

# LOUDSOFT

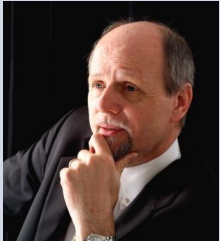
Denmark

## **FINE Speaker Test & Design**

Built on 40+ years loudspeaker experience

***Peter Larsen***

President of LOUDSOFT



## Bibliography for Peter Larsen

- 1974 – 1987 VIFA – Chief Engineer since 1976
- 1987 – 1988 Scan Speak – Chief Engineer
- 1988 – 1991 Dynaudio – Chief Engineer
- 1991 – 1993 JBL, California – Specialist designing tweeters –  
“Tweeter Peter”
- 1993 - Independent Consultant
- 2001 Founder of LOUDSOFT
- Working with audio companies like Audax, KEF, Gold Peak, SEAS, Vifa-Speak, Peerless India, NXT, GRAS etc.

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## Award:

The Titanium Driver Award recognizes a specific technical contribution, accomplishment or expertise in the loudspeaker industry.

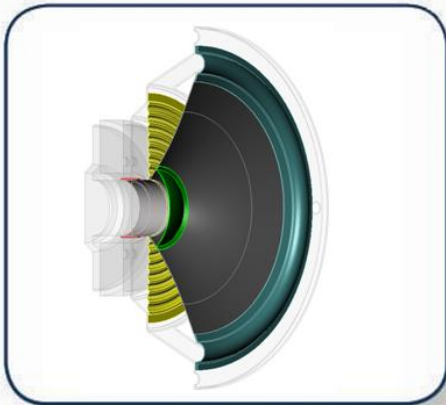
Peter Larsen, President of LOUDSOFT, Ltd., received this award at the annual ALMA symposium in Las Vegas January 2012. He received the award for his constant effort and expertise within the driver development and his hunt for better speaker designs for the loudspeaker industry worldwide.

Since 1974 Peter Larsen has designed drivers for Vifa, Dynaudio, JBL, KEF and many other driver manufacturers, but the most impressive invention was the Ring Radiator, created one Friday afternoon because of coincidence, curiosity and skills. The Ring Radiator today is used in thousands of loudspeaker system all over creating a sublime sound.



# 3 Product Groups:

**Design Software**  
**Speaker Simulation**



**Measuring Solutions**  
**QC Testing**  
**R+D Measurement**



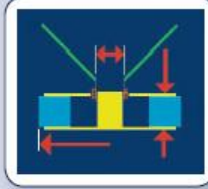
**Development**  
**Design Consulting**



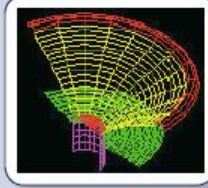
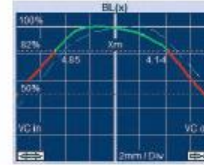
**LOUDSOFT**



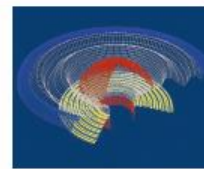
# Loudspeaker/Transducer Design Software



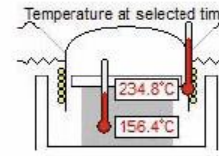
**FINEMotor™**  
Magnet System & Voice  
Coil Design Program  
"The Industry Standard"



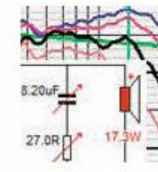
**FINECone™**  
Acoustic Finite Element  
Dome/Cone Simulation  
"Acoustic Optimization  
before Tooling"



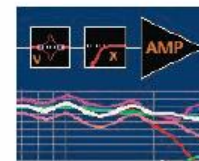
**FINEBox™**  
Non-Linear High Power  
Enclosure Simulation  
"Designing for safe &  
controlled Power input"



**FINE X-over™**  
X-over Simulation  
"Simulate & Optimize at  
your fingertips"



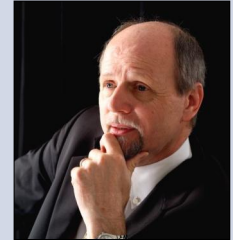
**FINE DSP**  
Digital / DSP X-overs –  
Hybrid DSP + Passive  
Max Power / Xmax  
Calculations



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## Peter Larsen - CONSULTING

Speaker design for individual customers combining experience,  
software and engineering skills



### References

<b>Asia:</b>	Fenda (F&D)	Peerless India	Tech Audio
	GGEC	Pulsus, Korea	Tekzone
	Microlab	Sambon, Korea	Unicond, Taiwan
	Soundking	Tymphony	Zenmay
<b>USA:</b>	New Jialian	Sinar Baja	
	OHM Audio Asia	Shinwoo, Korea	
<b>Europe:</b>	Apple	Pure Acoustics	FZ Audio
	Misco	THX	BOSE
	Polk Audio	Triad	David Clark
<b>Guest Lecturer:</b>	Accuton	Dali	Ole Wolff Electronics
	Bang & Olufsen	DTU (DK University)	Scandyna
	Bentley Motors	Focal	Vifa-Speak
	Blaupunkt	MB Quart	Kef / Celestion
	AiAiAi	GRAS	OHM, UK

**Feng Chai University, Taiwan**  
**DTU Technical University, Denmark**

# LOUDSOFT Cooperation partners

**DTU Technical University of Denmark  
Feng Chai University, Taiwan**



## **Projects DTU / LOUDSOFT:**

Ph.D New Amplifier Technology / Loudspeaker

Ph.D Amplifier / Loudspeaker Test interface (HTH funding)

GRAS

Pascal

Scan-Speak

GN-Jabra

Motorola

Tymphony

VECO

Redrock

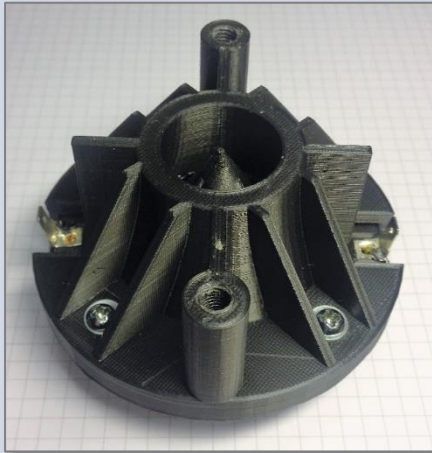
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## Drivers developed by Peter Larsen



Annular Compression Driver  
CD10 (F)



Vifa-Speak Ring Radiator:  
R25TG



Dynaudio Esotech D260 Dome tweeter.



Dynaudio Woofers 15W75 and 20W75.  
Alu frame, 3in Voice Coil. Inside magnets



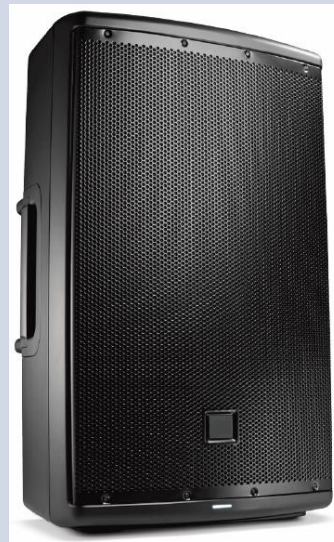
# LOUDSOFT

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## Speaker System Projects



2.1 Home Theater System for Harman / Infinity



Portable PA with Class D amps + DSP



AiAiAi Headphone TMA



Beolab 3  
Beolab 3



MicroPod for Scandyna



PURE Monitor series for Microlab  
"by Peter Larsen"

# LOUDSOFT

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## Car Speaker Projects



**Bentley GT and Arnage  
Speakers Systems**



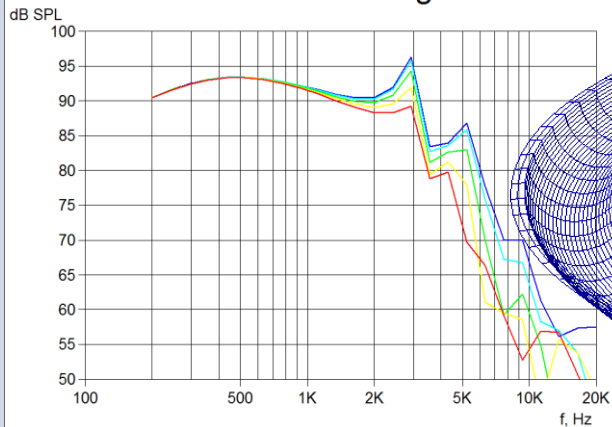
**Volvo – XC90 and Premium versions  
Dynaudio Speaker System**



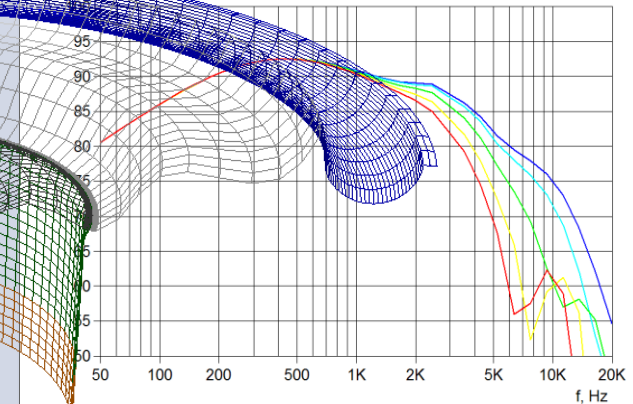
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4 in Woofer Original



Large diam, deep +conical



## Case Story: Bang & Olufsen (B&O) Cone Design

In 2003 Bang & Olufsen (B&O) Denmark developed a new special loudspeaker design.

The supplier could see this design would cause a poor performance. B&O only replied: Prove it!

To prove it in those days, the supplier had to manufacture a tool – which they knew would not work – at the price of more than 30,000 US\$ and 8 weeks of tooling time.

The supplier then asked Peter Larsen from LOUDSOFT to help.

Within 4 hours with FINECone he proved the cone would give a poor sound quality and after 4 more hours he changed the design fulfilling the design ambitions of B&O and at the same time giving a good performance.

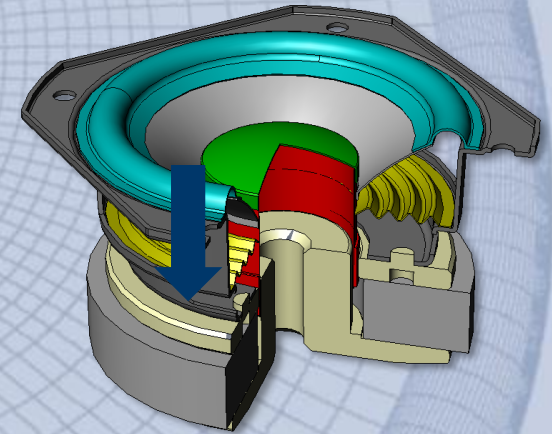
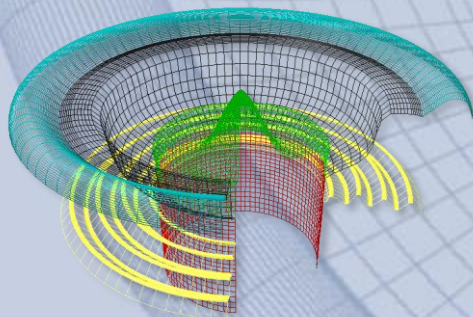
That speaker was named **Beolab 3**.



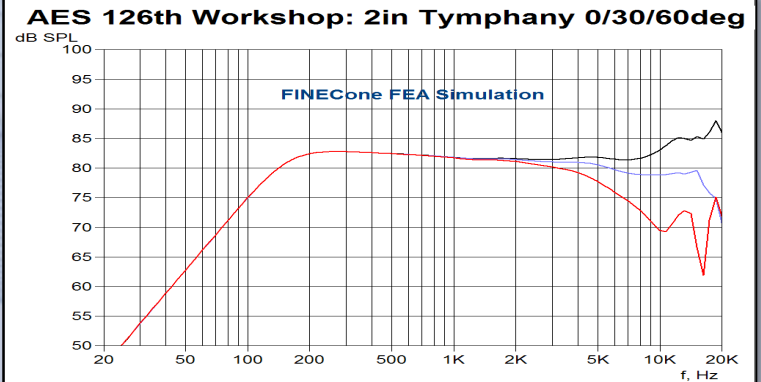


# LOUDSOFT Academy

Advancing Acoustic Level by Training & Software



- Basic Loudspeaker Acoustics
- Understanding the Loudspeaker components
- How to define FEA simulation
- Basic FINE modelling
- Basic LOUDSOFT Certificate\*
- Advanced principles of FINECone FEA
- Advanced Driver Motor Design
- Advanced DSP simulation
- Advanced Measurements
- Advanced FINECone Certificate\*\*



## Europe

AM Denmark

ANS

**Alpine**

**ASK Industries**

Audio Partnership

Audio Note

Audio Pro

Audio Technology

Audivers

Athens Speaker

Audyon

**Bang & Olufsen**

**B & C**

**Behringer**

**Bentley Motors**

Blast Loudspeakers

**Blaupunkt**

**Bosch, Berlin**

Bosch, Hildesheim

Cambridge Silicon

Canton

Chario

Coherent Acoustics

Cooper, UK

Creek Audio

Crystal

**D&M PSS**

**Dali**

Davis Acoustic

DLS

**DTU, Denmark**

**Dynaudio**

Ehmann Partner

Elac

Elettromedia

**FAITAL**

FANE

Fink audio

**FOCAL**

**Genelec**

GN Netcom

Grewus

Harbeth, UK

Harman, France

Harman Auto

Jabra R+D

**KEF**

Kuhnke Supply

**Kurt Müller**

Lautsprecher Teufel

Libratone

LLB

Lopacan

LPG Lautsprecher

MB Quart

Millon

Mission

MKG Sound

Monitor Audio

Mordaunt-Short

Musikelec. Geithain

**NEXO**

O-Engineering

Ohm UK

Ole Wolff Electronic

Oliver Schrott Kommunikation

Panasonic, DE

**Panasonic, UK**

Pioneer, France

**Philips, Dendermonde**

Philips, Leuven

Precision Devices

Procella

Pylon

Raidho Acoustics

**RCF**

ReVox

S1nn, Germany

Saitek

SC Bautech

**Scandyna**

**Scan Speak**

**SEAS**

Siltech

Siltech – IAH

Sony Ericsson

SP Acoustics

Swiss Audio

T+A Elektroakustik

Tannoy

Theis & Vögele

Thiel & pPartner

Tonkraft Audio

Triangle

TVM. Czech Rep.

