List of Variables and Symbols

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Hardware

Symbol	Description	Module	Unit
*A † *5	Symbols show status of DUTs connected to processor in uprising order (DUT No.1, DUT No.2, ... , DUT No.5)	PM8	
5	Number represents DUT currently updated in processor unit (DUT No.5)	PM8	
*	Star represents alive DUT	PM8	
†	Cross represents disconnected DUT due to malfunction	PM8	
A	Capital A represents amplifier switched off or having low gain	PM8	
B	Measured bottom value in displacement	DA2 (LASER)	mm
D	displacement from user defined reference position (distance)	DA2 (LASER)	mm
P	Measured peak value in displacement	DA2 (LASER)	mm
fLP	cut off frequency of low-pass, used for averaging high frequencies	DA2 (LASER)	Hz

Greek Symbols

Symbol	Description	Module	Unit
α	Factor describing the distribution of heat caused by eddy currents on voice coil and magnet	SIM, SIM-AUR	Hz
α	System compliance ratio	LSIM	
αn	Direction of the maximum tilting of the nth rocking mode, n = 1,2	RMA	°
γ	Bypass factor	SIM, SIM-AUR	
ΔCF	Difference between crest factor for voltage and current signal and crest factor for displacement signal	LSIM	dB
Δf	Difference of two frequencies		Hz
ΔT	Increase of temperature relative to the starting temperature All Temperatures are relative to the starting time of a measurement (normally ambient temperature)	LSI, SIM, DIS	K
ΔT_{lim}	Maximal allowed increase of temperature relative to the initial state	LSI, DIS	K
ΔT_v, T_v	Voice coil temperature		K
$\Delta T_v(t)$	Voice coil temperature, time dependent		K
ΔT_m, T_m	Temperature of magnet structure		K

Symbol	Description	Module	Unit
η	Mean efficiency for a certain stimulus	LSIM	%
$\eta(f)$	Efficiency	LSIM	%
η_0	Reference efficiency of electro-acoustical conversion, (2π-radiation load)	LPM	%
$\eta_0(t)$	Reference efficiency of electro-acoustical conversion, time dependent	LSI	%
η_n	Modal damping factor of the n^{th} mode Resonator H_n	RMA, HMA	none
η_{Pb}	Passband efficiency of driver operated in baffle	LSIM	%
ϑ	Polar angle	NFS, POL	°
κ	Creep factor of the *Ritter* model	MMT	
Φ	Mode shape of the n^{th} mode Resonator H_n	RMA, HMA	
λ	Creep factor, used for modeling low frequency behavior of mechanical suspension	LPM, MMT, SIM-AUR	
λ	Wave length	NFS	m
ρ	Density of air	SIM, SIM-AUR	kg/m^3
φ	Phase angle	SAN	°
φ	Circular angle	NFS	°
$\Re\{ZL(fs)\}$	Real part of voice coil impedance at resonance frequency fs	LPM	Ω

A

Symbol	Description	Module	Unit
a	Radius of validation of spherical wave expansion	NFS	m
AAL	Absolute summation of the cone acceleration. Scaled to be directly comparable to SPL.	SCN	dB
AAL_0	Cumulated acceleration of the piston mode	RMA	dB
$AAL_{n,E}$	Cumulated acceleration of the n^{th} rocking mode for the excitation terms E; Mass, Stiffness, Bl and the total contribution	RMA	dB

B

Symbol	Description	Module	Unit
b_1, …, b_8	Nonlinear coefficients for Bl(x) series expansion	LSI, SIM, SIM-AUR	$(N/A)^n$
Bl	Force factor (Bl product), constant, linear parameter. **Equivalent to Bl(x=0).**	LPM, LSI, MMT, LSIM	N/A
Bl(x)	Force factor (Bl product), nonlinear parameter, dependent on displacement	LSI, SIM, SIM-AUR	N/A
$Bl(x_{rel})$	Force factor, nonlinear parameter, dependent on relative displacement No absolute displacement information available	LSI	N/A
Bl_{lim}	Allowed minimal value of the force factor ratio Bl_{min} , used for protection system	LSI	%
Bl_{min}	Minimal force factor ratio for all x values, parameter for the highest deviation from any Bl(x) value relative to the Bl(x=0) value	LSI	%
B(f,**r**)	General basic function (solutions of the wave equation)	NFS	

C

Symbol	Description	Module	Unit
c	Speed of sound	LPM	m/s
c_1, …, c_8	Nonlinear coefficients for $C_{ms}(x)$ series expansion	LSI, SIM	$(mm/N)^n$
C_{ab}	Acoustical compliance of air in enclosure	LSIM	m³/Pa
$C_{ab}(p_{box})$	Acoustic compliance of the air in enclosure, dependent on p_{box}	SIM, SIM-AUR	mm/N
C_{at}	Total acoustical compliance of transducer and enclosure	LSIM	m³/Pa
C_f	Acoustical compliance of air in front enclosure	LSIM	m³/Pa
CF	Crest factor	LSIM	dB

