List of Variables and Symbols

Last updated: November 25, 2014

Symbol	Description	Module	Unit
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
$\Delta T_{v,}$ T_v	Voice coil temperature		K
$\Delta T_v(t)$	Voice coil temperature, time dependent		K
$\Delta T_{m,}$ T_m	Temperature of magnet structure		K
□	factor describing the distribution of heat caused by eddy currents on voice coil and magnet		
λ	Creep factor, used for modeling low frequency behavior of mechanical suspension	LPM	none
γ	bypass factor	SIM	
η_0	Reference efficiency of electro-acoustical conversion, (2π-radiation load)	LPM	%
$\eta_0(t)$	Reference efficiency of electro-acoustical conversion, time dependent	LSI	%
$\Re\{Z_L(f_s)\}$	Real part of voice coil impedance at resonance frequency f_s	LPM	Ω

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)	At display of hardware unit	
5	Number represents DUT currently updated in processor unit (DUT No.5)	Hardware unit	
*	Star represents alive DUT	Hardware unit	
†	Cross represents disconnected DUT due to malfunction	Hardware unit	
A	Capital A represents amplifier switched off or having low gain	Hardware unit	

A,B

Symbol	Description	Module	Unit
b_1, …, b_8	Nonlinear coefficients for Bl(x) series expansion	LSI, SIM	$(N/A)^n$
Bl	Force factor (Bl product), constant, linear parameter	LPM	N/A

Bl(x)	Force factor (Bl product), nonlinear parameter, dependent on displacement	LSI, SIM	N/A
$Bl(x_{rel})$	Force factor, nonlinear parameter, dependent on relative displacement No absolute displacement information available	LSI	N/A
Bl(x=0)	Force factor, value at the rest position	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	%

C

Symbol	Description	Module	Unit
c	Sonic speed	LPM	m/s
c_1, …, c_8	Nonlinear coefficients for $C_{ms}(x)$ series expansion	LSI, SIM	$(mm/N)^n$
$C_{ab}(p_{box})$	Acoustic compliance of the air in enclosure, dependent on p_{box}	SIM	mm/N
C_{lim}	Allowed minimal value of the compliance ratio C_{min}, used for protection system	LSI	%
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_{mes}	Electrical capacitance representing moving mass in mechanical system	LPM	µF
C_{mes} (x)	Electrical capacitance representing moving mass, nonlinear parameter, dependent on displacement	LSI	µF
$C_{mes}(x=0)$	Electrical capacitance representing moving mass, value at the rest position	LSI	µF
$C_{mes}(x_{rel})$	Electrical capacitance representing moving mass, nonlinear parameter, dependent on relative displacement, No absolute displacement information available	LSI	µF
C_{ms}	Mechanical compliance of driver suspension	LPM	mm/N
C_{ms} (x=0)	Mechanical compliance of driver suspension, value at the rest position	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
$C_{ms}(x)$	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_r	Acoustic compliance of air in rear enclosure in band pass systems	SIM	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	mm/N
C_{ta}	thermal capacitance of the air surrounding the coil giving convection cooling	SIM	

C_{tg}	thermal capacitance of pole tips and magnet surface close to coil (not used for simulation)	SIM	
C_{tm}	thermal capacity of the magnet frame structure	LSI, SIM	Ws/K
C_{tv}	thermal capacity of the voice coil structure	LSI, SIM	Ws/K

D

Symbol	Description	Module	Unit
D	displacement from user defined reference position (distance)	Laser	mm
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
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	%
dd	Diaphragm diameter of the driver	DIS	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	%

E

Symbol	Description	Module	Unit
E(t)	Envelope over one period t	DIS	
E_{Bottom}	Minimal value of the envelope over one period t		
$E_i(t)$	Relative error of the modeled current related to the measured current represents the quality of the agreement between learned parameters and reality	LSI	%
E_{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	%