**University of Madrid**

Velodyne

**Vifa Tymphany**

Visaton

Welcohm

Wwa

**LOUDSOFT**

## **America**

Accusonic  
Acoustic Design  
Adamson Audio  
Advanced Acoustic  
Aliphcom  
**Alpine**  
American Audio Co.  
Andover Audio  
API  
Apple  
Arelle Labs  
Audilab  
Audyssey  
Auradyne  
AuraSound  
Avalon Acoustics  
**Beats**  
Blue System  
Bogen  
Bomber  
**Bose**  
Bravox  
**Cerwin-Vega**  
**Cisco**  
CJS Labs  
CLC  
Correlated Magnetics  
**Creative**  
David Clark  
DB Acoustic  
Diamond Audio  
**Dolby Audio**

Ecco Group  
Elac, USA  
**Eminence**  
Eros. Brazil  
Extron Electronics  
Ferrotec  
Fitbit Inc.  
FZ Audio  
Fujitsu Ten  
**Gibson Pro**  
**Google Inc.**  
**Harman Multi Media**  
Hendershot  
Incriminator  
Infinity Systems  
Innovative Fluidics  
Intersource OEM  
James Loudspeaker  
JC Sales  
**JBL**  
JL Audio  
Klipsch  
KSC Industires  
La Clef de Sol  
Legacy  
LitePoint  
**Logitech**  
LoudspeakerComp.  
Magico  
McIntosh Labs  
Millson Custom Sol.  
Misco  
Montana Speakers

## **Motorola Solutions**

NH Industry  
NMB  
Orca design  
**Panasonic, USA**  
Paradigm  
**Philips, USA**  
**Pioneer, Pomona**  
**Pioneer, San Diego**  
Polk Audio  
Preco Electronic  
Presonus Audio  
PSB  
QSC  
Redrock  
Rockford  
Russound  
**Samsung**  
Sakar  
Scosche Industries  
Selenium  
Signeo  
Sonance  
Sonas  
**Sonos**  
SoundMatters  
Sound Research  
Spqder. Brazil  
Symphones Audio  
TC Sound  
Thiel C. Source  
Ultimate  
Vance Dickason  
**Walt Disney Imagineering**

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## Asia

A & D Audio Co.  
AAD Engineering  
ACE  
Acoustic Sound  
Advanced Acoustics  
Advanced Sound  
Alpine, Japan  
Anam, Korea  
Aolei  
Audio Plus  
Audio Star  
Behringer, China  
Be-Start  
Betetech, Australia  
Blue Tek (Samsung)  
Bluecom  
Bohai Electronic  
Bopro  
Bosch, Malaysia  
BSE, Korea  
Bujeon, Korea  
Bumjin  
Chiyu  
Chiyoda Kogyo  
Compupal  
Cosonic  
Dai-Ichi, Malaysia  
Dai-Ichi, Philippines  
Dakshin, India  
Eden Info Center  
Edge Wound  
Elder Audio  
Enrique Stiles  
Eastern Asia  
Estec, Korea

Eva Wang  
Evervictory  
Fenda  
Feng-Chia Uni.  
Fils  
**Forgrand**  
**Fortune Grand**  
**Foster, Japan**  
FS Audio  
FST  
Fujicon  
Fujitsu  
**GSEC**  
Guosheng  
Guang-Fann Co.  
Guangzhou Baisheng  
Golden Voice Tech.  
Guangshun  
Hanbittni  
Hang Cheng  
Heng Ke  
Hermit, India  
Hi power  
High End  
Highhit  
Hornsonic Intern.  
Hosheng  
Hygeia Electrical  
Intensity  
Inter-M, Korea  
IST Co. Ltd.  
Iwai  
Jalung Co.  
Jia Shan

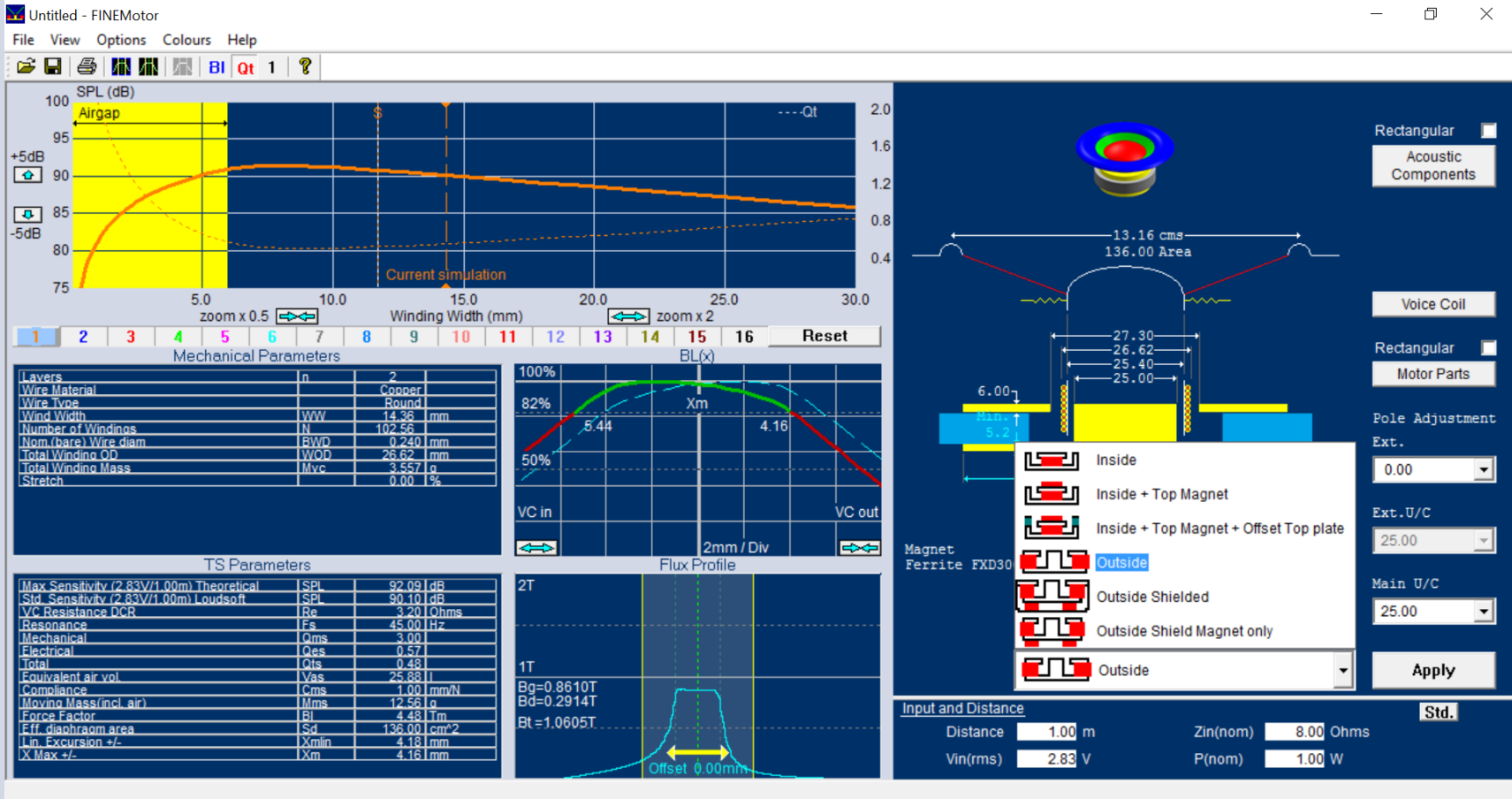
Jiefu Electro Acoustic  
Juseong College  
J&B Sound, India  
Kenwin  
Korea Omyang  
Korea TopTone  
KSY  
**LG, Korea**  
LEADtech  
Leilo  
Lilac, Japan  
Lightion Electronic  
LoqitechMaja Agung Elek.  
**Meiloon**  
**Merry Electronics**  
Microlab  
Minebea  
**Motorola**  
Nansin  
New Jialian  
NSSC, Korea  
NUTEK Corporation  
**Panasonic, Japan**  
**Panasonic, Singapore**  
Party House  
Peerless India  
**Philips, Shenzhen**  
**Pioneer, Japan**  
Premium, China  
Pulsus  
Qiaojan  
Qsun Music One  
R & S Electroncis  
Reaxt Electronics

**Samsung**  
Sambon  
Sanyo  
Shinwoo  
**Seoul Nat. University**  
ShengYun Audio  
Shin-hint Group  
Sinar Baja  
Solidex  
Sonavox  
**Sony**  
Sound Factor  
SoundKing  
SoundMaters  
S.S.Electronics  
Sung Ju, Korea  
Sun Technique  
Swan Speakers  
**Taiwan University**  
Taiyu  
Tanko  
TCL  
Tech-Audio  
Tekzone  
Tianle  
Tokyo Cone Paper MFG  
TSI  
Trueanalog  
Turbo Power  
**Unicond**  
Unicorn  
University of Taiwan  
Veco  
**Yamaha**  
Zenmay  
Zsound

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# FINEMotor

## Designing (PRO-) Woofers, Full-ranges, Tweeters etc.

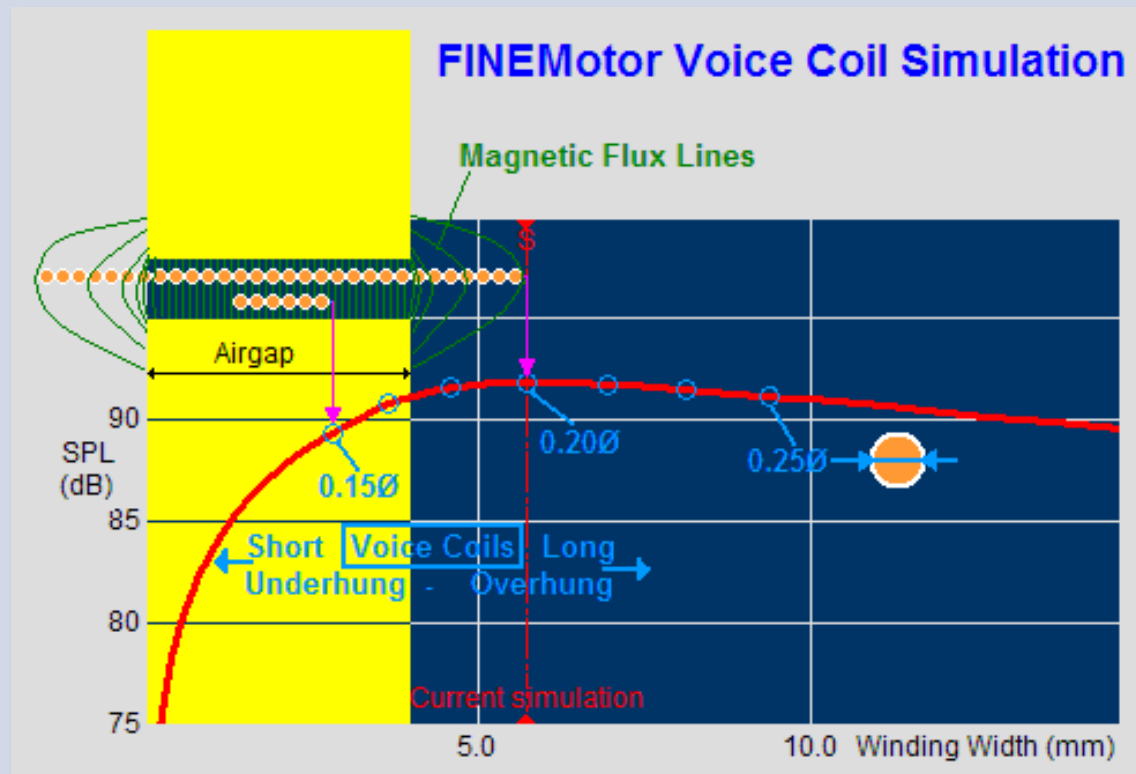


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# How FINEMotor works:

Input DCR, Cone mass and a magnet size. FINEMotor then calculates all TS parameters and plots SPL with the thinnest wire at left. The 0.15Ø (wire diam.) is a short 3mm Voice Coil winding, (underhung < air gap).