Symbol	Description	Module	Unit
CFRE	Combined Force Ratio (related to the voice coil excitation) considering the excitation of the two rocking modes, for the root causes E, Mass, Stiffness and Bl	RMA	%
C_{lim}	Allowed minimal value of the compliance ratio C_{min}, used for protection system	LSI	%
C_{mes}	Electrical capacitance representing moving mass in mechanical system in free air	LPM, LSI, MMT	µF
C_{med}	Electrical capacitance representing moving mass in mechanical system in vacuum	MMT	µF
C_{min}	Minimal compliance ratio for all x values, parameter for the highest deviation from any C(x) value relative to the C(x=0) value	LSI	%
C_{md}	Mechanical compliance of driver suspension in vacuum.	MMT	mm/N
C_{ms}	Mechanical compliance of driver suspension in free air. **Equivalent to C_{ms}(x=0).**	LPM, LSI, MMT	mm/N
$C_{ms}(x)$	Compliance of mechanical suspension, nonlinear parameter, dependent on displacement	LSI	mm/N
$C_{ms}(x=0, t)$	Mechanical compliance of driver suspension, value at the rest position, dependent on time (long time variation due to e.g. break in, aging or heating)	LSI	mm/N
C_{ms} (x_{rel})	Mechanical compliance of driver suspension, nonlinear parameter, dependent on relative displacement, No absolute displacement information available	LSI	mm/N
$C_{n,m}(f)$	Sound field weighting coefficients	NFS	
C_r	Acoustic compliance of air in rear enclosure in band pass systems	SIM, SIM-AUR	mm/N
C_r (p_{rear})	Acoustic compliance of air in rear enclosure in band pass systems, dependent on the pressure (for heavy compressions only)	SIM, SIM-AUR	mm/N
C_{ta}	Thermal capacitance of the air surrounding the coil giving convection cooling	SIM, SIM-AUR	Ws/K
C_{tg}	Thermal capacitance of pole tips and magnet surface close to coil	SIM, SIM-AUR	Ws/K
C_{tm}	Thermal capacity of the magnet frame structure	LSI, SIM, SIM-AUR	Ws/K

Symbol	Description	Module	Unit
C_{tv}	thermal capacity of the voice coil structure	LSI, SIM, SIM-AUR	Ws/K
$C_{xy}(f)$	Magnitude squared coherence	SAN	% or dB

D

Symbol	Description	Module	Unit
DET_{abs}	The DET_{abs} is an absolute measure for deterministic (strictly periodic) Rub&Buzz distortion. Based on long-term spectral analysis it evaluates the averaged high order harmonic distortion. It represents the SPL of the distortion peak value (using phase and amplitude).	QC LD	dB
DET_{rel}	The DET_{rel} is derived from DET_{abs} as a relative level measure representing the crest factor of deterministic distortion. It is calculated by relating the distortion peak to the distortion RMS value.	QC LD	dB
$DET(L)_{abs}$	The $DET(L)_{abs}$ is an absolute measure for specific deterministic distortion caused by air leaks and is based on averaged long-term spectral analysis. It represents the SPL peak value of the averaged leak distortion.	QC LD	dB
$DET(L)_{rel}$	The $DET(L)_{rel}$ is derived from $DET(L)_{abs}$ as a relative level measure. It represents the modified crest factor of deterministic leak distortion using a cleaned RMS value.	QC LD	dB
d(t)	Distortion / difference signal $d(t)=x(t)-x_{lin}(t)$ (*x* is a placeholder for an arbitrary signal)	SIM-AUR	
d2	Maximum Doppler distortions allowed at X_D	LSI	
d_{Bl}	Force factor distortion, caused from the nonlinear variation of the Bl(x) vs. displacement, related to the amplitude of the linear (fundamental) output signal	LSI	%
$d_{Bl}(t)$	Force factor distortion over time	LSI, AUR	%
d_C	Compliance distortion, caused from the nonlinear variation of the C(x) vs. displacement, related to the amplitude of the linear (fundamental) output signal	LSI	%
$d_C(t)$	Compliance distortion over time	LSI, AUR	%
d_d	Diaphragm diameter of the driver	DIS, SIM, SIM-AUR	cm
d_L	Inductance distortion, caused from the nonlinear variation of the L(x) vs. displacement, related to the amplitude of the linear (fundamental) output signal	LSI	%
$d_L(t)$	inductance distortion over time	LSI, AUR	%

$DMR(t,f_{spect})$	Disturbance to Mask Ratio	QC-Ear	dB
d_{ms}	Distance microphone to speaker	ISC	m
d_p	Diameter of port	LSIM	cm
d_r	Diameter of round effective projected surface area of passive radiator di-aphragm	LSIM	cm
DR	Dynamic range	SAN	dB
d_{rf}	Reflection Free Distance	NFS	m
d_r	Distance of first reflection	ISC	m
d_{sr}	Distance speaker to room wall	ISC	m
d_K	Distortion factor representing the distortion generated by the stiffness nonlinearity	MSPM	%

E

Symbol	**Description**	**Module**	**Unit**
E(t)	Envelope over one period *t*	DIS	
E_{Bottom}	Minimal value of the envelope over one period *t*		
E_F	residual error in force	MSPM	%
e_{Fit}	Fitting Error of spherical wave expansion	NFS	dB
$E_i(t)$	Relative error of the modeled current related to the measured current represents the quality of the agreement between learned parameters and reality	LSI	%
E_{lin}	Linear error in force, relative to stimulus signal F_{stim}	MSPM	%
E_{rm}	Parameter of the *Wright* inductance model	MMT, LSIM	
E_{Setup}	Error in measured transfer function in relation to the imported elements	MSPM	%
E_{Top}	Maximal value of the envelope over one period *t*	DIS	
$E_u(t)$	Relative error of the modeled voltage related to the measured voltage, represents the quality of the agreement between learned parameters and reality	LSI	%
$E_x(t)$	Relative error of the modeled displacement related to the measured displacement, represents the quality of the agreement between learned parameters and reality	LSI	%
E_{xm}	Parameter of the *Wright* inductance model	MMT, LSIM	

