software installation, **connect the Security Key - see page 18.8. SoundEasy ships with the standard Security Key driver for WinXP. For other systems, we have also included a dongle driver installation program that automatically detects your operating system and installs appropriate driver. The program is called “InstDrv.exe”. You can run it from your CD-ROM and all you need to do is to follow a couple of simple steps.**

6. For the latest Rockey4 drivers please visit http://www.ftsafe.com/download/rockey4.html

7. SoundEasy and BoxCad Manuals do not have icons created during installation process. Both manuals reside on the CD-ROM as “Adobe Acrobat PDF” files.

Screens As The Processing Tools

The operation of SoundEasy resembles a chain of "production line" activities. The raw driver data, entered at the beginning of the design process is being manipulated, processed and expanded by the rest of the modules. Each module operates on the data provided by the previous module. See Fig 1.1 for the path of data flow.

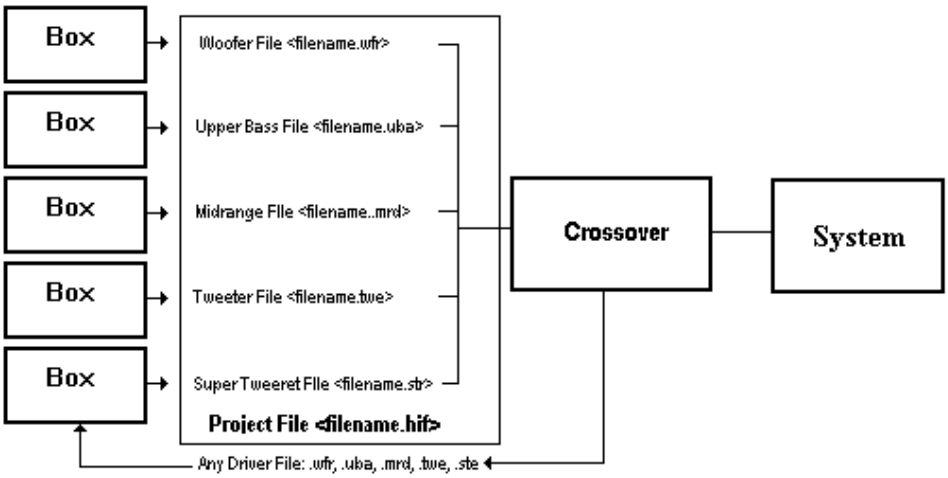


Figure 1.1 Information and data flow within SoundEasy

Data flow is sequential. This process does not allow you to jump a module. For example, you cannot use the summation screen to process data provided by the 'Box' module. The “Crossover” and summation screens requires up to 5 files to be loaded at the same time. To speed up the process, a Project File is being used, where paths and file names can be stored for automatic loading. Passive or active circuits can be created using Crossover Screen and then loaded back into the Box Screen to be included in the modeling of the enclosure frequency response (EQ circuit for subwoofer design). The description of the modules as tools is deliberate. It is essential to the successful use of this program that each module is seen as a tool which the designer uses to work on the available data and arrive at desired results. More exact block diagram of module operation is provided in the following sections of this manual.

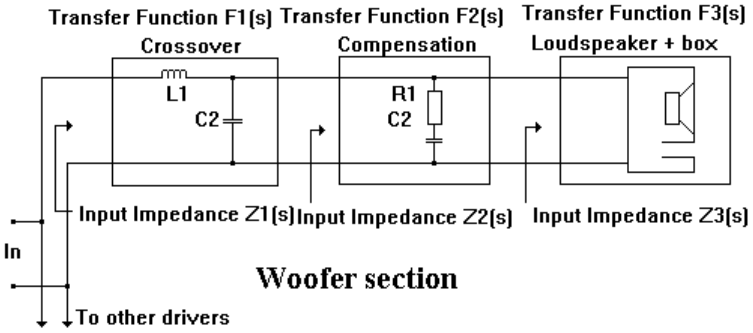


Figure 1.2 Transfer Function example.

In the above example, 'Box' module were used to (1) synthesize driver's input impedance while mounted in the selected box - $Z_3(s)$ and (2) generate transfer function of the driver mounted in the box - $F_3(s)$. $Z_3(s)$ becomes the load impedance for the compensation circuit - that is, if you use loudspeaker symbol in the compensation network developed using 'Crossover' module. Also, total transfer function is now $F_3(s)*F_2(s)$. Finally, $Z_2(s)$ becomes the load impedance for the crossover network, again, if the loudspeaker symbol was used in the crossover network. The total transfer function now equates to $F_3(s)*F_2(s)*F_1(s)$. Input impedance of the woofer section is $Z_1(s)$, $s = j\omega$.

Printing Session Results

All images of the program's windows within this manual have been developed using the program's graphics capabilities. Printing session results is achieved by selecting the "Print" option from the window's menu. This selection opens SoundEasy printer dialog box (Fig 1.3) and the user may select orientation of the printout, scaling factor and location of the printout. Some users may give preference to smaller or half-size print-outs. The final dimensions of the print are a combination of the scaling factors entered and the resolution of the printer used. It is therefore recommended to perform a test print-out for the current printer settings and if the results are satisfactory, use the same scaling factor consistently throughout the program. All options selected from the printer dialog box will be saved to the driver's data file. Orientation (Portrait or Landscape) selected from the SoundEasy printer dialogue box must be the same as the one entered in the Standard printer control dialogue box. This is required to avoid graphics being stretched vertically over the whole page by the Standard printer control dialogue box. The "Offset X" and "Offset Y" parameters can be used to move the location of the graph on the printed page independently in X and Y direction. Finally, a small window which appears on the screen and informs the user of the progress of the banded or non-banded print-out.