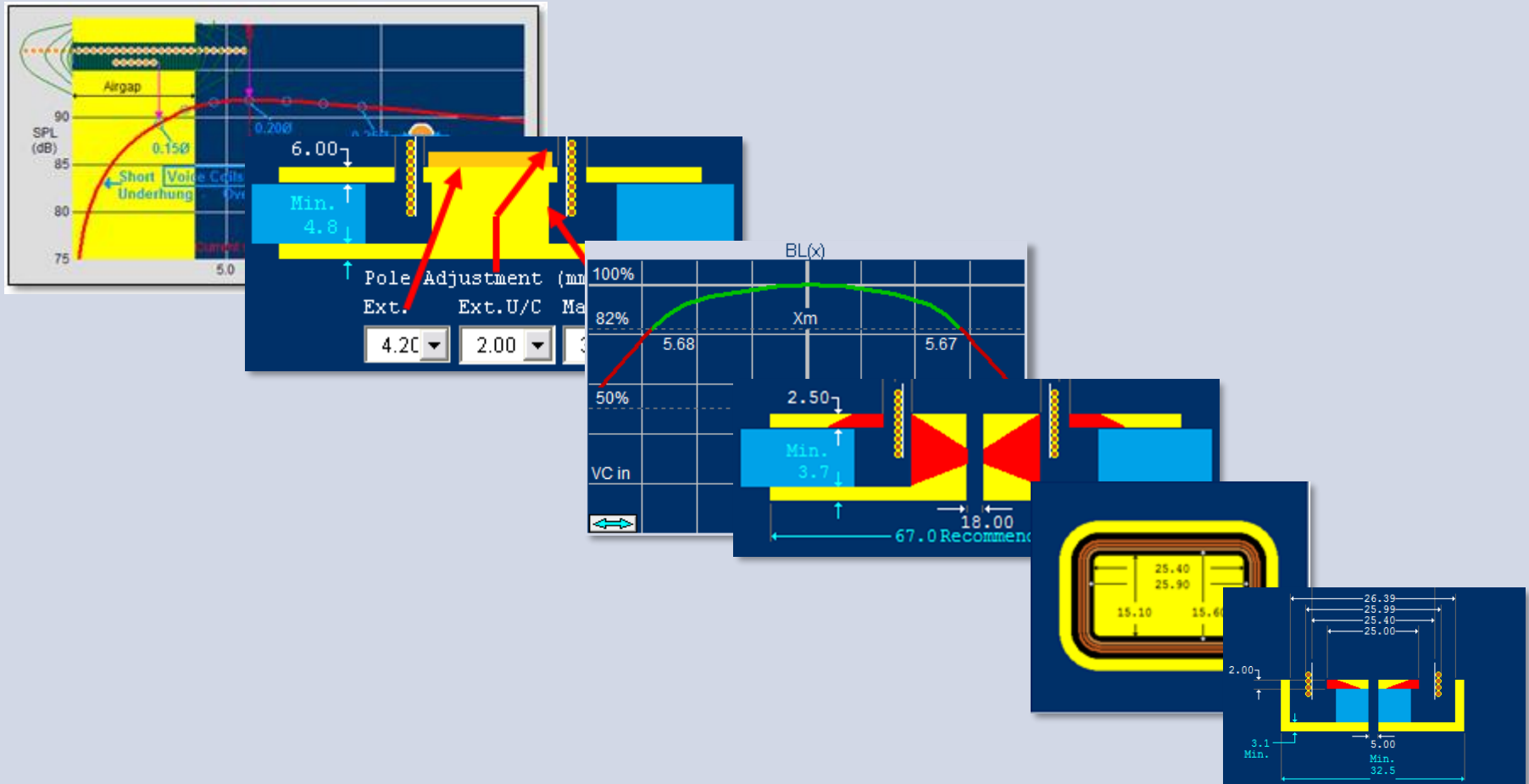
In contrast, the 0.20Ø shows an overhung 6mm winding > air gap and picks up some stray magnet field giving higher SPL.



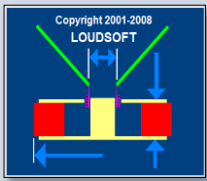
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# FINEMotor optimizes pole / top plate for optimum BL(x) curve, while avoiding Saturation



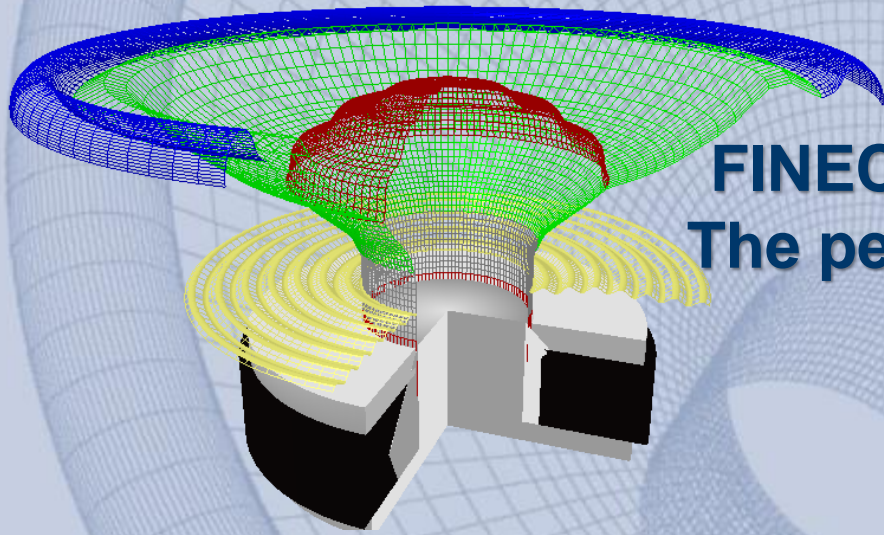
**LOUDSOFT**



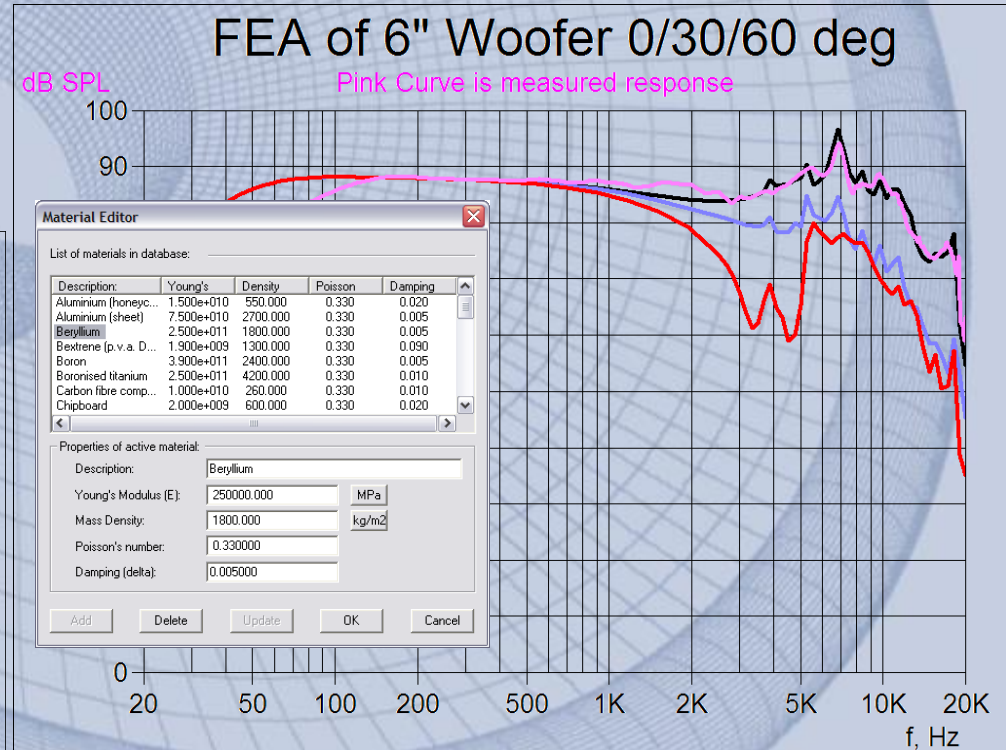
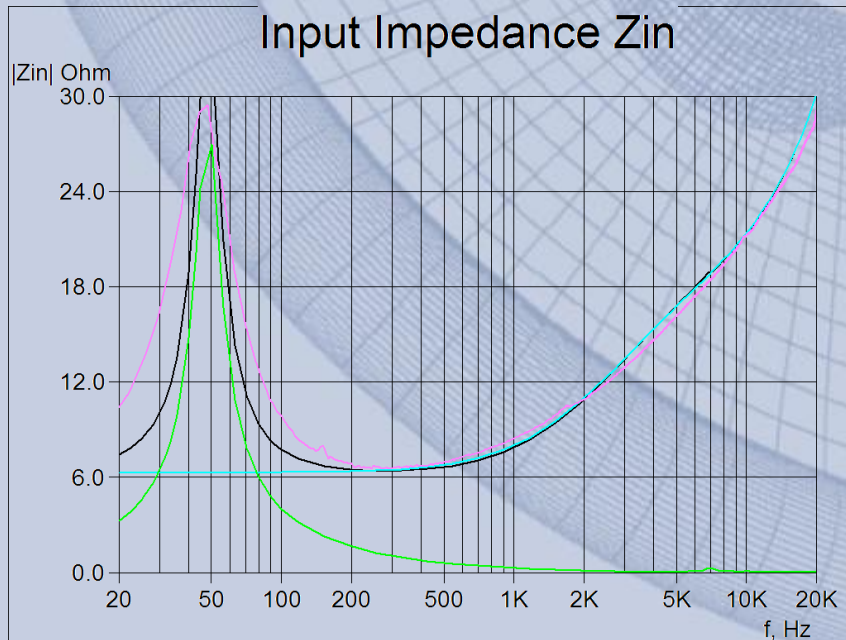
# FINEMotor™

## Magnet System & Voice Coil Design Program

1. Designs Woofers, Midranges, Tweeters, Headphone drivers, Micro Speakers etc.
2. Accurate prediction of SPL and TS parameters
3. All VC solutions are calculated using all available wires and shown as curve
4. Accurate prediction of VC winding width, DCR, N, VCOD, VC mass etc.
5. Accurate prediction of BL(x) curves: +/- Xmax defined as 82% BLmax (Klippel)
6. FINEMotor is instant with 36,000 stored Magnetic Finite Element calculations
7. Wire stretch is calculated
8. Round and Flat /Edge wound Voice Coils
9. Copper, Aluminum and Copper Clad VC wires
10. Standard Chinese Ferrite and Neodymium magnet grades available
11. Magnet grades and -sizes can be user modified
12. Wire diameters can be user modified for both round and flat wires
13. Automatic compensation of magnetic air gap for multi-layer VC's
14. Twin Voice Coils can be designed as 1 +1, 2 + 2, 4 + 4 layers etc.
15. Qms is estimated by including Paper, Kapton, Nomex or Aluminum VC former
16. Fs is calculated from Cone Fo and Spider deflection / resonance / flexibility
17. Magnetic saturation is calculated in Pole, top plate and back plate
18. Magnetic loss from steel frame is included
19. Voice Coil can be offset up / down by dragging with the left mouse button
20. Motor can be optimized with pole extension, undercut and extension undercut
21. Outside Ferrite and inside Neodymium motors with top and rear magnets
22. Voice Coil calculated as 1-layer, 2-layer etc up to 10-layers
23. Motor design including Ferrofluid, for damping and cooling
24. Attach flux profiles from other FEA software
25. Input data and parameters with extra precision for Micro Speakers
26. Rectangular Micro Speakers with both rectangular VC and magnet system