F

Symbol	Description	Module	Unit
Fdz	Federzahl (spider flexibility)	QC LST	-
F_{stim}	Force generated by the excitation of the suspension part	MSPM	N
f_1	frequency for sweep tone, variable (used in DIS module)	DIS	Hz
$f_1 - f_2$	constant difference between first tone and second tone (for intermodulation)	DIS	Hz
f_1 / f_2	constant ratio between first tone and second tone (for intermodulation)	DIS	
f_2	Specifies the second tone for intermodulation measurements	DIS	Hz
f_b	Resonance frequency of enclosure-port system	SIM, SIM-AUR, LSIM	Hz
f_c	Box resonance frequency, used for modeling closed box systems	SIM, SIM-AUR	Hz
f_{cross}	crossover frequency for tweeter / woofer channel separation	AUR	Hz
f_{ct}	Resonance frequency of driver in enclosure, used for measuring linear parameters with two step measurement (no laser, additional enclosure)	LPM	Hz
f_d	Resonance frequency of the driver in vacuum	MMT	Hz
f_f	Resonance frequency of enclosure-port system (only Bandpass systems)	LSIM, SIM, SIM-AUR	Hz
f_{high}	cut-off frequency for lowpass filter or Higher frequency limit of fitting or signal related processing range	LSI MSPM, LSIM	Hz
$f_{I,SNR}$	frequency of minimal SNR in i(t)	LPM	Hz
f_{low}	cut-off frequency for high-pass or Lower frequency limit of fitting or signal related processing range	LSI MSPM, LSIM	Hz
f_m	Resonance frequency of driver with additional mass, used for measuring linear parameters with two step measurement (no laser, additional mass)	LPM	Hz
$F_m(x,i)$	Reluctance (electromagnetic) Force, dependent on dL(x)/dx and $i(t)^2$	LSI, SIM, SIM-AUR	N
f_{max}	Lower frequency of excitation or processing range	LPM, NFS, MTON, TRF, TFA	Hz

Symbol	Description	Module	Unit
f_{min}	Frequency representing the minimum retardation time of the Ritter creep model or Lower frequency of excitation or processing range	MMT SAN, NFS, MTON, TRF, TFA	Hz
f_n	Resonance frequency of the n^{th} mode	RMA, HMA	Hz
f_p noise	Frequency of noise maximum in microphone signal	LPM	Hz
f_r	Resonance Frequency of passive-radiator (free-air)	LSIM, SIM, SIM-AUR	
FR(f)	Frequency response	SAN	dB
$FR_p(f)$	SPL Frequency Response – identical to SPL(f)	SAN	dB
f_{ref}	Reference frequency, relative resolution will be ensured for all frequencies above f_{ref}	LPM	Hz
f_{res}	Frequency resolution	LPM, NFS, MTON	1/oct
f_{rf}	Reflection Free Frequency	NFS	Hz
f_s	Resonance frequency of driver in free air	ALL, LSIM	Hz
$f_S(t)$	Resonance frequency of driver in free air, time dependent (long time variations)	LSI	Hz
$f_S(x)$	Resonance frequency of driver in free air, dependent on displacement considering the compliance as a function of x	LSI	Hz
$f_s(x=0)$	Resonance frequency of driver in free air $f_S(x)$ at the rest position	LSI	Hz
$f_S(x=0, t)$	Resonance frequency of driver in free air $f_S(x)$ at the rest position, considering time dependent variations of $C_{ms}(x=0, t)$ (long time variations)	LSI	Hz
f sample	Sample frequency	LPM	Hz
f_{start}	start value of frequency sweeps	DIS, SIM	Hz
$f_{u,noise}$	frequency of minimal SNR in u(t) $f_{u,noise}$	LPM	Hz
$f_{x,cutoff}$	Highest reliable frequency using the laser sensor	LPM	Hz

G

Symbol	Description	Module	Unit
G_{large}	Variable gain for Large Signal Identification, specifies the ratio from Large Signal and Small Signal excitation level	LSI	dB
g_n	Modal gain of the n^{th} mode Resonator H_n	RMA, HMA	dB
G_{max}	Maximum allowed gain for Power Testing	PWT	dB
G_{pre}	Input preamplifier gain	QC	dB
G_{small}	Excitation level for small signal identification, 0dB corresponds to the maximal realizable voltage, used for optimizing the parameter measurement due to different driver sensitivities	LSI	dB
G_U	Step size of amplitude amplification	PWT MTON	dB V
RG_n	Relative modal gain of the rocking modal resonator H_n	RMA	dB