Printing capabilities of the program were developed for commonly supported printer drivers and tested on number of printers and emulators. If your printer is not operating properly, further customization may be needed, as it is likely, that your printer driver file is supporting only limited functionality or it can not be invoked from within the application program. Also, in case of difficulties, we recommend to experiment with your printer DPI settings and start with low DPI: 75, 150 and then 300. Reduce size of the printout (30%, 50% 80% and 100%) and landscape or portrait orientation.

Please consult Windows™ manual for screen settings. Low DPI and smaller printout size will work better on lower memory hardware. Finally, please review your printer's manual and make sure, that your printer is set optimally for complex graphics printouts. For example: HP LaserJet 5L with standard 1Mb memory needs to be set to Manual/Raster/300dpi setting for optimum screen dumps. All graphics screens presented in this manual were printed on DeskJet1220C

Saving a New Driver

It is recommended that you save intermediate data 3-4 times per design session. To save data select the "Save Driver File" option from the windows menu.

Loading Data File

Loading woofer data file is achieved by using the corresponding menu option. Other driver types follow the same procedure. Once the "Open Driver File" option is activated, user may select the whole path, including drive, directory, sub-directories and finally the name of the file. The dialogue box is a standard WinXP™ box.

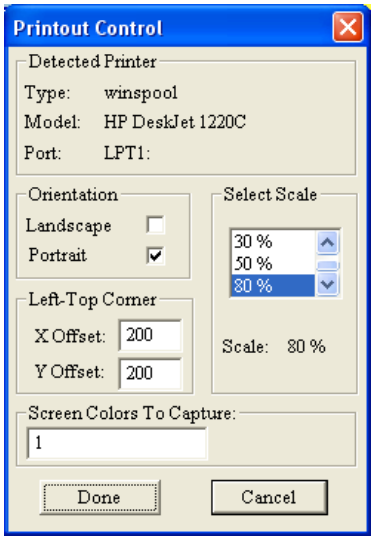


Figure 1.3 “Print” dialogue box

File Compatibility

SoundEasy V21.00 data files are in a new format. However, files created with versions 18, 19 and 20 can be imported into the program. There are new test files included on the CD-ROM:

1. Woofer test files: **Test_21_W7_1.wfr** and **Test_21_W7_2.wfr**
2. Tweeter test files: **Test_21_W7_1.twe** and **Test_21_W7_2.twe**
3. Test file for non-linear Method II: **Test_21_W7_1_Non_Linear.wfr**
4. Project test files**:** **Test_21_W7_System_Crossover_Rotations_1.hif** and **Test_21_W7_2.hif**

Preferences Screen

The preference screen is divided into several blocks of common data.

1. **Frequency Range.**

Before beginning to use the SoundEasy you should decide on what preferences setting you intend to use. SoundEasy is unique in that storage of SPL and impedance data in driver files is associated with specific preference settings for the system and box frequency range. Project files are also associated with a specific system frequency range and any drivers loaded into a project must be associated with the same system frequency range as the project. Additionally, when generating and saving a mic calibration file, the calibration data saved is also associated with the system frequency range. For this reason, it is suggested that when first starting to use SoundEasy you make a decision on what system and box frequency range you wish to use and set these once and then user them for all modeling. Once this decision is made, changing the system or box frequency range can be performed but drivers and system files will not display the correct SPL or impedance data until the frequency range preferences are reset to those which were in place when the driver or project file was saved. If you must change the system frequency range and want to have the SPL and impedance data displayed correctly with this new setting consult main manual regarding exporting and re-importing this data.

Since it would be difficult for the user to remember the correct settings for all saved driver files, when a driver or project file is opened SoundEasy will warn and **based on user selection, will** change the preferences to those in place when a file was saved. In addition to the frequency range preferences there are a number of other preference settings which are less important in that they are not related to how data is saved.

There are three options available: System, FEM and Box. The System option sets the lower and upper frequency limits for all screens with the exception of enclosure design screen. The limits are selected from the provided list boxes and the selected options are saved to driver's data file. We suggest, that you select the most preferred frequency range option and use it consistently within the program. **Please pay particular attention to the fact, that importing SPL and Zin data will be arranged depending on the screen frequency range. This has the consequences, that if you import the measurements for one frequency range and then switch the program to another frequency range, the imported SPL/Zin data becomes invalid.**

2. Colour Scheme.
Several options for choosing colour scheme for plotting curves is also provided. Adjusting colour is as easy as sliding the "Red", "Green" and "Blue" sliders. Pen colours are also editable from the main menu option.

3. **Audio Devices**.
This section allows you to disable mixer device control by SoundEasy and also invert left and right channels. Also, the **preferred audio devices for input and output can be selected from this screen**.

There are also a check boxes available for setting the whole program to 16-bit or 24-bit sound card operation. Typically, you would make the selection when you install your sound card. It is essential, that you read Chapter 18, pages 18-27 for detailed information related to PC and sound cards.

4. Environment.
There is only one field available for entering the speed of sound you wish to be used for the analogue and digital measurement screens.

5. Non-Linear Screen.

There are several list boxes to select the frequency range of the screen, scaling of the THD vertical axis and two check boxes for enabling F4 and F5 display and finally, enabling the THD plots.

All settings of the “Preferences” screen are saved into the preferences file. This file is stored in the same directory as the main executable code and is automatically loaded when the SoundEasy is invoked. The preferences are saved automatically on exit as well.