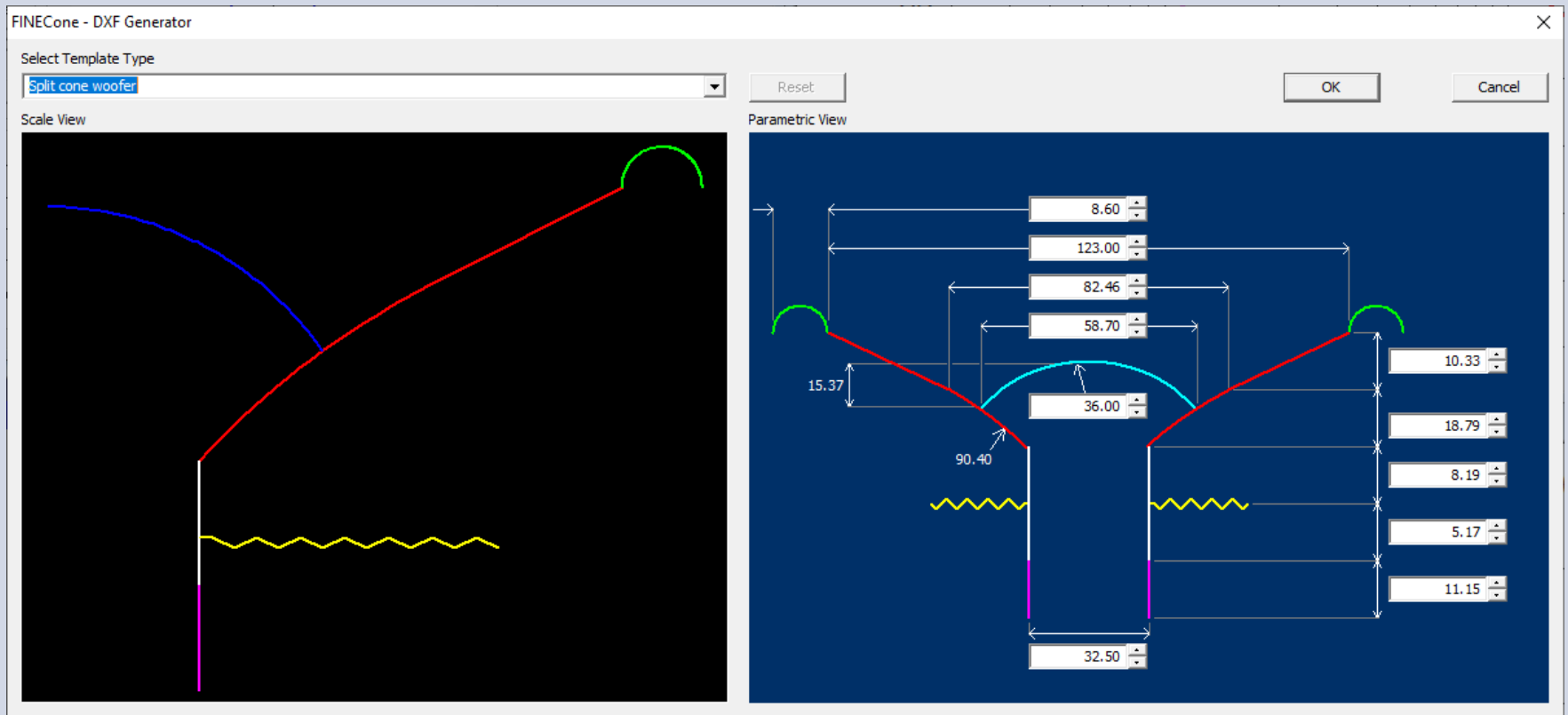
# **FINECone calculates Cone break-up = The perfect Tool for Cone/Dome Design**



**LOUDSOFT**



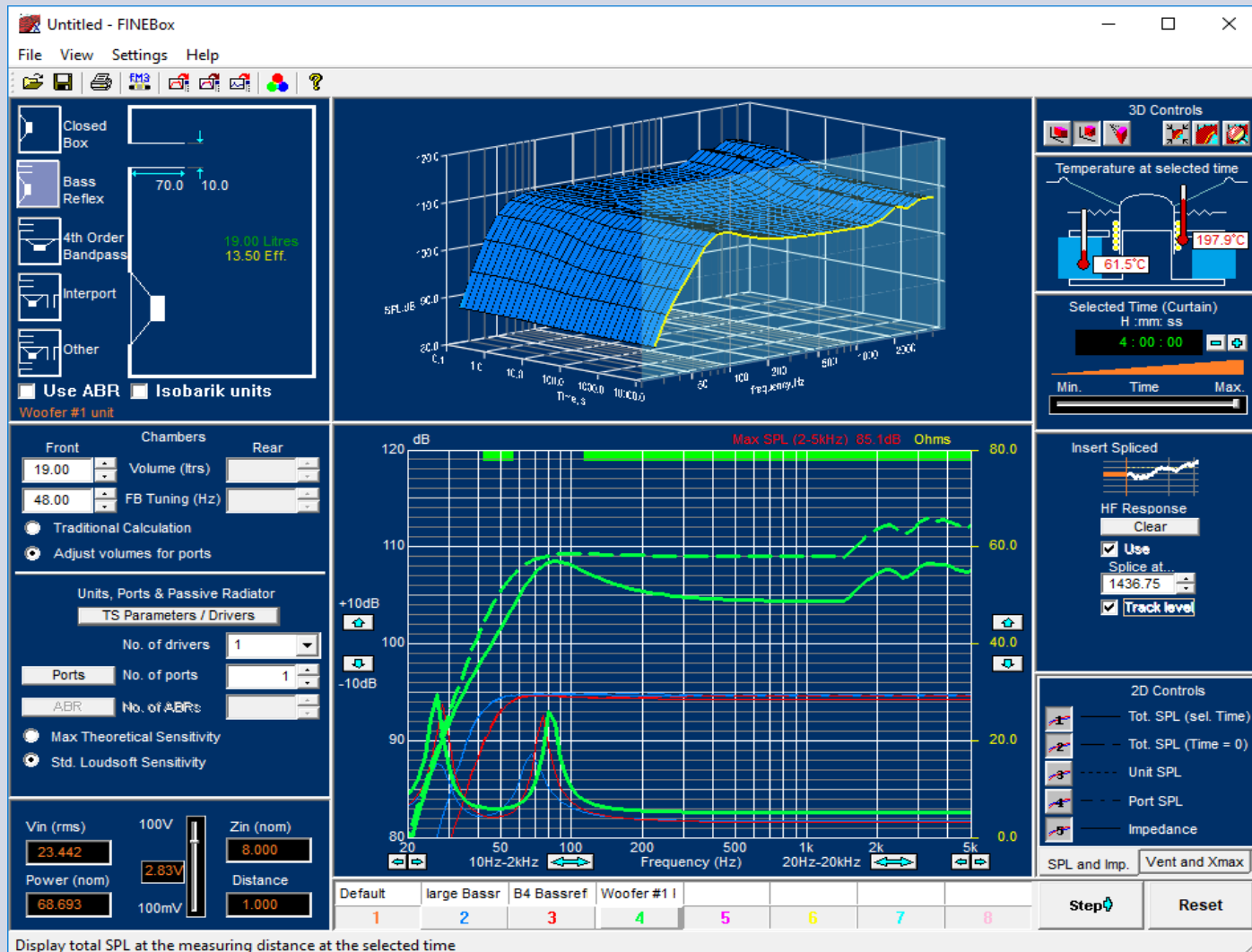
# **NEW** FINECone 2020: Geometry Modeler → User-friendly



**Just input dimensions and geometry will Auto-update!**

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# FINE Box: Direct TS simulation + Hi-Temp Power



# FINE Box: Net. vol. Reflex simulation + ABR Designer

☒ Closed Box
 ☐ Bass Reflex
 ☐ 4th Order Bandpass
 ☐ Interport
 ☐ Other

☐ Use ABR
 ☒ Isobarik units

Woofer #1 unit

Front: 19.00  
 Chambers: Volume (lts)  
 Rear: 48.00  
 FB Tuning (Hz)

☐ Traditional Calculation  
☒ Adjust volumes for ports

70.0  
 10.0  
 19.00 Litres  
 13.50 Eff.

Passive Radiator (ABR) Parameters

TS Parameters


Free air resonance	Fs	15.00	Hz
Moving mass	Mms	70.00	g
Mechanical Q	Qms	7.00	
Effective diaphragm area	Sd	220.00	sq.cm

Mechanical dimensions

Diaphragm diameter: 167.37 mm

All dimensions are in mm

OK Cancel



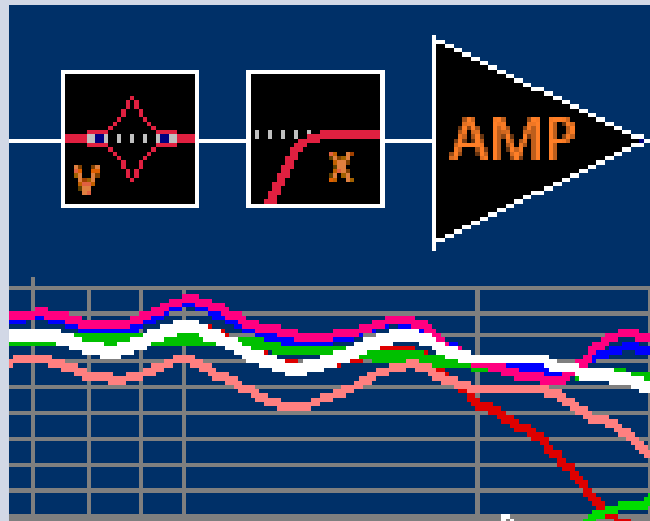
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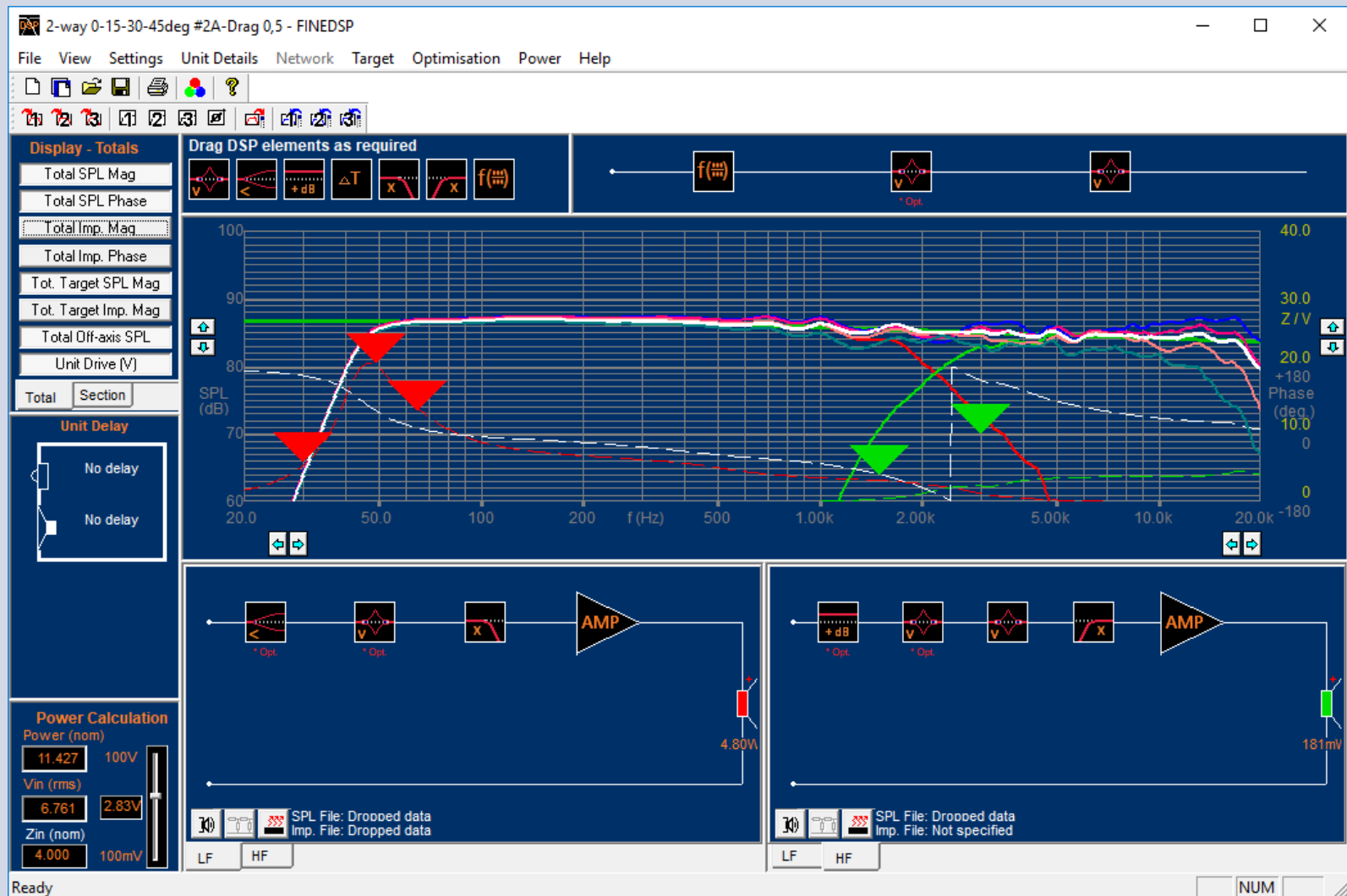
# FINE DSP <sup>TM</sup>