H

Symbol	Description	Module	Unit
H(f,**r**)	Transfer function of a specific point in 3D space	NFS	dB / V
$H_a(f)$	Transfer function between voltage and acceleration	SAN	ms^{-2}/V
$H_{\mathrm{equ}}(f)$	Equalizer	LSIM	dB
$H_{\mathrm{F}}(f)$	Transfer Function between Force and Voltage	LSIM	N/V
$H_n(f)$	Transfer resonator of the n^{th} mode	RMA, HMA	
$h_n^{(1)}(kr)$	Hankel function of the 1st kind	NFS	
$h_n^{(2)}(kr)$	Hankel function of the 2nd kind	NFS	
$H_p(f)$	Transfer function between voltage and sound pressure	SAN	p/V
h_{p}	Height of surface area of port	LSIM	cm
$H_{\mathrm{pfar}}(r,f)$	Transfer Function between Sound Pressure in Far Field and Voltage	LSIM	p/V
$H_{\mathrm{q}}(f)$	Transfer Function between Volume Velocity and Voltage	LSIM	m^3/Vs
$H_{\mathrm{v}}(f)$	Transfer Function between Velocity and Voltage	LSIM	m/Vs
$H_{\mathrm{x}}(f)$	Transfer function between U and x, $H_x(f)= x(f)/U(f)$	LPM, MMT, LSIM	mm/V

I

Symbol	Description	Module	Unit
I_{ac}	AC part of current signal	LPM	A

Symbol	Description	Module	Unit
I(f)	Spectrum of measured current	LPM	dB(A)
I(t)	Time signal of measured current	LPM	A
I_{head}	Headroom in i(t) measurement (due to limited input capabilities)	LPM	dB
I_{peak}	Peak-to-peak value of current i(t)	LPM	A
$I_{peak}(t)$	Peak value of measured input current	LSI	A
$I_{rms}(t)$	RMS value of measured input current	LSI	A
$I_{T_{peak}}$	Input current (peak) for stimulus (ÜBERARBEITUNG)	LSIM	A
$I_{T_{rms}}$	Input current (rms) for stimulus (ÜBERARBEITUNG)	LSIM	A
I_{SNR}	Signal to noise ratio of measured input current	LPM	dB
I_{SNR+D}	Ratio of signal to noise + distortion in current signal	LPM	dB

J

Symbol	Description	Module	Unit
$j_n(kr)$	Bessel function	NFS	

K

Symbol	Description	Module	Unit
k	Wavenumber	NFS	1/m
K	Mechanical stiffness of suspension part (linear).	MSPM	N/mm
K	Parameter of the *Leach* inductance model	MMT, LSIM	Ω
$C_{chebychev}$	Chebychef Konstante	LSIM	
K_{mb}	Mechanical stiffness of air in enclosure	LSIM	N/mm
K_{md}	Mechanical stiffness of driver suspension in vacuum	MMT	N/mm
K_{mr}	Mechanical stiffness of passive radiator suspension (inverse of compliance C_{mr})	LSIM	N/mm
K_{ms}	Mechanical stiffness of driver suspension in free air. **Equivalent to $K_{ms}(x=0)$.**	LPM, LSI, MMT	N/mm
$K_{ms}(x)$	Mechanical stiffness of driver suspension, nonlinear parameter, dependent on displacement	LSI, SIM, SIM-AUR	N/mm
K_{mt}	Total mechanical stiffness of transducer and enclosure	LSIM	N/mm
$K_{mr}(x)$	Mechanical stiffness of passive radiator suspension, nonlinear parameter, dependent on displacement	SIM, SIM-AUR,	N/mm

Symbol	Description	Module	Unit
K_{rm}	Parameter of the *Wright* inductance model	MMT, LSIM	
K_{xm}	Parameter of the *Wright* inductance model	MMT, LSIM	
k_0	Effective mechanical stiffness (small signal, at rest position)	QC LST	N/mm

L

Symbol	Description	Module	Unit
L	Mean Voltage Sensitivity of selected stimulus for r_{ref} and u_{ref}	LSIM	dB
$L(f)$	Voltage Sensitivity	LSIM	dB
$l_1, \ldots, l_8$	Nonlinear coefficients for L(x) series expansion	LSI, SIM, SIM-AUR	$(mH)^n$
L_2	Electric Inductance of voice coil structure, modelling eddy currents (with L and R2). **Equivalent to $L_2(x=0)$.**	LPM, LSI, MMT, LSIM	mH
L_2 (x_{rel})	Electric Inductance of voice coil structure modelling eddy currents (with L and R2), nonlinear parameter, dependent on relative displacement, No absolute displacement information available	LSI	mH
$L_2(x)$	Electric Inductance of voice coil structure modelling eddy currents (with L and R2), nonlinear parameter, dependent on displacement	LSI, SIM, SIM-AUR	mH
L_3	Electrical inductance due to eddy current losses	LSIM	mH
$L_3(x)$	Electric Inductance of voice coil structure modelling eddy currents (with L, L2, R2 and R3), nonlinear parameter, dependent on displacement	SIM, SIM-AUR	mH
L_a	Acceleration level	SAN	dB
L_{ces}	Electric inductance representing driver compliance in free air	LPM, LSI, MMT	mH
L_{ced}	Electric inductance representing driver compliance in vacuum	MMT	mH
L_e	Voice coil inductance. **Equivalent to $L_e(x=0)$.**	LPM, LSI, MMT, LSIM	mH
L_e (x_{rel})	Voice coil inductance, nonlinear parameter, dependent on relative displacement, No absolute displacement information available	LSI	mH
$L_e(x)$	voice coil inductance, nonlinear parameter, dependent on displacement	LSI, SIM, SIM-AUR	mH
$L_{Hi\text{-}2}$	Level of Hi-2 distortion	SPL-Hi2	dB
L_m	Characteristic sound pressure level	SIM	dB
$L_m(t)$	Characteristic sound pressure level over time	SIM	dB

