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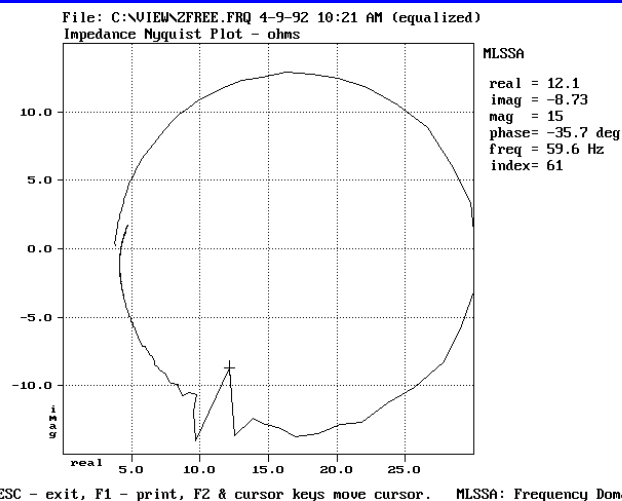
Thiele-Small Parameter Option

The *MLSSA Speaker Parameter Option (SPO)* is an optional software module for *MLSSA*. Since its introduction in 1990, *MLSSA SPO* has been widely adopted by the loudspeaker industry. Manufacturers of loudspeaker drivers and systems alike find it indispensable for quality control (QC) testing of dynamic drivers. *MLSSA SPO* is the only speaker parameter measurement system available at any price featuring fast 3-D curve-fitting analysis.

Fast 3-D Curve-Fitting Analysis Method

Driver impedance is a complex quantity that includes both magnitude and phase. The complex driver impedance can also be expressed in terms of its real and imaginary parts. In this form, driver impedance forms a spiral in 3-D space where the X-axis represents the real part, the Y-axis the imaginary part and the Z-axis represents frequency. A Nyquist plot shows this 3-D impedance spiral as viewed along the Z-axis (see figure). *MLSSA SPO* quickly finds the unique set of driver parameters that best fits this spiral over any selected frequency range. 3-D curve-fitting analysis is vastly superior to traditional methods: It's faster, more accurate and much more immune to noise. Over 1000 complex impedance points are typically fitted so that a few erroneous points contaminated, for instance, by 60 Hz interference (see figure) have a negligible influence on the measured parameters.

Typical measurement times are fast. Woofers take the longest to measure. For woofers, *MLSSA SPO* employs a 4095-point maximum-length sequence (MLS) to measure driver impedance in only 2.5 seconds over a 1 kHz bandwidth. The post-measurement 3-D curve-fitting analysis is extremely fast requiring less than 0.1 seconds when running on Pentium PCs.



Integrated Driver DCR Measurement

Voice coil DC resistance, R_e , is a critical speaker parameter that other parameters, notably Q_{es} , Q_{ts} and SPL_{ref} depend upon. *MLSSA SPO* measures true DCR with 1.0% absolute accuracy at 0.01 ohms resolution in 3 seconds or less. Driver DCR measurements are completely automated and even corrected for the residual resistance of your test leads. For DCR measurements requiring virtually zero measurement time but at slightly reduced accuracy, *MLSSA SPO* can optionally estimate driver DCR from the measured driver impedance curve.

Integrated QC PASS/FAIL Facility

QC PASS/FAIL testing is directly supported and QC acceptance limits can be individually programmed for each parameter on either an absolute or percentage basis. Additionally, all parameter data are automatically logged to a text file for driver matching purposes or, for later statistical analysis by *MLSSA SPO* or by other programs. Both automatic and manual serialization is supported.

Integrated Statistical Analysis Facility

Statistics are computed from parameter data previously stored on disk. Statistics include mean, standard deviation, minimum and maximum for each parameter. The number of failures and total yield are also computed based on any QC acceptance limits. This allows what-if yield comparisons between tighter or looser QC acceptance limits without the need to repeat the parameter measurements.

over

Measured Parameters

Measured parameters (see figure below) include Fs, Re, Res, Qms, Qes, Qts, Vas, Cms, Mms, SPLref and the BI product. In addition, parameters L1, L2 and R2 describing the driver's motor impedance are also measured. Parameter SPLref is the dB-SPL at 1 meter for a 1 watt input referred to the driver's DCR, Re. SPLref can optionally be referred to 8 ohms (2.83 volts RMS input) or any another reference load impedance.