## Digital X-Over/DSP simulation



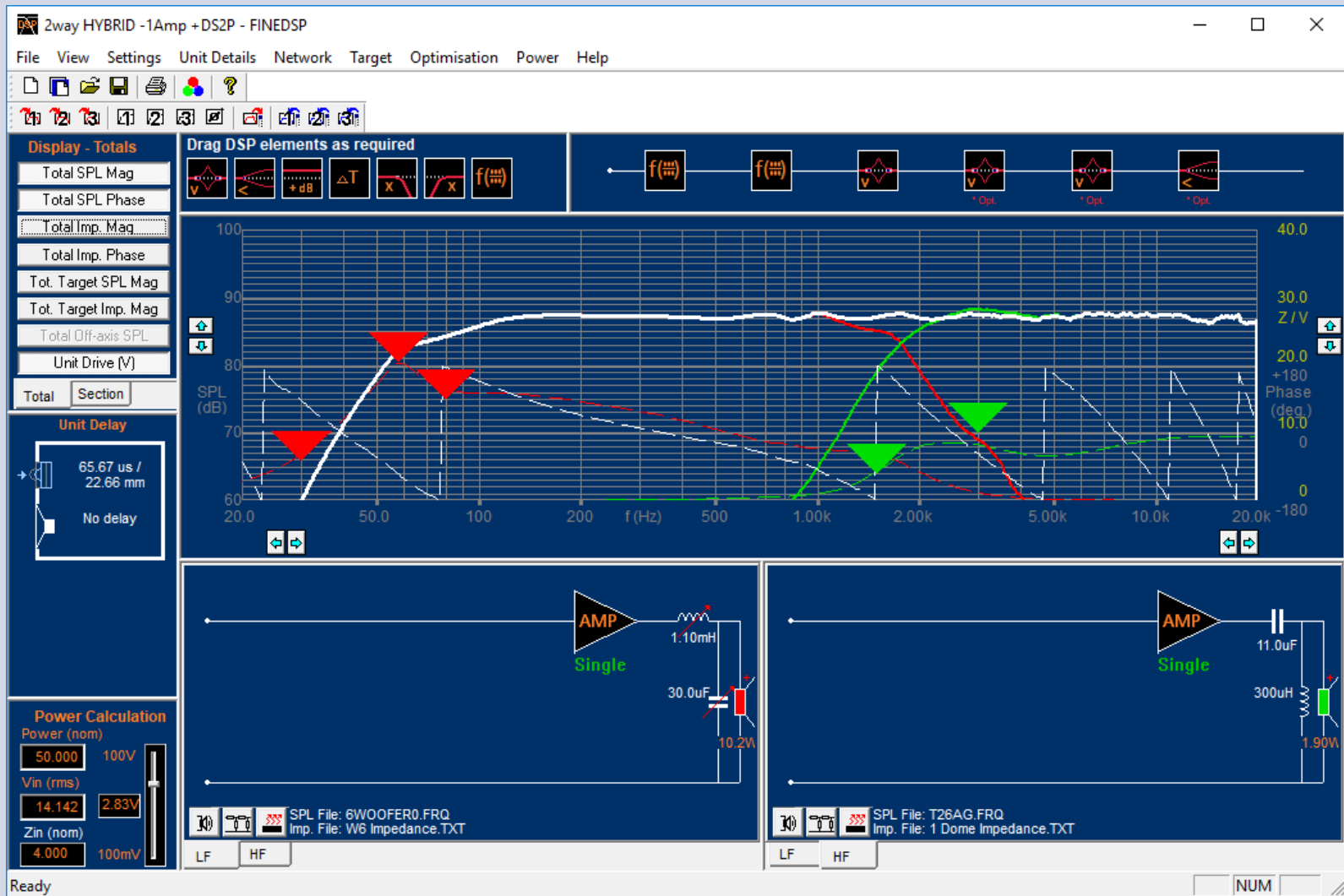
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# FINE DSP X-over: On/Off-axis SPL + Power & Xmax Limits



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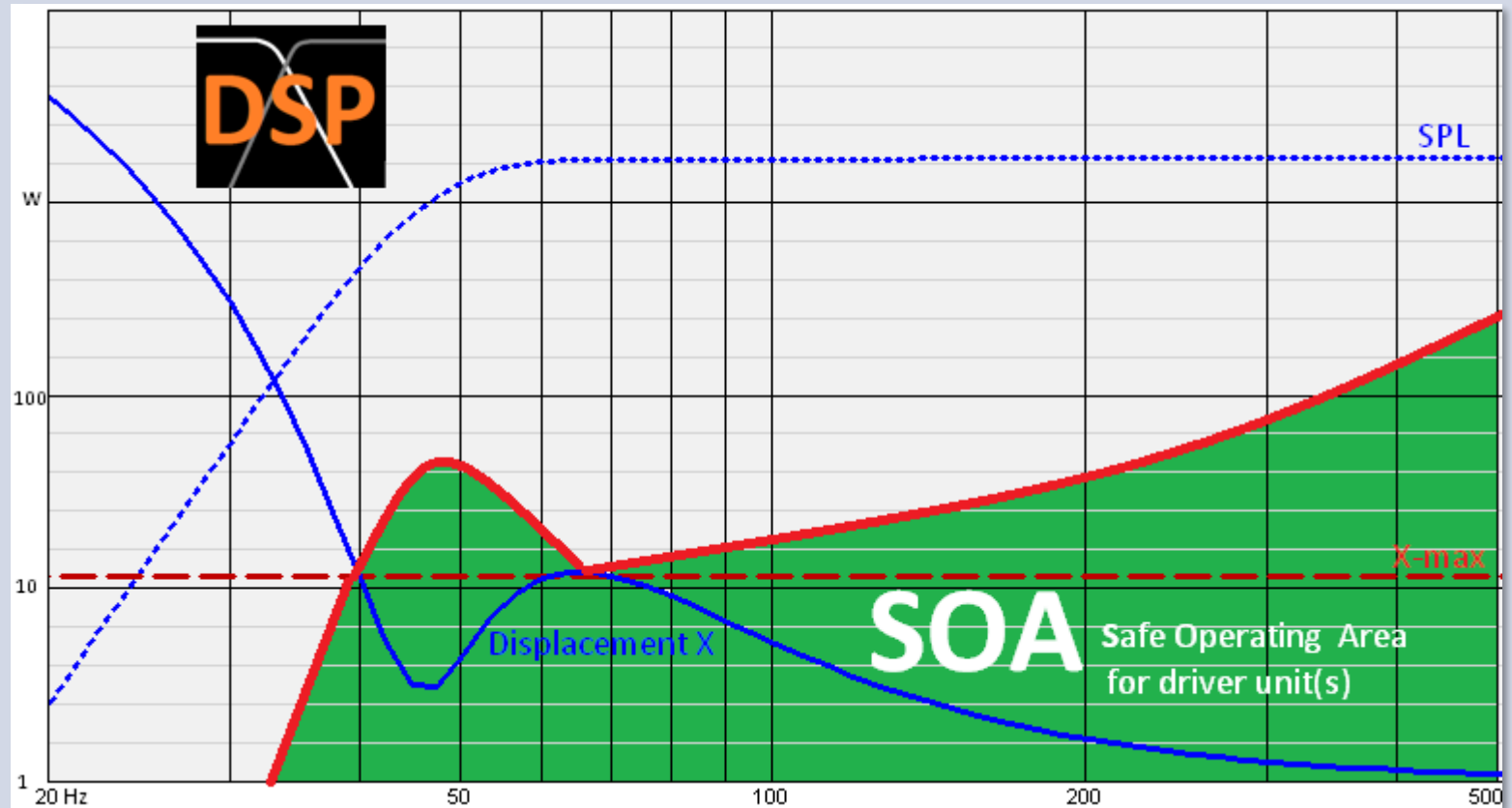
## FINE DSP Hybrid Cross-over: 1 Amplifier +passive comps.



# LOUDSOFT

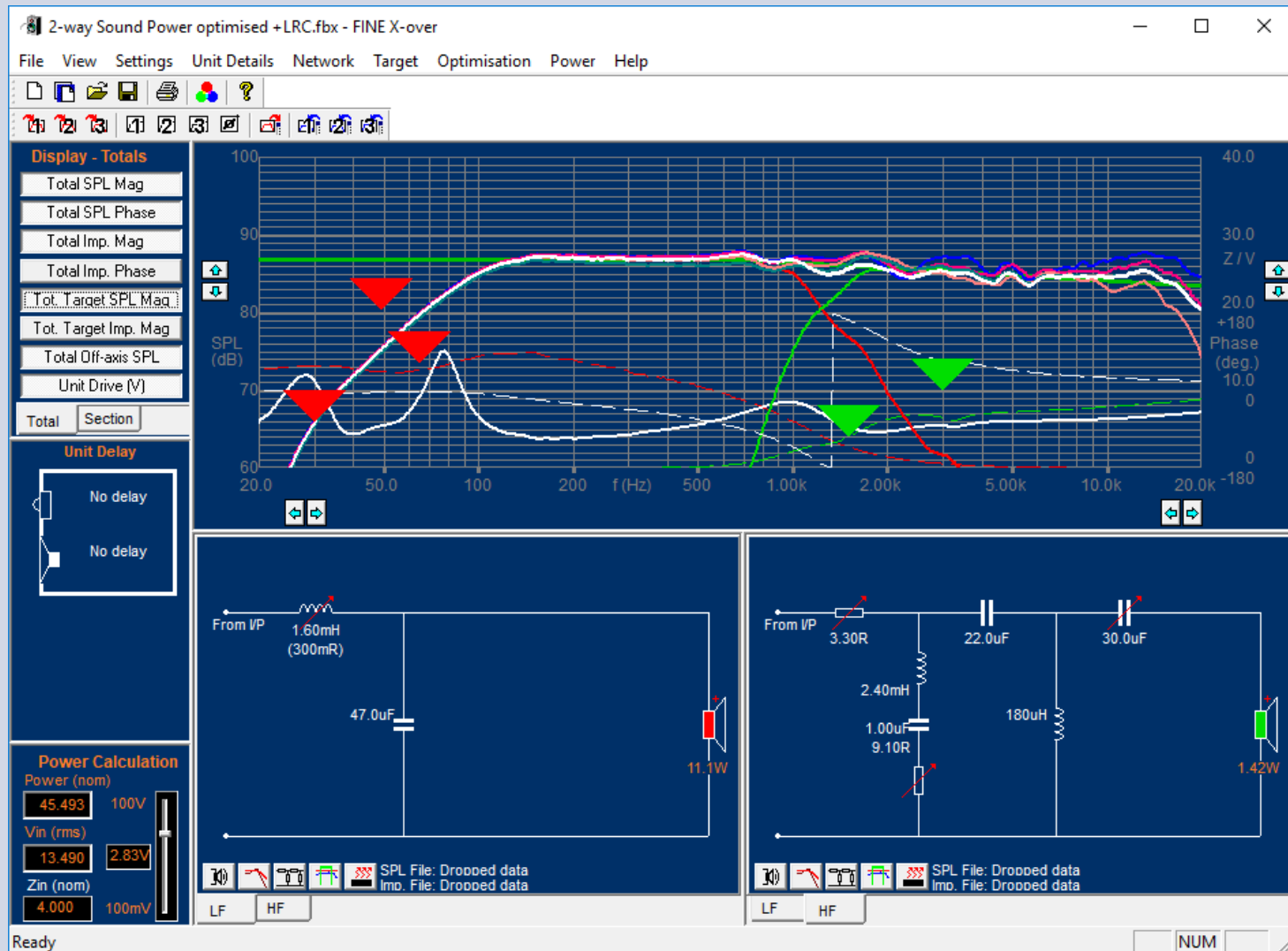


# Power / Displacement of drivers



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# FINE X-over: Power Response + Power & Xmax Limits

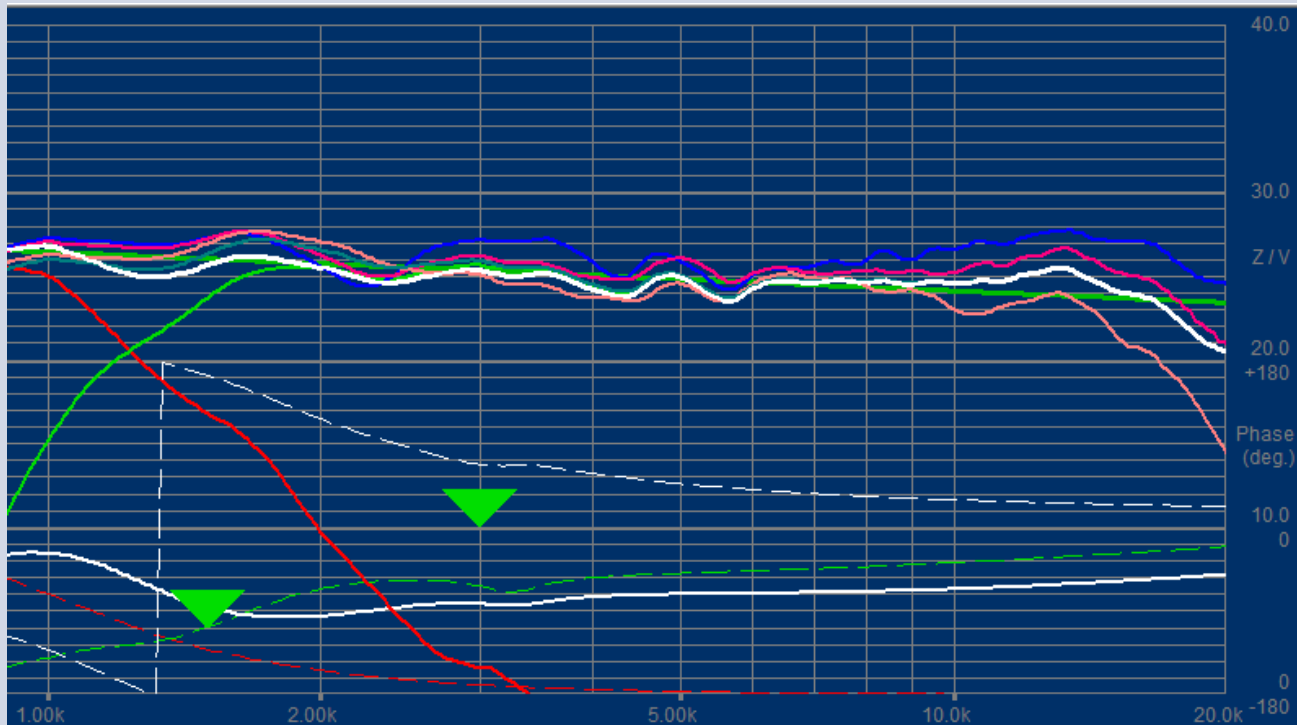


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# FINE X-over: Sound Power Control

This is part of an optimized Sound Power curve (white). This curve was optimized for the green target response, which is gently sloping down.