F

Symbol	Description	Module	Unit
Fdz	Federzahl (spider flexibility)	QC LST	-
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	Port resonance frequency, used for modeling vented box / band pass systems	SIM	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_{high}	cut-off frequency for lowpass (tweeter)	AUR	Hz
$f_{I,SNR}$	frequency of minimal SNR in i(t)	LPM	Hz
f_{low}	cut-off frequency for highpass (woofer)	LPM	Hz
f_{LP}	cut off frequency of low-pass, used for averaging high frequencies	Laser	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	N
f_{max}	upper frequency limit	LPM	Hz
fp noise	Frequency of noise maximum in microphone signal	LPM	Hz
f_{ref}	Reference frequency, relative resolution will be ensured for all frequencies above f_{ref}	LPM	Hz
f_s	Resonance frequency of driver in free air	ALL	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_{max}	Maximum allowed gain for Power Testing	PWT	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	dB

H

Symbol	Description	Module	Unit
$H_x(f)$	Transfer function between U and X, $H_x(f)= X(f)/U(f)$	LPM	mm/V

I

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

K

Symbol	Description	Module	Unit
K_{ms}	Mechanical stiffness of driver suspension	LPM	N/mm
$K_{ms}(x)$	Mechanical stiffness of driver suspension, nonlinear parameter, dependent on displacement	LSI	N/mm
k_0	Effective mechanical stiffness (small signal, at rest position)	QC LST	N/mm

L

Symbol	Description	Module	Unit
L	Electric Inductance of voice coil structure	LPM	mH

L(x)	Electric Inductance of voice coil structure, nonlinear parameter, dependent on displacement	LSI	mH
I_1, …, I_8	Nonlinear coefficients for L(x) series expansion	LSI	$(mH)^n$
L_2	Electric Inductance of voice coil structure, modelling eddy currents (with L and R2)	LPM	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	mH
$L_2(x=0)$	Electric Inductance of voice coil structure, modelling eddy currents (with L and R2), value at the rest position	LSI	mH
L_{ces}	Electric inductance representing driver compliance	LPM	mH
L_{ces} (x)	Electric inductance representing driver compliance, nonlinear parameter, dependent on displacement	LSI	mH
L_{ces} (x_{rel})	Electric inductance representing driver compliance, nonlinear parameter , dependent on relative displacement, No absolute displacement information available	LSI	mH
$L_{ces}(x=0)$	Electric inductance representing driver compliance, value at the rest position	LSI	mH
L_e	Voice coil inductance	LPM	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	mH
$L_e(x=0)$	voice coil inductance, nonlinear parameter, value at the rest position	LSI	mH
L_m	Characteristic sound pressure level	SIM	dB
$L_m(t)$	Characteristic sound pressure level over time	SIM	dB

M

Symbol	Description	Module	Unit
M_{add}	Additional mass	LPM	g
M_{ap}	Mass of air load in port systems (in vented box / bandpass systems)	SIM	g
M_{Bottom}	Bottom-Modulation	DIS	
M_{ms}	Moving mass	LPM	g
M_{Top}	Top-Modulation	DIS	
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
m	Mass, mechanical (moving) mass	QC LD	g

N

Symbol	Description	Module	Unit
n	order of distortion analysis, number of highest harmonic distortion component which will be measured	DIS	
N stim	Stimulus length	LPM	

P

Symbol	Description	Module	Unit
P	input power	LPM	W
p	Density of air	LPM	kg/m^3
p_{ac}	AC part of microphone signal	LPM	mV rms
p(f)	Sound pressure spectrum	LPM	Pa
p(t)	sound pressure signal	LPM	Pa
P	Measured peak value in displacement	LASER	mm
B	Measured bottom value in displacement	LASER	mm
p_{Bl}, $p_{Bl}(t)$	Distortion component caused by Bl(x) nonlinearity (in pressure signal)	AUR	Pa
P_{box}	Pressure in box enclosure	SIM	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	
P_{con}	power transferred to the air in the gap due to convection cooling	SIM,LSI	
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_{eg}	power transferred to the pole tips due to eddy currents	SIM	
$p_{far}(t)$	Sound pressure in the far field	SIM	
P_g	power transferred to the pole tips	SIM	
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	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	