Symbol	Description	Module	Unit
L_p	Sound pressure level	SAN	dB
l_p	Length of port	LSIM	cm
L_{Pb}	Passband sensitivy of driver operated in baffle with reference voltage u_{ref} and reference distance r_{ref}	LSIM	dB
L_{stim}	Stimulus level	SAN	dBFS
L_u	Voltage Level	SAN	dB
L_x	Displacement level	SAN	dB

M

Symbol	Description	Module	Unit
m	Mass, mechanical (moving) mass	QC LD MSPM	g
m	Sub order of spherical harmonics	NFS	
M	Number of measurement points	NFS	
M_{add}	Additional mass	LPM	g
M_{ap}	Mass of air load in port systems (in vented box / bandpass systems)	SIM, SIM-AUR, LSIM	g
M_{Bottom}	Bottom-Modulation	DIS	
mDMR(t)	Mean Disturbance to Mask Ratio	QC-EAR	dB
$MFR_{n,E}$	Modal Force Ratio of the n^{th} (n =1,2) rocking mode of each root cause. E = Mass, Stiffness or Bl	RMA	%
M_{md}	Mechanical moving mass of driver diaphragm assembly including voice coil without air load	MMT	g
M_{mr}	Moving mass of passive radiator diaphragm including air load	SIM, SIM-AUR, LSIM	g
M_{ms}	Mechanical moving mass of driver diaphragm assembly including voice coil and air load	ALL, LSIM	g
MOD_{abs}	The MOD_{abs} describes the absolute level of amplitude-modulated noise as generated by turbulent flow in leakages and other semi-random defects. The modulation envelope peak value is related to the standard reference sound pressure p_0 (comparable to SPL).	QC LD	dB
MOD_{rel}	The MOD_{rel} is a relative measure derived from the MOD_{abs} measure. The peak value of the modulation envelope is related to the average broadband floor of the modulation spectrum. It can be interpreted as a modulation ratio.	QC LD	dB

Symbol	Description	Module	Unit
M_{Top}	Top-Modulation	DIS	

N

Symbol	Description	Module	Unit
n	order of distortion analysis, number of highest harmonic distortion component which will be measured	DIS	
n	Main order of spherical harmonics	NFS	
N	Parameter of the *Leach* inductance model	MMT	
N(f)	Order of spherical wave expansion	NFS	
N stim	Stimulus length	LPM	
$\mathbf{n}_{ref}$	Reference Vector	NFS	m

O

Symbol	Description	Module	Unit
$\mathbf{o}_{ref}$	Orientation Vector	NFS	m

P

Symbol	Description	Module	Unit
P	input power	LPM	W
p	Density of air	LPM	kg/m^3
p(f)	Sound pressure spectrum	LPM, NFS	Pa
p(t)	sound pressure time signal	LPM	Pa
P_a	Total acoustical output power	LSIM	µW
p_{ac}	AC part of microphone signal	LPM	mV rms
p_{Bl}, $p_{Bl}(t)$	Distortion component caused by Bl(x) nonlinearity (in pressure signal)	AUR	Pa
P_{box}	Pressure in box enclosure	SIM, SIM-AUR, LSIM	Pa
PC(t)	Power Compression factor, specifies decrease of output due to heating	LSI	DB
p_C, $p_C(t)$	Distortion component caused by $C_{ms}(x)$ nonlinearity (in pressure signal)	AUR	Pa
P_{coil}	power dissipated in voice coil and former	SIM, SIM-AUR	W

Symbol	Description	Module	Unit
P_{con}	power transferred to the air in the gap due to convection cooling	LSI, SIM, SIM-AUR	W
pdf(x)	Probability Density Function of displacement in the last update period	LSI	
pdf(U)	Probability Density Function of voltage in the last update period	LSI	
P_e	Total electrical transducer input power	LSIM	W
P_{eg}	power transferred to the pole tips due to eddy currents	SIM, SIM-AUR	W
$p_{far}(t)$	Sound pressure in the far field	SIM, SIM-AUR	Pa
P_g	power transferred to the pole tips	SIM, SIM-AUR	W
p_{head}	Headroom in pressure p(t) measurement (due to limited input capabilities)	LPM	dB
p_K, $p_K(t)$	Distortion component caused by $K_{ms}(x)$ nonlinearity (in pressure signal)	AUR	Pa
p_L, $p_L(t)$	Distortion component caused by $L_E(x)$ nonlinearity (in pressure signal)	AUR	Pa
P_{lim}	Allowed maximal value of electric input power P, used in protection system of Large Signal Identification	LSI	W
p_{lin}, $p_{lin}(t)$	linear component of output pressure signal	AUR	Pa
P_N	nominal input power U_{rms}^2 / Z_N	LSI	W
p_{RE}	effective Input Power under consideration of phase	LSI	W
p_{rear}	Pressure in rear enclosure in band bass or vented box systems	SIM, SIM-AUR	Pa
p_{SNR}	Signal to noise ratio in measured pressure signal p(t)	LPM	dB
p_{SNR+D}	Ratio of signal to noise + distortion in microphone signal	LPM	dB
P_{tv}	power transferred to the pole tips from coil	SIM, SIM-AUR	W