The sound power is controlled by smooth responses, with the off-axis responses gently sloping down towards the high frequencies



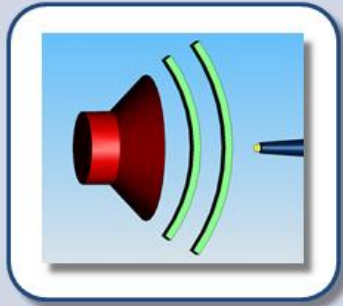
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## “FINE Speaker Test”



**FINE QC™**  
Audio Test System



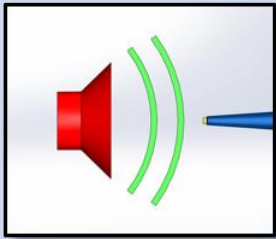
**FINE R+D™**  
Acoustic Analyzer



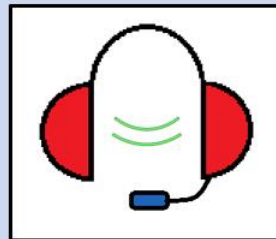
# LOUDSOFT

Denmark

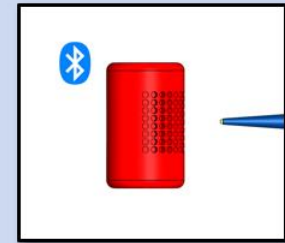
## FINE R+D & FINE QC Applications



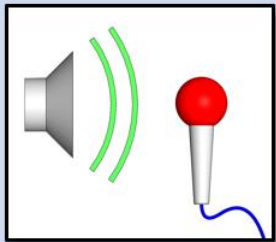
**Micro & Driver Test**



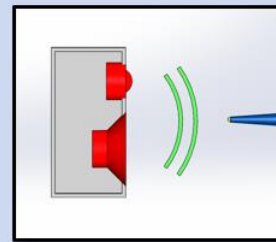
**Headset Test**



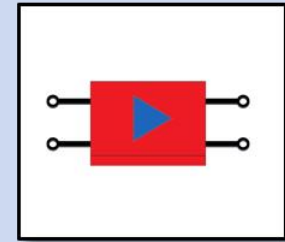
**Smart Speaker Test**



**Microphone Test**

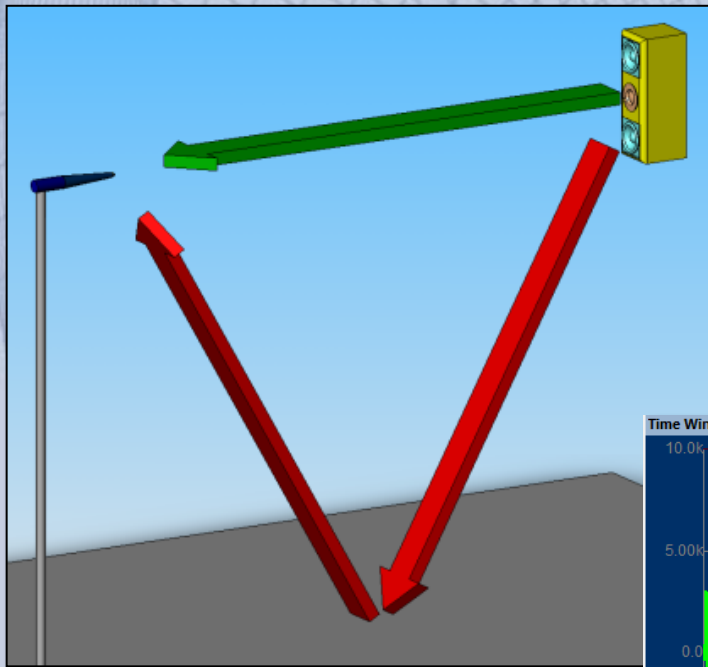


**Loudspeaker Test**



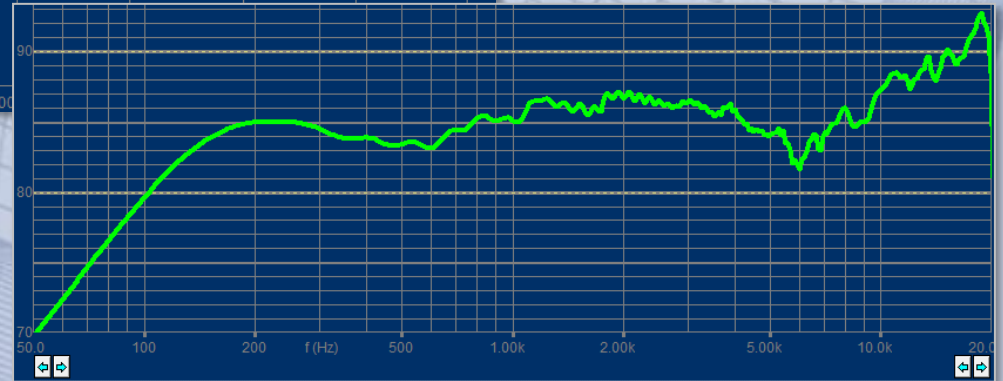
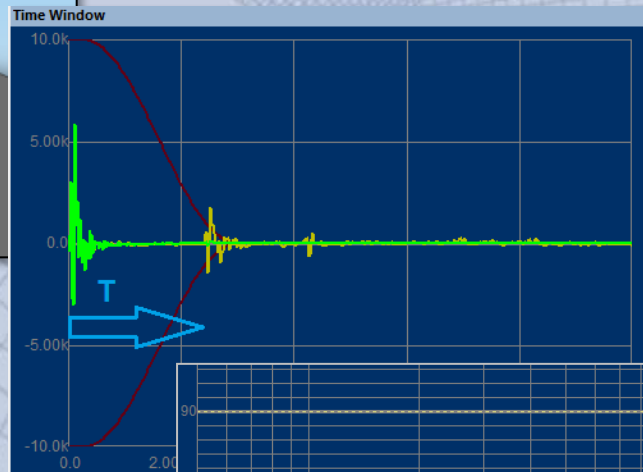
**Amp/X-over Test**

# Measuring with FINE R+D)))™



10 Hz-100 kHz Range

**Anechoic** measurements can be done in a **normal** room. The reflections from walls and floor/ceiling will be excluded by the FINE R+D software.

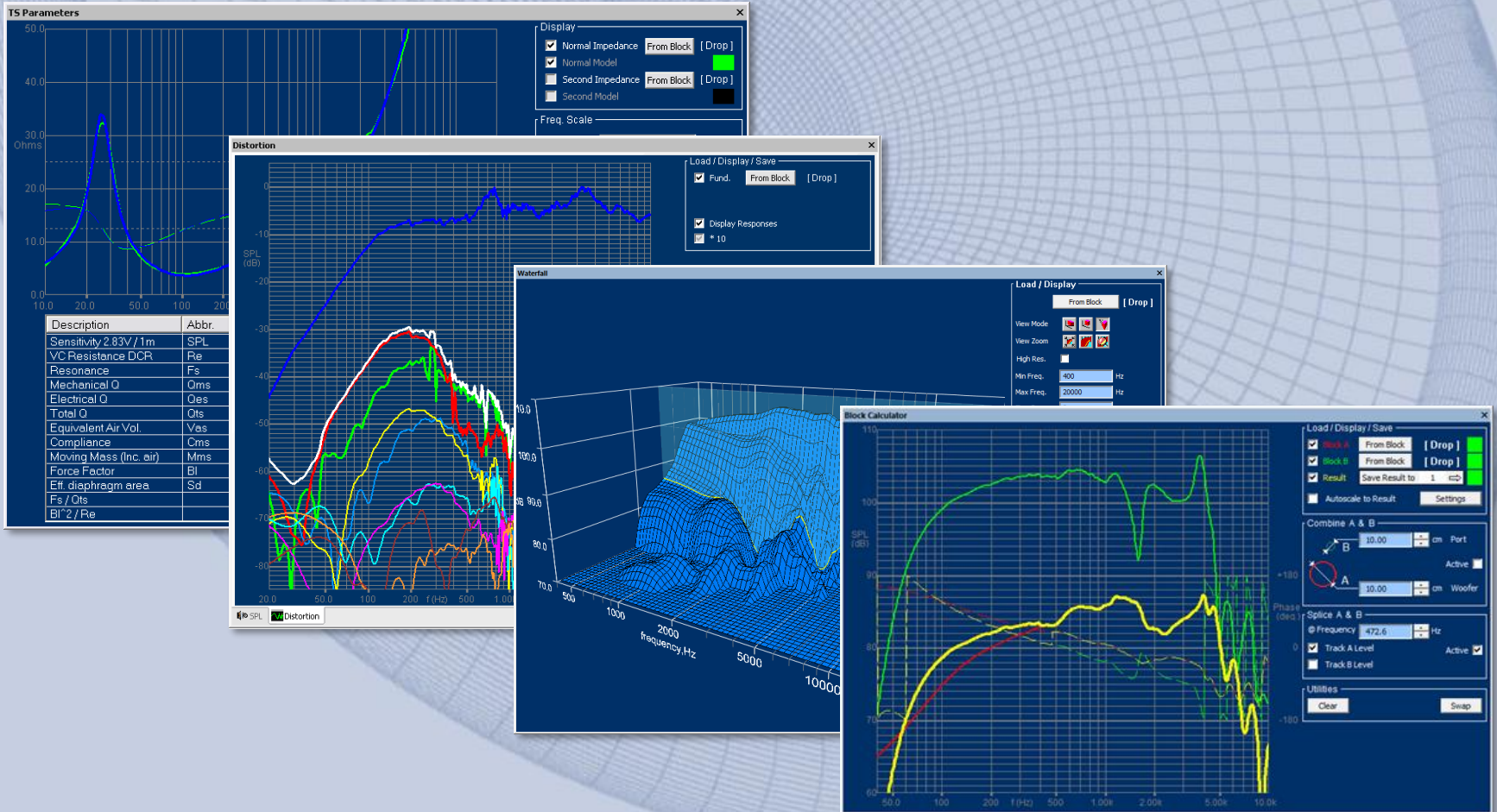


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# Measuring with FINE R+D)))™