6. MLS System.

You can opt to use SPL/Phase calculated in MLS system directly as the driver transfer function. This way you’ll by-pass HBT calculations – see Figure 1.4

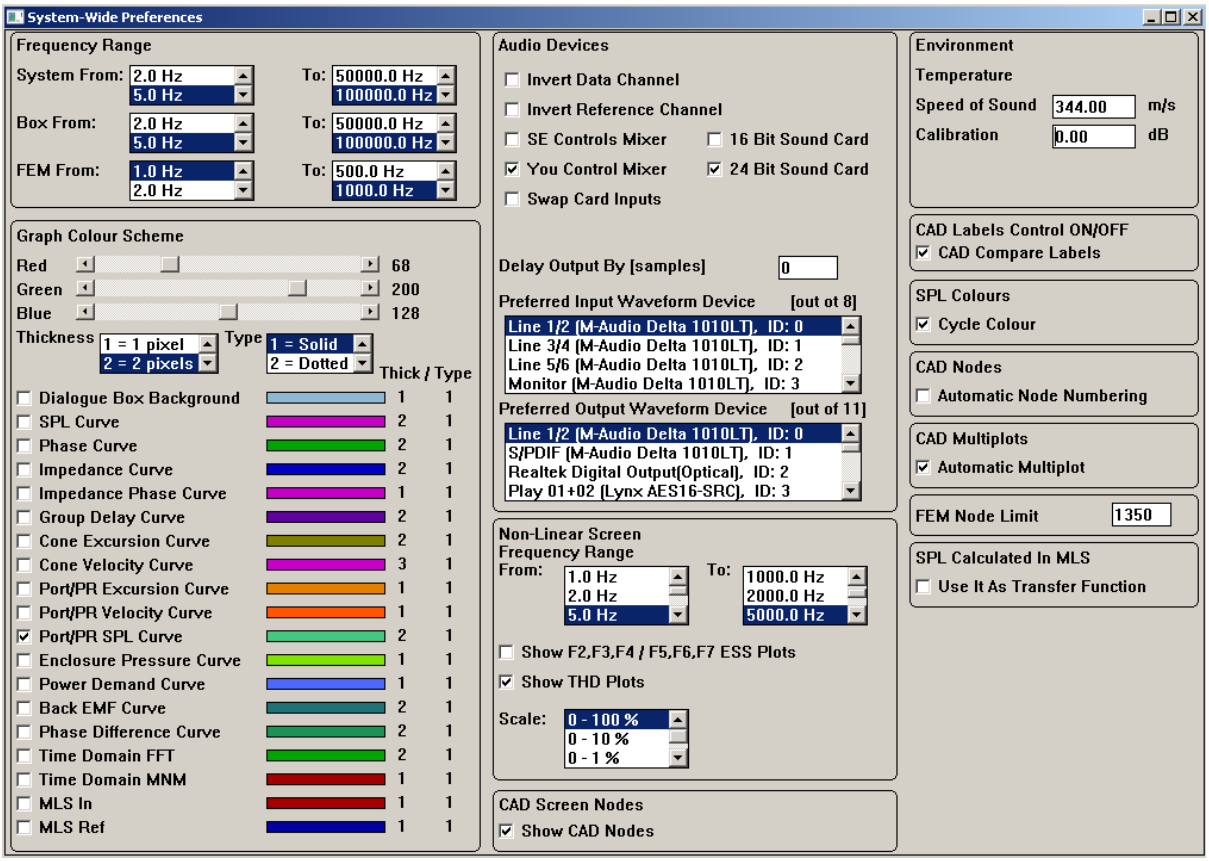


Fig. 1.4 Example of Preferences screen settings

User Interface Customization

The GUI of the program has been designed around standard Windows™ control-display techniques of using dialogue boxes to enter and control of the processing of the data and then using re-sizable windows to display the results. Typical control box is movable and has fixed size, and all plotting windows are re-sizable and movable. SoundEasy "remembers" the last location of the dialogue boxes and the size and location of the plotting windows, so perhaps the first step into the GUI should be the "customization" – meaning, moving around and adjusting the size of SoundEasy screens and dialogue boxes, depending on your PC screen size and resolution.

Minimum recommended screen size is: 1024x768 pixels. You can also use larger sizes: 1280x1024, 1600x1200pixels and so on.

As you may noticed already, the program is divided into several areas of functionality. For instance, when you concentrate on editing of the driver, it is unlikely, that you will need EasyLab screens opened at the same time. Therefore, SoundEasy automatically closes the EasyLab section when you work with the driver, enclosure, CAD or System sections of the program. This approach is applied consistently throughout the program and all unnecessary screens, that do not belong to the current activity are closed. However, be prepared, that many times, you will be working with 3 or 4 screens/control boxes opened at the same time.