Q

Symbol	Description	Module	Unit
Q	Quality Factor of measured DUT (diaphragm)	MSPM, QC LST	
Q_l	Loss factor for the acoustic system at f_b considering leakage losses	SIM, SIM-AUR, LSIM	
Q_b	Total Q-factor considering all acoustical losses	LSIM	
Q_{ed}	Electrical Q-factor of driver in vacuum considering R_e only	MMT	

Symbol	Description	Module	Unit
Q_{es}	Electrical Q-factor of driver in free air considering R_e only, neglecting $\Re\{Z_L(f_s)\}$	LPM, MMT, SIM, SIM-AUR, LSIM	
Q_{es} (x=0, t)	Electrical loss factor considering nonlinear parameter Bl(x) and $f_S(x)$ and time variation (due to heating), value at the rest position	LSI	
$Q_{es}(T_v,x)$	Electrical loss factor considering nonlinear parameter Bl(x) and $f_S(x)$ and time variation (due to heating)	LSI	
$Q_{es}(x)$	Electrical loss factor considering nonlinear parameter Bl(x) and $f_S(x)$	LSI	
Q_{md}	Mechanical Q-factor of driver in vacuum considering R_{md} only	MMT	
Q_{ms}	Mechanical Q-factor of driver in free air considering R_{ms} only	LPM, MMT, SIM, SIM-AUR, LSIM	
Q_{ms} (x, T_v)	Mechanical Q-factor of driver considering R_{ms} only, dependent on displacement and voice coil temperature, nonlinear parameter	LSI	
Q_{ms} (x=0, T_v)	Mechanical Q-factor of driver considering R_{ms} only, dependent on voice coil temperature, value at the rest position	LSI, SIM	
Q_{mp}	Mechanical Q-factor of passive radiator in free air, considering R_{mr} only	LSIM	
Q_n	Modal Q-factor factor of the n^{th} rocking mode Resonator H_n	RMA	
Q_p	Loss factor for the acoustic system at f_b considering vent losses	SIM, SIM-AUR, LSIM	
$q_p(t)$	Volume velocity in port of vented box systems	SIM, SIM-AUR	
Q_{tp} Q_{tps}	Total Q-factor in free air considering all losses (R_e, R_{ms}, $\Re\{Z_L(f_s)\}$)	LPM, MMT	
Q_{tpd}	Total Q-factor in vacuum considering all losses (R_e, R_{ms}, $\Re\{Z_L(f_s)\}$)	MMT	
Q_{tc}	Total loss factor of system at f_c including all system resistances	SIM, SIM-AUR, LSIM	
Q_{td}	Total Q-factor in vacuum considering R_e and R_{ms} only	MMT, SIM, SIM-AUR	
Q_{ts}	Total Q-factor in free air considering R_e and R_{ms} only	MMT, SIM, SIM-AUR, LSIM	
Q_{ts} (x, T_v)	Total Q-factor of driver considering all losses, dependent on displacement and voice coil temperature, nonlinear parameter	LSI	
Q_{ts} (x=0, T_v)	Total Q-factor of driver considering all losses, dependent on displacement and voice coil temperature, parameter at the rest position	LSI	

R

Symbol	Description	Module	Unit
r	distance between diaphragm and listening position	SIM, SIM-AUR	m
r	Coordinate vector of listening position	NFS	m
R	Mechanical Resistance of suspension part	MSPM	N/mm
r_1, ..., r_8	Nonlinear coefficients for $R_2(x)$ series expansion	LSI, SIM, SIM-AUR	$(\Omega)^n$
R_2	Resistance modeling eddy currents in electric input impedance. **Equivalent to $R_2(x=0)$.**	LPM, LSI, MMT, LSIM	Ω
$R_2(x)$	Resistance modeling eddy currents dependent on absolute displacement, nonlinear parameter	LSI, SIM, SIM-AUR	Ω
$R_2\,(x_{rel})$	Resistance modeling eddy currents dependent on relative displacement, nonlinear parameter, no absolute displacement information available	LSI, SIM	Ω
R_3	Electric resistance due to eddy current losses	LSIM	Ω
R_{al}	Acoustic resistance of enclosure losses due to leakage	SIM, SIM-AUR LSIM	kNs/m^5
Random	The Random is an absolute measure for randomly occurring distortion. It represents the instantaneous peak level of the non-deterministic sound pressure response. The distortion signal is obtained by removing the deterministic distortion components (fundamental and harmonic distortion).	QC LD	dB
R_{ap}	Acoustic mass of port including air load	LSIM	kNs/m^5
$R_{ap}(v_p)$	Acoustic resistance of air in port (vented box system), dependent on velocity in vent	SIM, SIM-AUR,	kNs/m^5
r_b	convection cooling parameter describing the dependence of R_{tt} from cone velocity	SIM	Ws/Km
R_e	Electric input resistance of voice coil at DC	LPM, MMT, LSIM	Ω
$R_e(t)$	Electric input resistance of voice coil, time dependent due to heating	LSI, SIM, SIM-AUR	Ω
$R_e(T_V)$	Electric input resistance of voice coil, temperature dependent due to heating	LSI, SIM	Ω
$R_e(T_V=T_a)$	Electric input resistance of voice coil, at ambient temperature	LSI, SIM	Ω
R_{es}	Electrical resistance representing mechanical losses in free air	LPM, MMT	Ω
R_{ed}	Electrical resistance representing mechanical losses in vacuum	LPM, MMT	Ω