## TS parameters, Harmonics, Waterfall, Offset, Splice etc.

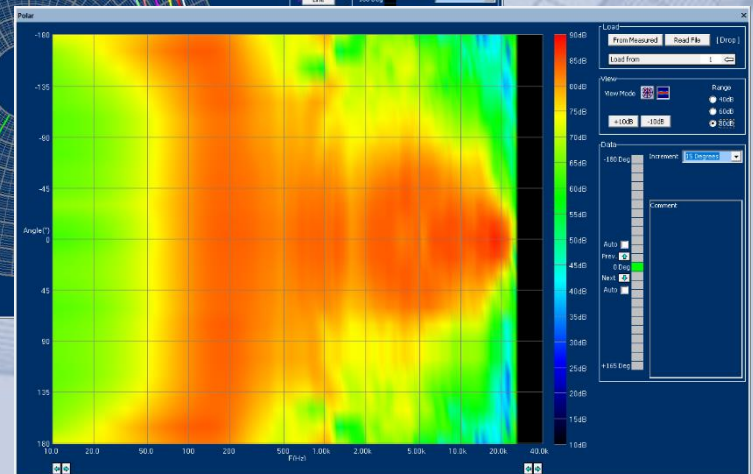
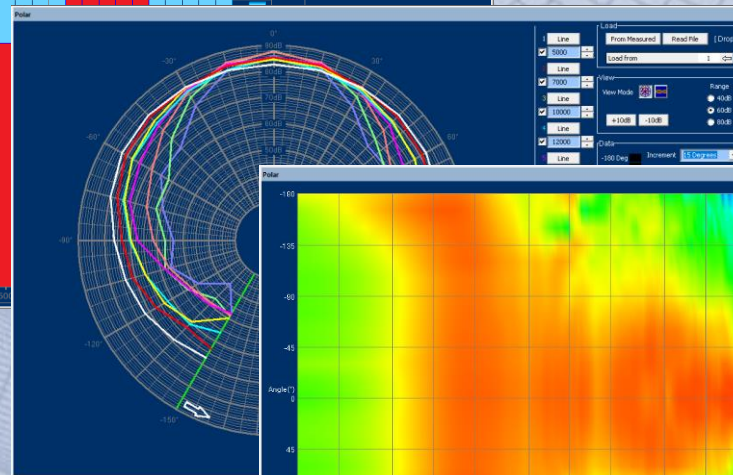
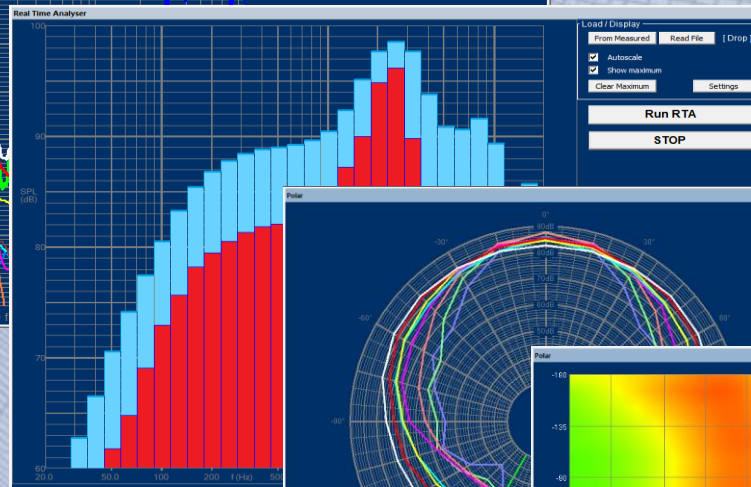
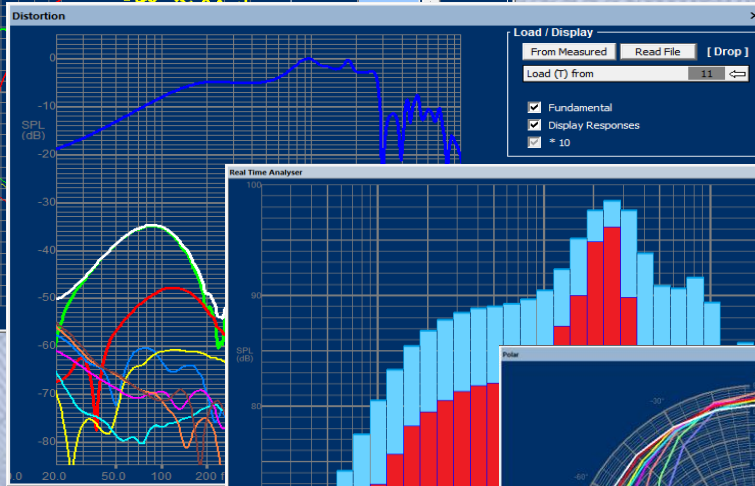
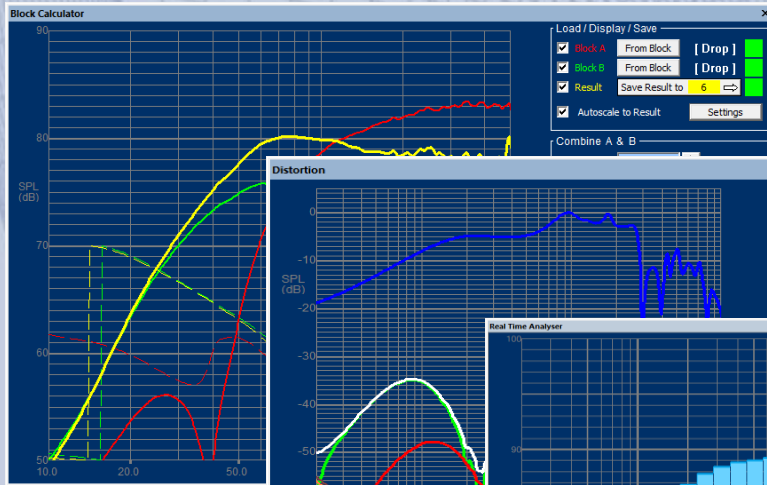


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# Measuring with FINE R+D))™

Bass Reflex Woofer + Port, Average SPL, Dist. dB, RTA, Polar



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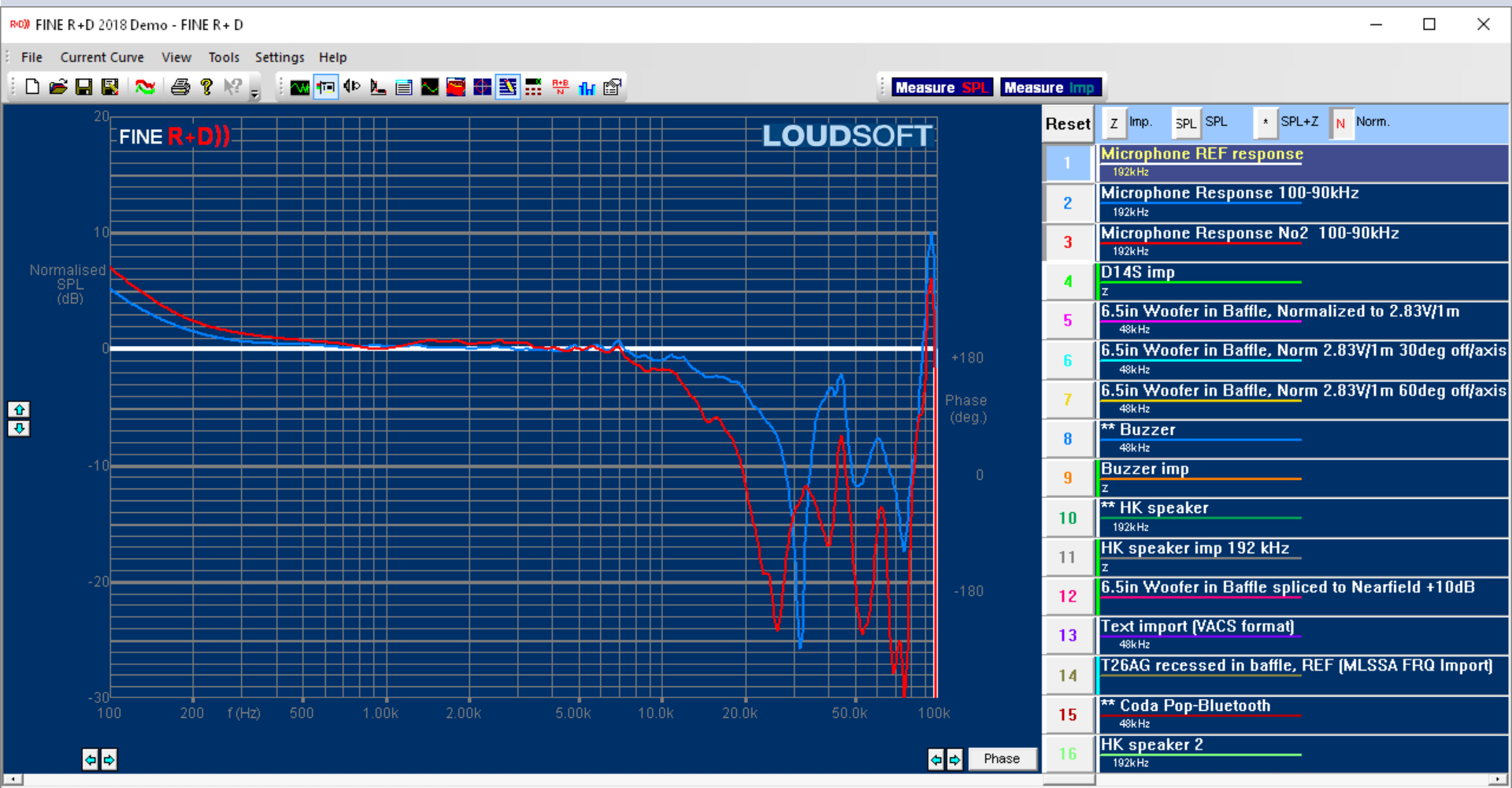
Denmark

## FINE R+D 2018: ~100 kHz Freq range



# LOUDSOFT Denmark

## FINE R+D 2018: Microphone Testing ~100 kHz

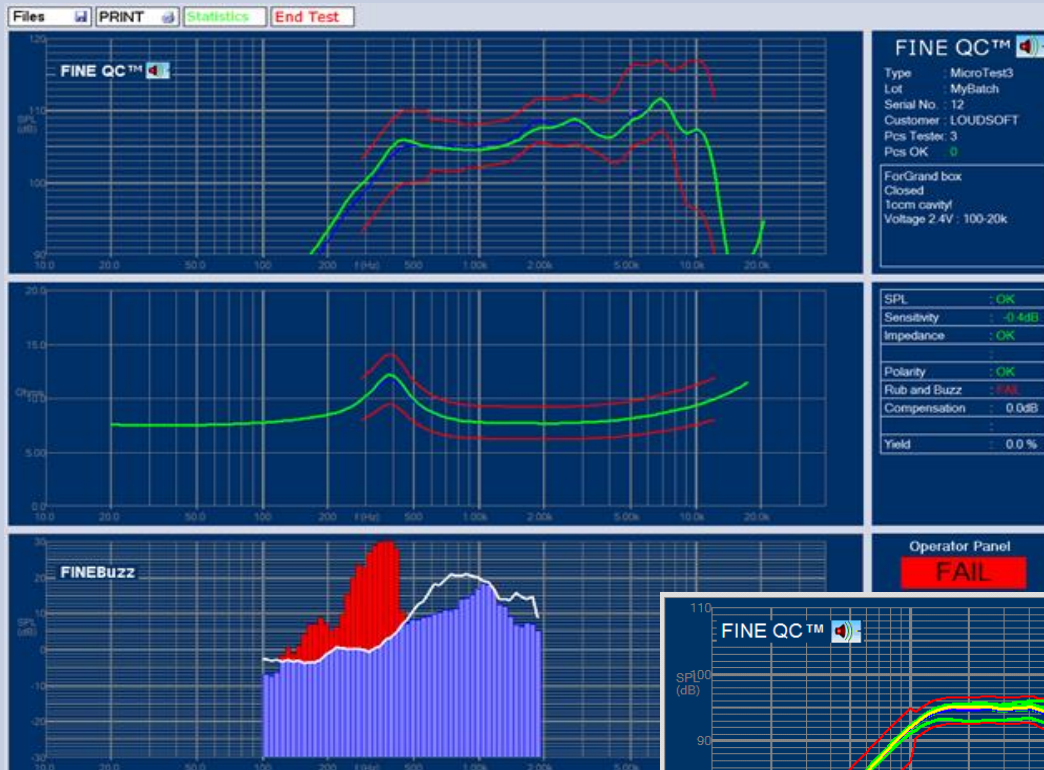


## LOUDSOFT FINE QC: Industry Firsts

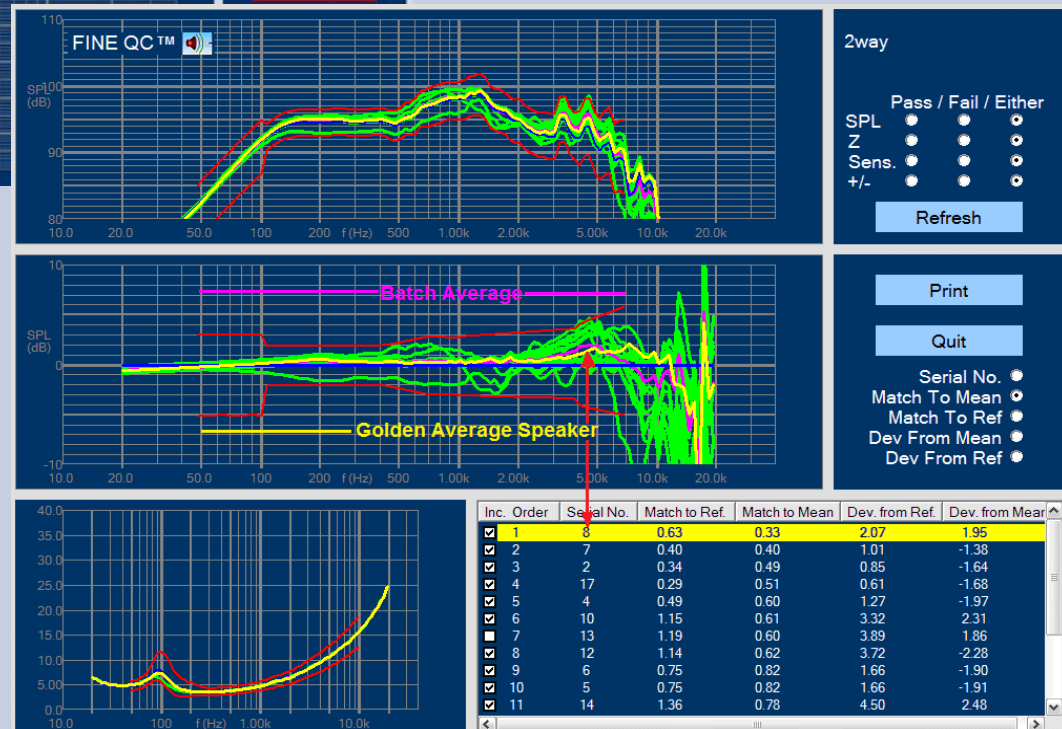
- Automatic Golden Average Speaker
- Enhanced 3rd generation Rub & Buzz Test (Post Leonhard method)
- USB2 Hardware with AD/DA, Phantom Mic & Power Amp
- Automatic Test Statistics
- Automatic Acoustic Pair Matching of Speakers
- Fast Simultaneous SPL & impedance Test w/o switching
- Automatic Rub & Buzz setup: Just measure some Good and Bad