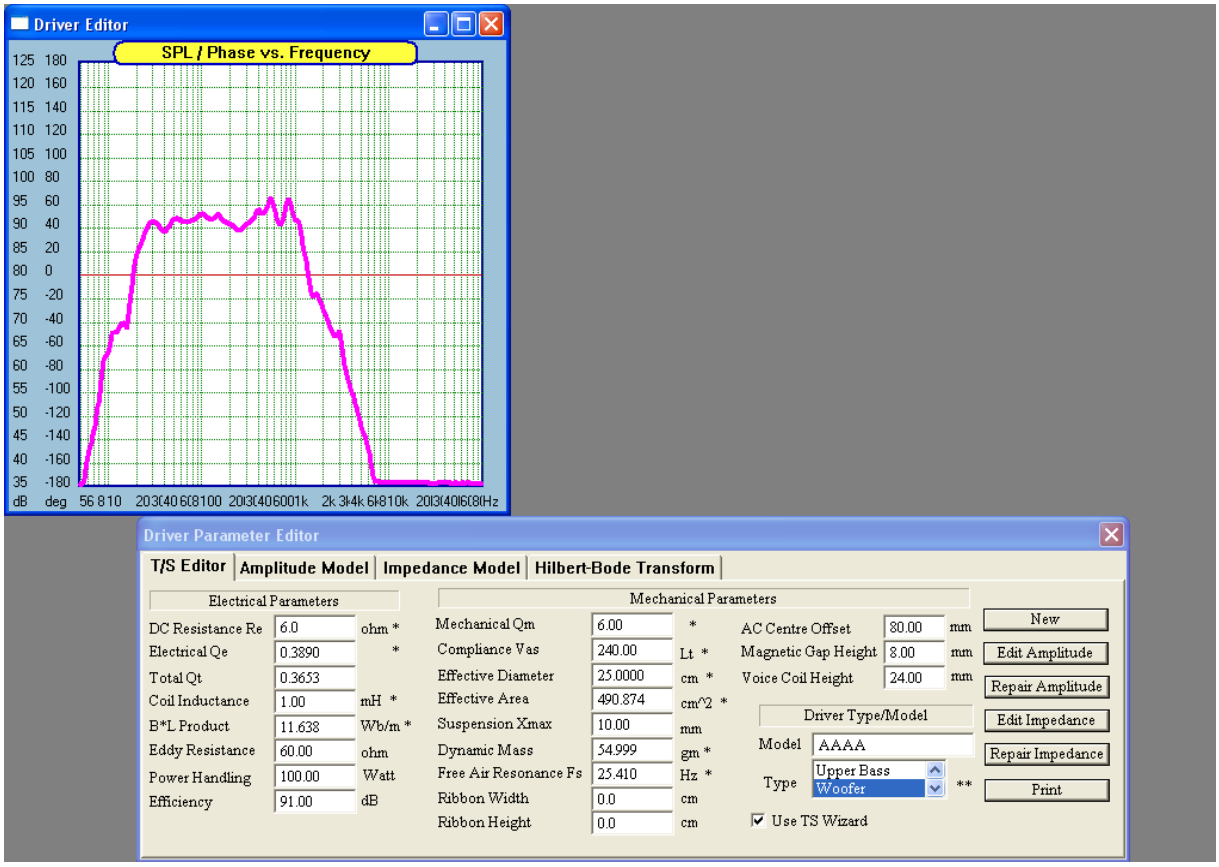


Fig 1.5. Plotting window reduced in size

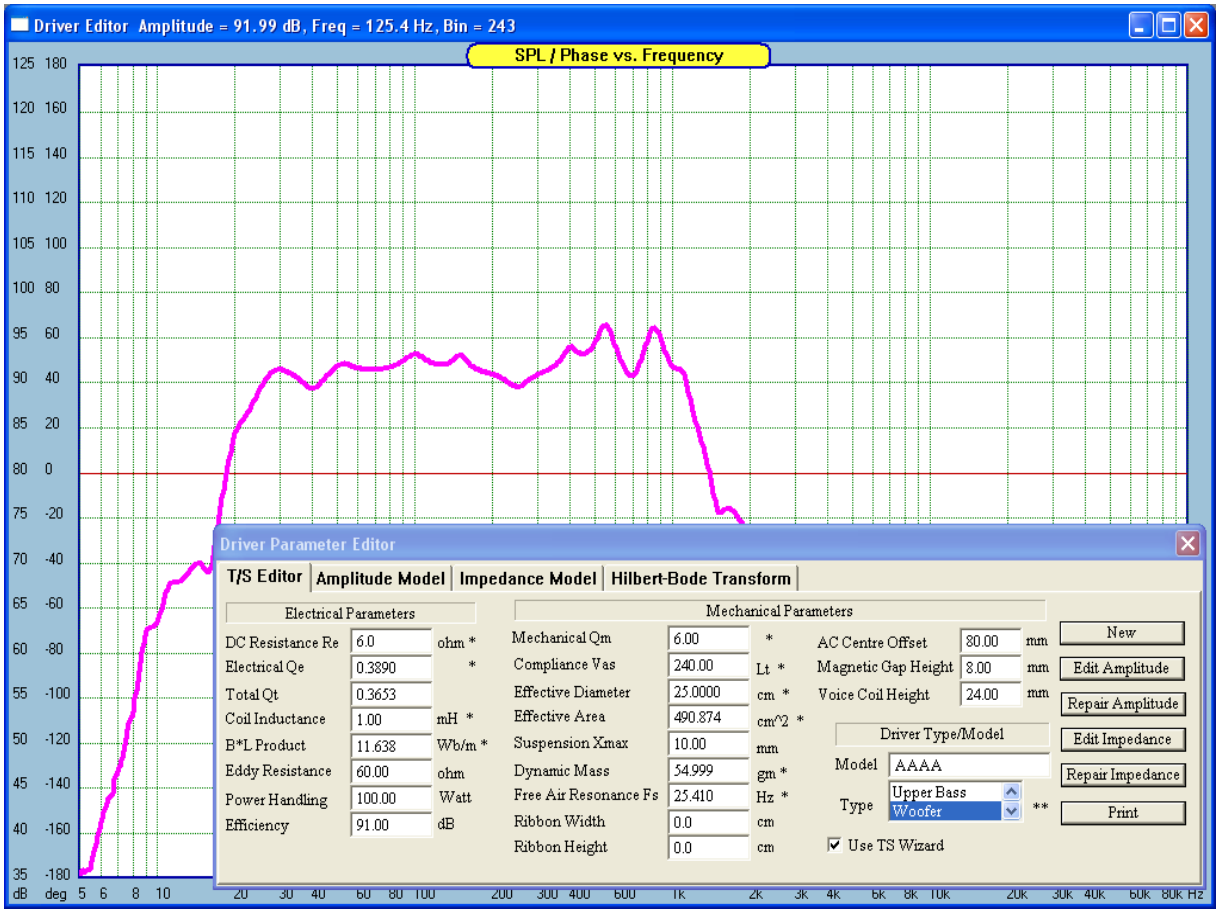


Fig 1.6 Plotting window maximized.

You can customize the look-and-feel of the GUI.

Please follow the main menu of the program and open menu items (screens) as you are moving from left-to-right along the menu. When you start the program for the first time, all windows will be opened with their respective default size and locations. Please feel free to make the necessary adjustments to suit your taste and your monitor. Next time you return to this screen, it will be opened in the same location and same size.