MLSSA SPO 4.0A #960121-2615-2683 for DRA Laboratories
Measured Data C:\VIEW\DEMO.PLM

Line	Parameter	Value	Units	Nominal	Min	Max	Result
1	RMSE-free	0.21	Ohms	0.21	0.00	0.50	PASSED
2	Fs	45.88	Hz	45.87	42.00	48.00	PASSED
3	Re	3.64	Ohms[dc]	3.64	3.50	3.90	PASSED
4	Res	26.52	Ohms	26.52	23.00	27.00	PASSED
5	Qms	2.85		2.85	2.75	3.00	PASSED
6	Qes	0.39		0.39	0.38	0.43	PASSED
7	Qts	0.34		0.34	0.33	0.37	PASSED
8	L1	0.22	mH	0.22	0.20	0.30	PASSED
9	L2	0.57	mH	0.57	0.40	0.70	PASSED
10	R2	3.10	Ohms	3.10	2.75	3.25	PASSED
11	RMSE-load	0.23	Ohms	0.23	0.00	0.50	PASSED
12	Vas(Sd)	34.27	liters	34.27	33.00	38.00	PASSED
13	Mms	8.69	grams	8.69	8.50	8.75	PASSED
14	Cms	1386	µM/Newton	1385.79	1375.00	1400.00	PASSED
15	BI	4.83	Tesla-M	4.83	4.75	5.25	PASSED
16	SPLref(Sd)	94.5	dB[8 ohms]	94.52	87.00	95.00	PASSED
17	Rub-index	0.17		0.17	0.00	0.00	

Method: Mass-loaded (10.00 grams) Area (Sd): 132.70 sq cm
DCR mode: Measure QC file: CLOSED

LIB PARAMETERS: Go Calc Method DCR-mode Area Synthesize QC Export Z-ref Print
F1 for Help or ESC to exit MLSSA: Parameters

Improved Added-mass Method

To determine parameters Vas, Mms, Cms, BI and SPLref, a second impedance measurement is usually required. In the added mass method this second impedance measurement is performed with the driver's effective moving mass intentionally increased by attaching a known test mass and observing the shift in the driver's resonant frequency and Q. The conventional added-mass method also assumes that driver compliance is the same both before and after attaching a test mass. But compliance shifts often occur when the driver's suspension is disturbed in the process of attaching or removing the test mass. Such compliance shifts can result in significant errors in the measured parameters. MLSSA SPO eliminates this problem through an improved added-mass algorithm that is immune to driver compliance shifts.

Closed-box and Fixed-Mmd Methods

In addition to the improved added-mass method, the traditional closed-box method is also supported for determining parameters Vas, Mms, Cms, BI and SPLref. A third method called Fixed-Mmd requires only one impedance measurement when the driver's moving mass, Mmd, can be determined by other means.

Rub Detection Parameter

In addition to the Thiele-Small parameters, the MLSSA SPO also includes a proprietary rub detection parameter. This parameter is very sensitive to driver rub problems caused by mechanical misalignment of the voice coil or by the presence of chips or other foreign matter lodged in the air gap. The rub parameter can be used by the QC PASS/FAIL facility to automatically reject defective drivers with no increase in the total measurement time.

MLSSA SPO QC Statistics of Passed Drivers Only

Line	Parameter	Units	Mean	STD	Low	High	Failures
1	RMSE-free	Ohms	0.000	0.000	0.00	0.00	0
2	Fs	Hz	0.000	0.000	0.00	0.00	0
3	Re	Ohms	0.000	0.000	0.00	0.00	0
4	Res	Ohms	0.000	0.000	0.00	0.00	0
5	Qms		0.000	0.000	0.00	0.00	0
6	Qes		0.000	0.000	0.00	0.00	0
7	Qts		0.000	0.000	0.00	0.00	0
8	L1	mH	0.000	0.000	0.00	0.00	0
9	L2	mH	0.000	0.000	0.00	0.00	0
10	R2	Ohms	0.000	0.000	0.00	0.00	0
11	RMSE-load	Ohms	0.000	0.000	0.00	0.00	0
12	Vas	liters	0.000	0.000	0.00	0.00	0
13	Mms	grams	0.000	0.000	0.00	0.00	0
14	Cms	µM/Newton	0.000	0.000	0.00	0.00	0
15	BI	Tesla-M	0.000	0.000	0.00	0.00	0
16	SPLref	dB	0.000	0.000	0.00	0.00	0
17	Rub-index		0.000	0.000	0.00	0.00	0

Total: 0 units QC file: C:\VIEW\TEST.PQC
Yield: Limits file: C:\VIEW\DEMO.PLM

LIB PARAMETERS QC STATISTICS: Calculate QC-file Limits-file Mode Print
F1 for Help or ESC to exit MLSSA: Parameters

Multimedia Drivers

MLSSA SPO measures small multimedia drivers with ease. Due to the 3-D curve-fitting analysis method, highly damped, highly inductive as well as drivers with high Fs can be measured; drivers that previously were impossible to characterize using traditional parameter measurement methods.

Macros and Export Support

Complete parameter measurements and QC PASS/FAIL tests can be performed without macros but the integrated MLSSA macro facility is also accessible from the MLSSA SPO menu for more customized and sophisticated applications. For example, macros allow you to display your own custom messages and prompts to production line operators. Measured parameters can also be exported to standard text files for importing into CAD packages.

Ordering Information

The MLSSA SPO includes its own manual and free software upgrades for the first year after purchase. When ordering separately, please specify your MLSSA card filter module serial numbers. These are obtained by pressing Alt-3 from the main MLSSA menu.