# Speaker End of Line QC testing with FINE QC



- 100% verified at ForGrand, China
- Has fully replaced testing by ear



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# FINE QC

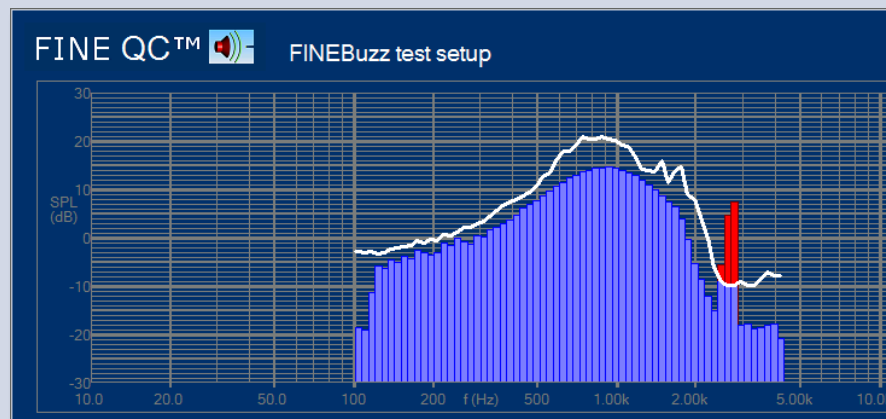


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## Rub & Buzz testing in FINE QC

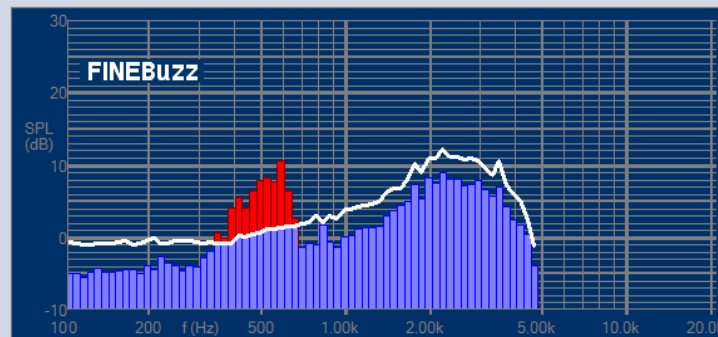
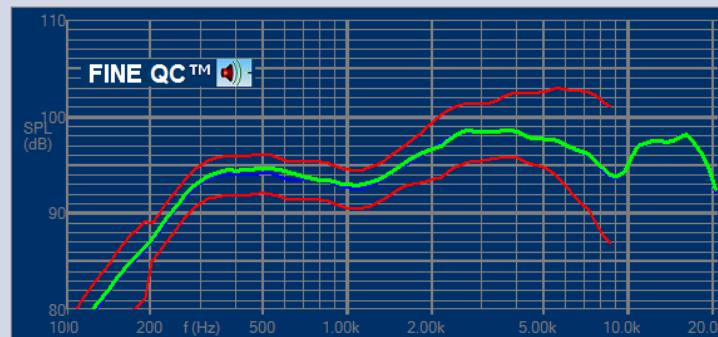
Danish F. Leonhard derived in 1993 a new auditory model how the human ear perceives sound. The FINEBuzz detection method was introduced in 2008 using an improved algorithm that finds all the annoying sounds, which cannot be detected by THD or IM.

Loudspeakers with Rub and Buzz have high irregular noise distortion. The enhanced 3<sup>rd</sup> generation FINEBuzz algorithm finds all impulsive noise in the signal using very advanced High Pass filtering. These signals are often 80-110 dB below test signal. FINEQC measures Rub & Buzz with very fine correlation with listening tests.



## Bluetooth Speaker Test on FINE QC

- Testing Wireless Bluetooth Speakers is difficult.
- FINE QC tests Frequency response, Sensitivity and Rub & Buzz (<1sec).
- FINE QC handles the latency problem in an elegant way.



FINE QC™	
SPL	: OK
Sensitivity	: 0.4dB
Polarity	: OK
Rub and Buzz	: FAIL
Compensation	: 0.0dB
Yield	: 50.0 %

**Operator Panel**

**FAIL**

Retest Ser No.: 4

Single/Re-Test ☐

Measure Ser No.: 5

**RUN**

**Z Active**

**R&B Active**



# LOUDSOFT

Denmark

## FINE Hardware 3

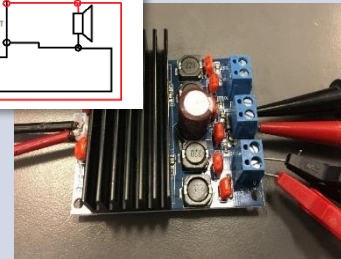
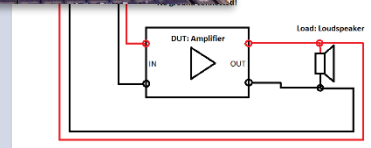
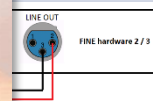
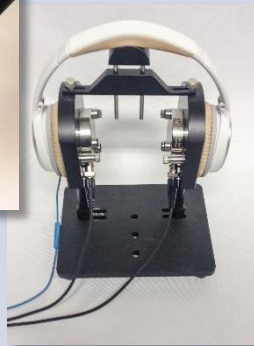
- 3 Mic./Line balanced inputs (w pre-amp) /+ 48V Phantom power
- Fast USB-2 with 48, 96 and 192 kHz sampling
- All measurements done in hardware, only results to PC
- Separate L + R headphone amplifier output
- Main amplifier 25W, balanced
- LO and HI impedance modes
- XLR balanced Line Out
- 3 TTL input + 3 TTL output (Rear)
- Total of 8 input channels and 3 output channels
- Factory calibrated
- For windows 7, 8 and 10 (+64bit) with dedicated Windows drivers



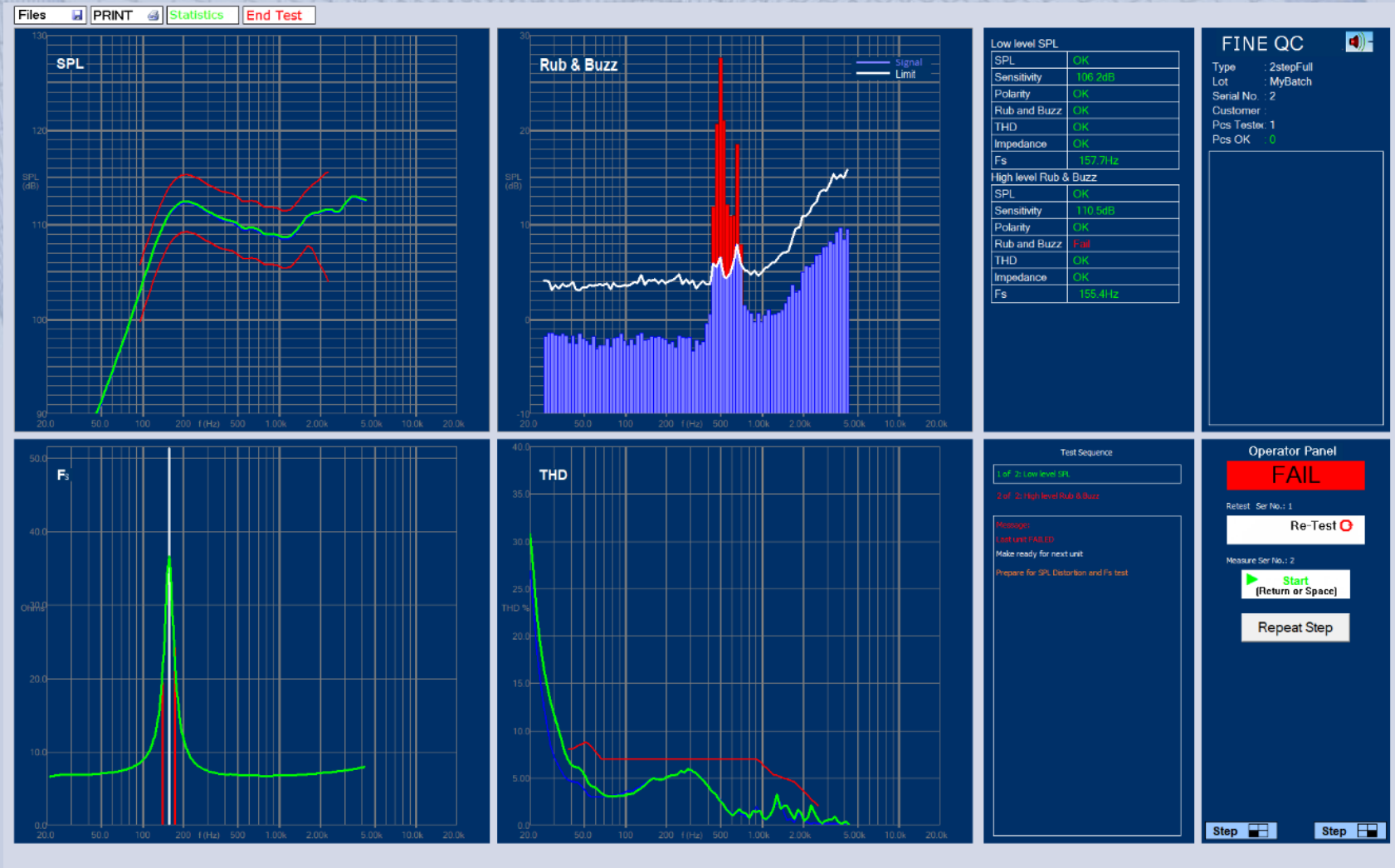
# LOUDSOFT

Denmark

## FINE Measurements:



# New FINE QCX™



# LOUDSOFT



# New FINE QCX™



One sweep QC Test: SPL, Sensitivity, Polarity, Impedance, **Fs, THD + Rub & Buzz**  
Automatic “**Golden Average unit**” and pairing of DUTs/units  
3rd gen Enhanced Rub & Buzz Test, “Best in the Industry”. **Measure Good and Bad**  
Automatic saved Statistics for all steps on **Network Drive**, including Rub & Buzz  
Pass/Fail statistics by serial numbers and Pre-Production for steps  
Bluetooth Speaker testing  
Reading Barcode serial number can start test  
Operator interface with display of pictures  
For windows 7, 8 and 10 (+64bit).

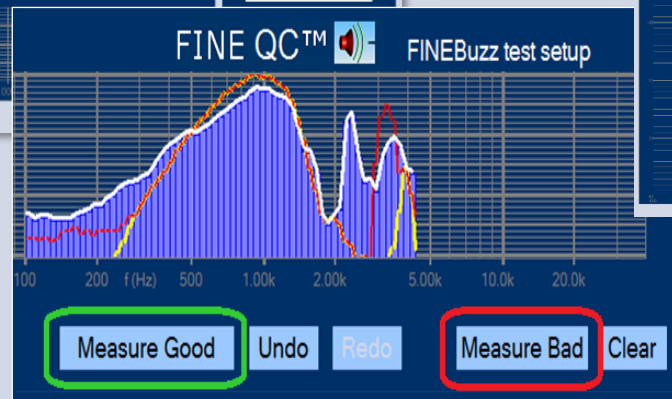
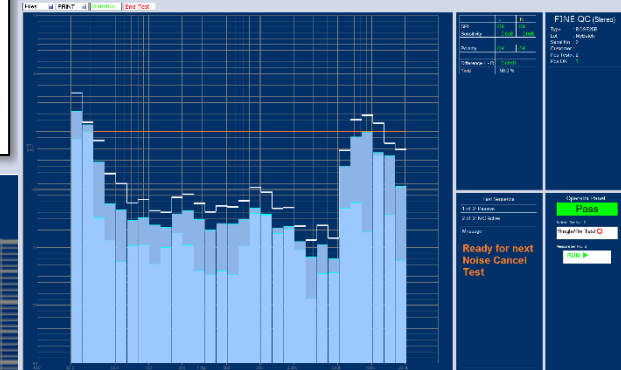
Modules (add-ons):      **Full Automation, with control to/from production line**  
                                 **Multi-step / Sequence Tests, incl. multi-microphones**  
                                 **Digital S/PDIF Output**  
                                 **Project type Auto-selection by barcode**

## LOUDSOFT



# LOUDSOFT Denmark

## FINE QC™ / Headphone / Headset



Fast Testing: Left +Right < 2.5s

# LOUDSOFT

Denmark

## The FINE Circle



[www.loudsoft.com](http://www.loudsoft.com)