MLS Measurement Screen & Editor Screen

In some instances, it may be beneficial to have uninterrupted access to Editor screen while you make measurements. This would allow you to setup measurement system once, perform an SPL or Zin measurement, save the driver file, open a new driver file obtain measurements for the new driver and save them an so on….

If you need to be working in this mode, please open the measurement screen first and then Driver Editor screen second. Both functions will stay opened now as shown for example on Fig 1.7.

Driver & Project Notes

It is often desirable to remember some unusual details about this particular driver file or a project file. Those details can now be conveniently entered into the **Notes Windows**. There are two Notes Windows: one associated with Driver File and one associated with Project File. Both Windows can store 1024 characters each.

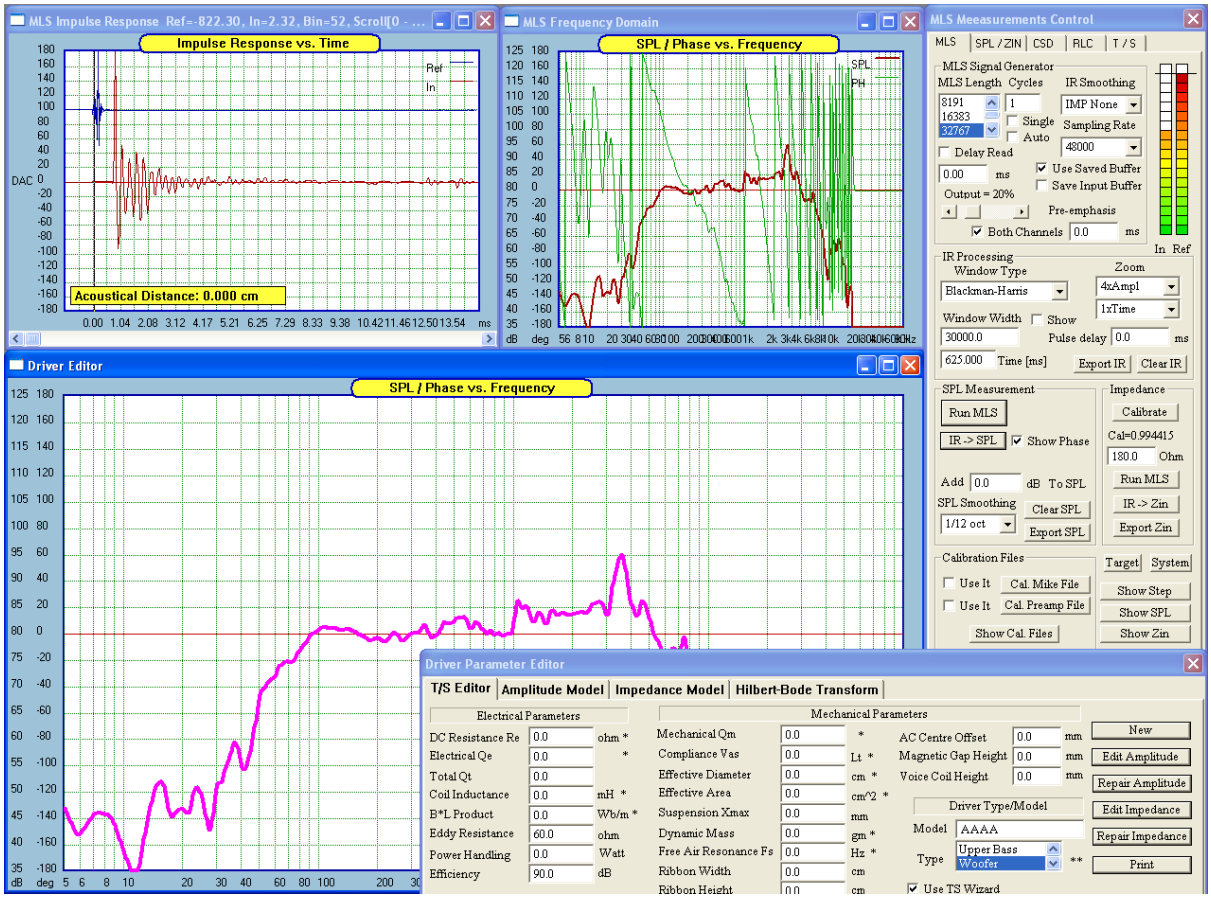


Fig 1.7. MLS Measurement screen opened with Driver Editor screen.