Symbol	Description	Module	Unit
R_g	Output-resistance of amplifier including cables	LSIM	Ω
R_{md}	Mechanical resistance of driver in vacuum due to mechanical losses.	MMT	kg/s
R_{mr}	Mechanical resistance of passive radiator suspension losses	LSIM	kg/s
$R_{mr}(v_r)$	Mechanical resistance of the passive radiator	SIM, SIM-AUR,	kg/s
R_{ms}	Mechanical resistance of driver in free air due to mechanical losses. **Equivalent to R_{ms}(v=0).**	LPM, LSI, MMT	kg/s
R_{ms} (v)	Mechanical resistance representing mechanical losses, nonlinear parameter, dependency on voice coil velocity v	LSI, SIM	kg/s
R_{ms} (v_{rel})	Mechanical resistance representing mechanical losses, nonlinear parameter, dependency on relative voice coil velocity v. No absolute displacement information available.	LSI	kg/s
Rmse Hx	Root-mean-square fitting error of the transfer function Hx(f)	LPM	%
Rmse Z	Root-mean-square fitting error of the driver impedance Z(f)	LPM	%
RR(t), RR(f_{stim})	Roughness ratio	QC-EAR	dB
R_{Series}	Resistance of series resistor	LPM	Ω
R_{ta}(x)	Thermal resistance of path from air in the gap to ambience due to convection cooling	SIM, SIM-AUR	K/W
R_{tg}	Thermal resistance of path from pole tips to magnet and frame	SIM, SIM-AUR	K/W
$R_{th\ total}$	Estimate of total thermal resistance = ΔT/P_{RE}	LSI	K/W
R_{tm}	Thermal resistance of magnet and frame structure, Thermal Parameter	LSI, SIM	K/W
R_{tt}(v)	Thermal resistance of path from air in the gap to the magnet structure due to convection cooling	SIM, SIM-AUR	K/W
R_{tv}	Thermal resistance of voice coil structure, Thermal Parameter	LSI, SIM	K/W
r$_{ref}$	Reference Point	NFS	
$RRL_{n,E}$	Relative Rocking Level of the nth rocking mode for each excitation term E, Mass, stiffness, Bl and total	RMA	dB
r_{tl}	Time-lapse factor, describes a ratio $r_{tl}=t_{signal}$ / (2·T_{cal}). Higher values decrease accuracy, but increase performance, and vice versa.	SIM-AUR	
r_v	convection cooling parameter describing the dependence of R_{tc} from cone velocity	SIM, SIM-AUR	Ws/Km
r_x	convection cooling parameter considering the effect of cone displacement	SIM, SIM-AUR	W/Km

S

Symbol	Description	Module	Unit
S_{Bl}	Gain control for Bl(x) contribution to total output signal	AUR	dB
S_c	Gain control for C(x) contribution to total output signal	AUR	dB
S_d	Effective area of the driver diaphragm.	ALL	cm^2
S_{DIS}	Gain control for distortion signal *d*(*t*) contribution to total output signal	SIM-AUR	dB
S_{in}	Input signal gain controller	AUR	dB
S_K	Gain control for K(x) contribution to total output signal	AUR	dB
S_L	Gain control for C(x) contribution to total output signal	AUR	dB
S_{lin}	Gain control for linear output signal to total output signal	AUR	dB
S_{out}	Gain control for total output signal	AUR	dB
S_p	Area of port	SIM, SIM-AUR LSIM	cm^2
SPL(f)	SPL Frequency Response – identical to FR_p	SAN	dB
SPL_{far}	Far field SPL at distance r_{ref} for stimulus	LSIM	
SR(t), SR(f_{stim})	Sharpness Ratio	QC-EAR	dB
S_r	Effective projected surface area of passive radiator diaphragm	SIM, SIM-AUR LSIM	cm^2
$S_{tweeter}$	Gain control for high frequency channel (added to woofer channel)	AUR	dB
S_s	Scanning Surface	NFS	

T

Symbol	Description	Module	Unit
T_a	ambient temperature	LSI, SIM, SIM-AUR	K
T_{cal}	Calibration section. For time-lapse solving, the full simulation will be used in calibration sections.	SIM-AUR	s
T_m	Temperature of magnet structure	LSI, SIM, SIM-AUR	K
t_{meas}	Duration of a single Measurement (acquisition time of measurement data only, no pre-excitation included)	DIS	s
t_{off}	Duration of Off-phase in Power Test cycle	PWT	min
t_{on}	Duration of On-phase in Power Test cycle	PWT	min

Symbol	Description	Module	Unit
t_{signal}	Length of the input signal	SIM-AUR	s
t_{tot}	total duration of Power Test Measurement	PWT	min
T_v	Voice coil temperature	ALL	K
$T_v(t)$	Voice coil temperature, time dependent due to varying input power	LSI, SIM, SIM-AUR	K
$T_v(t=0)$	Voice coil temperature at start of the measurement	LSI, SIM, SIM-AUR	K
t_{win}	Window length	SAN	ms