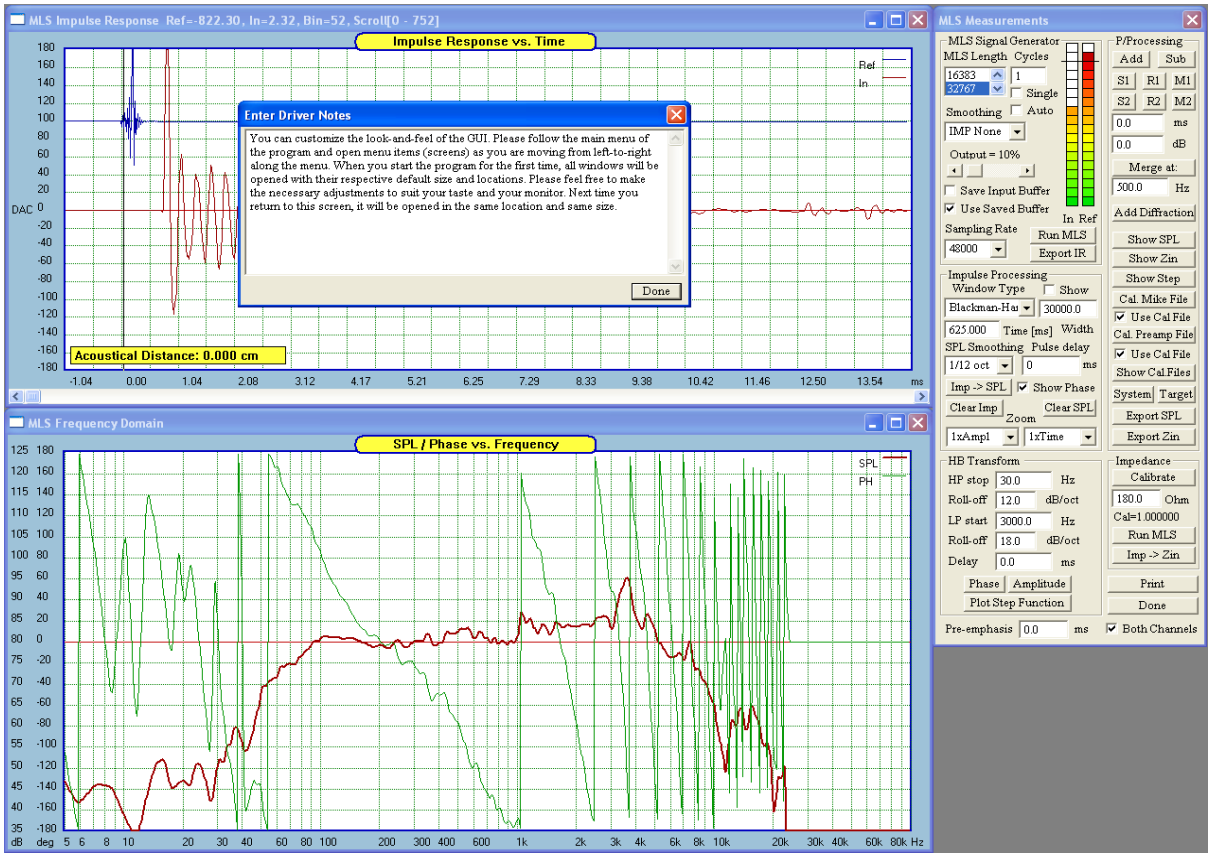


Fig 1.8. Driver Notes window.

Printing Driver and Project Data

Apart from straightforward screen dump, there are three printing options for hard copy output.

1. Print Driver – Selecting this option prints ALL parameters listed on Figure 1.9a,b, SPL/Phase curves and Zin/Phase curves. You may expect 2 pages of printouts.

2. Print Project Drivers - Selecting this option prints ALL parameters listed on Figure 1.9a,b, SPL/Phase curves and Zin/Phase curves for ALL 5 drivers. You may expect 10 pages of printouts.

3. Print CAD + Parts List – Selecting this option prints CAD schematic compressed to a single A4 page and complete parts list. You may expect the CAD schematic to be rather small. However, this is expected to providing printing capabilities for all home-type of printers with A4 capabilities.

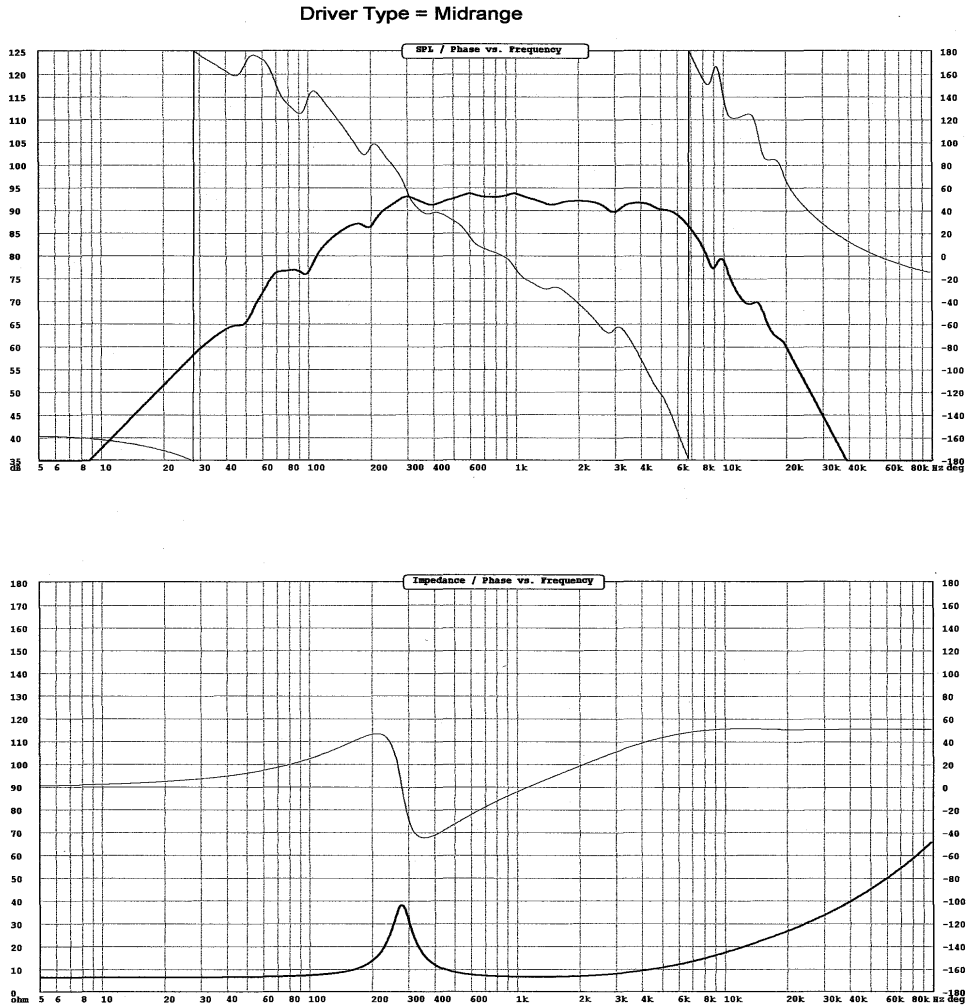


Figure 1.9a. SPL and Zin printout examples.

Driver T/S Parameters

DC Resistance = 5.80 ohm
Electrical Qe = 0.5405
Mechanical Qm = 5.46
Total Qt = 0.4918
VC Inductance = 0.31 mH
Force Factor = 5.000 N/A
Eddy Resistance = 39.00 ohm
Compliance Volume = 1.3 Lt
Nominal Power = 90.00 W
Efficiency 1W/1m = 92.50 dB
Piston Area = 50.265 cm^2
Effective Diameter = 8.0000 cm
Max Linear Excursion = 2.50 mm
Dynamic Mass = 2.000 gm
Free Air Resonance = 185.395 Hz
Dynamic Mass = 2.000 gm
Accoustical Offset = 30.00 mm
Magnetic Gap = 2.00 mm
Voice Coil Height = 5.00 mm
Thermal resistance VC-Magnet = 1.00 ohm
Thermal resistance Magnet-Air = 0.280 ohm
Thermal resistance Total = 1.28000 ohm
VC Thermal Coefficient = 0.00393 mm
Magnet Type = Alnico 5
Z min = 8.00 ohm
Driver Type = Midrange
Driver Model = AAA-85

Driver Volterra Parameters

Nonlinear_BL0 = 4.9
Nonlinear_b1 = 82.0
Nonlinear_b2 = -20000.0
Nonlinear_K0 = 28.8
Nonlinear_k1 = -6067.0
Nonlinear_k2 = 9000000.0
Nonlinear_Le0 = 0.0015
Nonlinear_l1 = 0.0873
Nonlinear_l2 = 10.0
Nonlinear_Rm = 2.6
Nonlinear_m = 0.014
Nonlinear_Eg = 17.0

Non-Linear Diff-EQ Parameters

Asymmetry BL (A1) = 0.00000
Flat/Peak BL (A2) = -0.02000
Wide/Narrow BL (A4) = -0.00050
Shift BL (AS) = 0.00000
Asymmetry Cas (B1) = 0.00000
Flat/Peak Cas (B2) = -0.00002
Wide/Narrow Cas (B4) = -0.00150
Shift Cas (BS) = 0.00000

Figure 1.9b. T/S parameters printout example.

Driver Characteristics Screen

At times, it may be convenient to have detailed information about individual drivers in the project available at your fingertips. You an do just that, by selecting any of the driver file from: “Enclosure Design” -> “Show Driver XXXXX File” menu option.

A screen similar to the one shown below will be opened, where you can examine **amplitude + phase transfer function, input impedance + phase transfer function** and also all related mechanical and TS parameters.

Please note, that transfer functions that are displayed in this window, are used by the remainder of the program. So, this gives you a good opportunity to instantly examine, if your HBT generated transfer functions were correct. You should be able to open HBT dialogue box, change the HBT parameters, plot the new transfer function, and then open the Driver Characteristics window to examine the newly created changes to the transfer functions.

The Driver Characteristics window will also display file names and directory paths for all 5 possible drivers in your project. You may find this information quite handy, and be able to access it from anywhere throughout the program.