U

Symbol	Description	Module	Unit
U_{ac}	AC part of voltage signal	LPM	V rms
U(f)	Spectrum of measured voltage at speaker terminal	LPM	V
U(t)	Time signal of measured voltage at speaker terminal	LPM	V
U_1	Amplitude of first tone (at speaker terminals or at output port of hardware)	DIS, SIM	V
U_2	Amplitude of second tone (at speaker terminals or at output port of hardware)	DIS, SIM	V
U_{end}	End value (rms) of amplitude sweep	DIS, SIM	V
$U_{G_{\mathrm{pk}}}$	Generator voltage (peak) for stimulus	LSIM	V
$U_{G_{rms}}$	Generator voltage (rms) for stimulus	LSIM	V
U_{head}	Headroom in u(t) measurement (due to limited input capabilities)	LPM	dBu
$U_{p,p}$	Peak-to-peak value of voltage u(t)	LPM	V
$U_{peak}(t)$	peak value terminal voltage	LSI, AUR	V
$U_{rms}(t)$	RMS value terminal voltage	LSI, AUR	V
U_{SNR}	Signal-to-noise-ratio in measured voltage u(t)	LPM	dB
U_{SNR+D}	Ratio signal / (noise + distortion) in voltage signal	LPM	dB
U_{start}	start value(rms) of amplitude sweep	DSI, SIM	V
$\widetilde{U}_{\mathrm{stim}}$	RMS stimulus voltage	All QC	V
$U_{\mathrm{T}_{\mathrm{pk}}}$	Terminal voltage (peak) for stimulus	LSIM	V
$U_{\mathrm{T}_{rms}}$	Terminal voltage (rms) for stimulus	LSIM	V

V

Symbol	Description	Module	Unit
V(t)	Velocity of voice coil	SIM, SIM-AUR	m/s
V_{as}	Equivalent air volume of suspension	LPM, LSIM	l (dm^3)
V_b	Volume of sealed enclosure	LPM, SIM, SIM-AUR, LSIM	l (dm^3)
$V_{c_{rms}}$	Voice coil velocity (rms) for stimulus	LSIM	m/s
V_f	Volume of air in front enclosure (Bandpass systems only)	LSIM	l (dm^3)
V_p(t)	Velocity of air in vent	SIM, SIM-AUR	m/s
$V_{p_{pk}}$	Passive radiator velocity (peak) for stimulus	LSIM	m/s
$V_{p_{rms}}$	Passive radiator velocity (rms) for stimulus	LSIM	m/s
V_r	Equivalent air volume of passive radiator suspension	SIM, SIM-AUR	l (dm^3)
V_r(t)	Velocity of passive radiator	SIM, SIM-AUR	m/s

W

Symbol	Description	Module	Unit
w_p	Width of surface area of port	LSIM	cm

X

Symbol	Description	Module	Unit
x	Current displacement of voice coil relative to the rest position	ALL	mm
x(f)	Spectrum of measured / simulated displacement using laser sensor	LPM, SIM	mm
x(t)	Time signal of measured / simulated displacement using laser sensor	LPM, SIM	mm
x(t=0)	Initial value of displacement for simulation	SIM, SIM-AUR	mm
X_{ac}	AC part of displacement signal	LPM	mm rms
x_{bottom}	Negative peak value of displacement	LSI	mm
x_{bottom}(t)	Negative peak values of displacement vs. Measurement time	LSI, SIM-AUR	mm
$X_{c_{pk}}$	Voice coil displacement (peak) for stimulus	LSIM	mm
$X_{c_{rms}}$	Voice coil displacement (rms) for stimulus	LSIM	mm

Symbol	Description	Module	Unit
$x_{dc}(t)$	Integrated displacement (DC component) vs. Measurement time	LSI, SIM-AUR	mm
$x_{dc\ max}(t)$	Maximal DC-value in voice coil excursion $x_{DC\ max}(t)=(x_{peak}(t)+x_{bottom}(t))/2$	LSI, SIM-AUR	mm
x_{head}	Headroom in x(t) measurement	LPM	dB
$x_{p-} < x < x_{p+}$	Range of 99% confidence $x_{p-} < x < x_{p+}$ of the nonlinear parameter measurement	LSI	mm
x_{peak}	positive peak values of displacement	LSI	mm
$x_{peak}(t)$	positive peak values of displacement vs. Measurement time	LSI, SIM-AUR	mm
x_{pp}	Peak-to-peak value of displacement x(t)	LPM	mm
$-x_{prot} < x < x_{prot}$	The maximum displacement range detected by the automatic gain adjustment (limited by the protection system).	LSI	mm
x_{pse}	describes the range $-x_{pse} \leq x \leq x_{pse}$ in which the power series is fitted to the original data.	LSI	mm

Y

Symbol	Description	Module	Unit
Y_1	Output signal of routing into first channel of analysis	DIS	
Y_2	Output signal of routing into second channel of analysis	DIS	
$Y_n^m(\phi,\theta)$	Spherical Harmonics	NFS	
$y_n(kr)$	Neumann function	NFS	

Z

Symbol	Description	Module	Unit
$Z(f)$	Electrical impedance, Z(f)= U(f)/I(f)	LPM, LSI, LSIM	Ω
Z_{Max}	Maximum variation of Inductance allowed at X_L	LSI	
Z_N	Nominal Impedance of the driver	DIS, LSIM	Ω
Z_R	corresponds to the back induced voltage (caused by the voice coil movement)	LPM	
$Z_p(f)$	impedance due to the voice coil inductance and eddy current losses	LPM	

Disclaimer

This document lists symbols as used in software, manuals, specifications, application notes and documents released by KLIPPEL. The list does not claim to be complete. Inconsistencies among different documents and software versions may be possible. Symbols do not necessarily comply with related standards or literature.