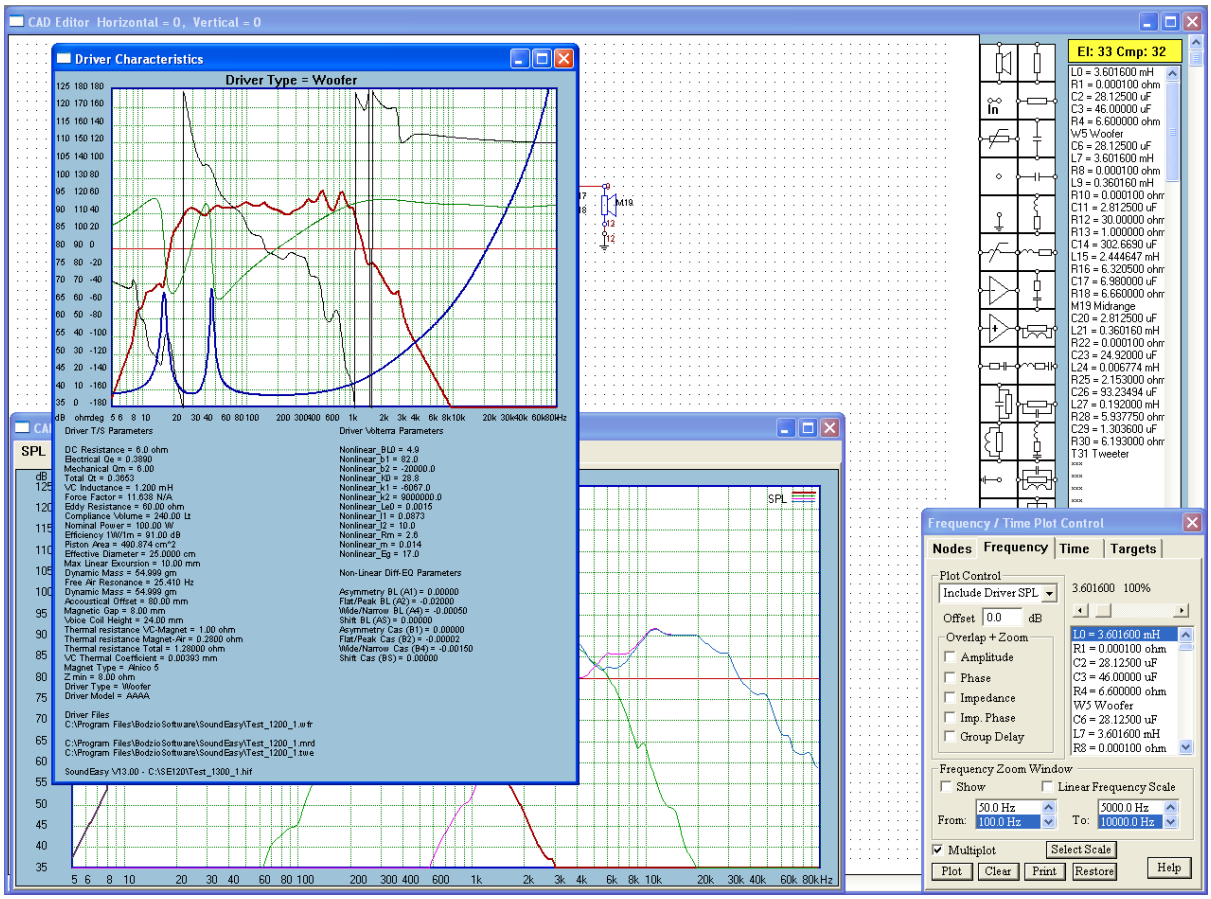


Figure 1.10. Example of Driver Characteristics window opened for woofer driver.

Help Files On-Line

There are several Help Files incorporated in this release. These files are accessible via a “Help” button where applicable. An example of a Help File related to CAD system is shown below.

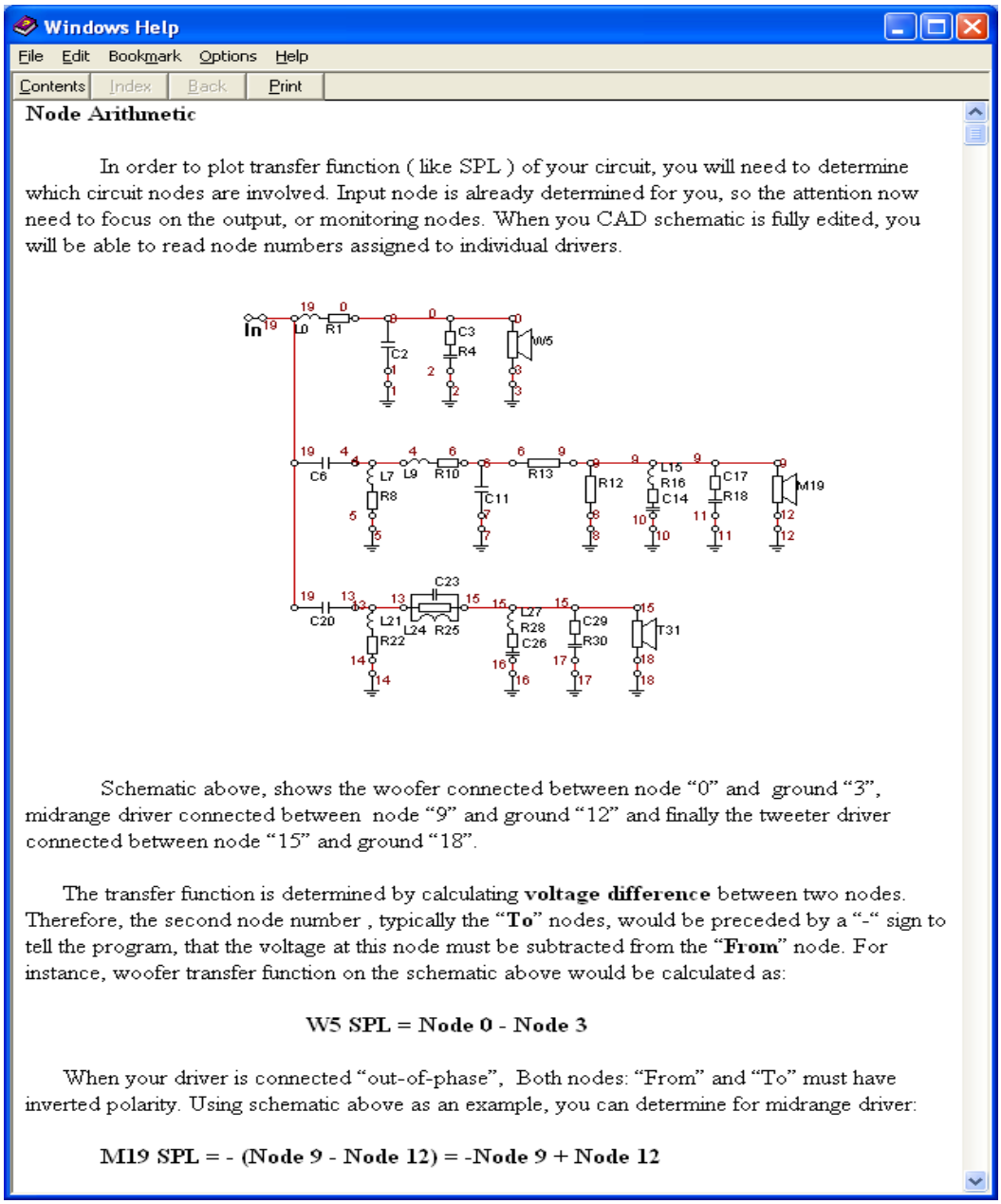


Figure 1.11. Example of a Help File in CAD section.

The most recommended help file has been written by John Kreskovsy. This file can be accesses via “User Help” -> “SoundEasy Help” menu option. Information contained in this file will help you navigate through SoundEasy and also will provide you with general assistance with building your loudspeakers – highly recommended !.

Dongle Serial Number

Your electronic key (dongle) serial number is displayed in the “About” dialogue box – see below – **ABCD23456.**



Figure 1.12. ABCD23456 serial number in “About” dialogue box.