Q

Symbol	Description	Module	Unit
Q_{ect}	Electrical Q-factor of driver in enclosure	LSI	
Q_{eps}	Electrical Q-factor of driver in free air considering R_e and $\Re\{Z_L(f_s)\}$	LSI	
$Q_{eps}(x, T_v)$	Electrical Q-factor of driver in free air, dependent on displacement and voice coil temperature, nonlinear parameter	LSI, SIM	
$Q_{eps}(x=0, T_v)$	Electrical Q-factor of driver in free air, dependent on voice coil temperature at the rest position of the driver	LSI, SIM	
Q_{es}	Electrical Q-factor of driver in free air considering R_e only, neglecting $\Re\{Z_L(f_s)\}$	LPM	
$Q_{es}(T_v)$	Electrical Q-factor of driver in free air considering R_e only, voice coil temperature dependent, considering heating and increasing of R_e	LSI, SIM	
$Q_{es}(T_V, t)$	Electrical Q-factor $Q_{es}(T_v)$, considering changes due to heating over time	LSI, SIM	
$Q_{es}(x=0, t)$	Electrical loss factor considering nonlinear parameter Bl(x) and $f_S(x)$ and time variation (due to heating), value at the rest position	LSI, SIM	
$Q_{es}(x,t)$	Electrical loss factor considering nonlinear parameter Bl(x) and $f_S(x)$ and time variation (due to heating)	LSI, SIM	
$Q_{es}(x)$	Electrical loss factor considering nonlinear parameter Bl(x) and $f_S(x)$	LSI, SIM	
Q_l	Loss factor for the acoustic system at f_b considering leakage losses	SIM	
Q_{ms}	Mechanical Q-factor of driver considering R_{ms} only	LPM	
$Q_{ms}(x, T_v)$	Mechanical Q-factor of driver considering R_{ms} only, dependent on displacement and voice coil temperature, nonlinear parameter	LSI, SIM	
$Q_{ms}(x=0, T_v)$	Mechanical Q-factor of driver considering R_{ms} only, dependent on voice coil temperature, value at the rest position	LSI, SIM	
Q_p	Loss factor for the acoustic system at f_b considering vent losses	SIM	
q_p	Volume velocity in port of vented box systems	SIM	
Q_t	Total Q-factor considering R_e and R_{ms} only	LPM	
$Q_t(x, T_v)$	Total Q-factor of driver considering R_e and R_{ms} only, dependent on displacement and voice coil temperature, nonlinear parameter	LSI, SIM	
$Q_t(x=0, T_v)$	Total Q-factor of driver considering R_e and R_{ms} only, dependent on displacement and voice coil temperature, parameter at the rest position	LSI, SIM	
Q_{tp}	Total Q-factor considering all losses (R_e, R_{ms}, $\Re\{Z_L(f_s)\}$)	LPM	
$Q_{tp}(x, T_v)$	Total Q-factor of driver considering all losses, dependent on displacement and voice coil temperature, nonlinear parameter	LSI, SIM	

Q_{tp} (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, SIM	

R

Symbol	Description	Module	Unit
r	distance between diaphragm and listening position	SIM	
r_1, ..., r_8	Nonlinear coefficients for $R_2(x)$ series expansion	LSI, SIM	$(\Omega)^n$
R_2	Resistance modeling eddy currents in electric input impedance	LPM	Ω
R_2 (x_{rel})	Resistance modeling eddy currents dependent on relative displacement, nonlinear parameter, no absolute displacement information available	LSI, SIM	Ω
$R_2(x)$	Resistance modeling eddy currents dependent on absolute displacement, nonlinear parameter	LSI, SIM	Ω
$R_2(x=0)$	Resistance modeling eddy currents dependent on absolute displacement, nonlinear parameter, Parameter at the rest position	LSI, SIM	Ω
R_{al}	Acoustic resistance of enclosure losses due to leakage	SIM	kg/s
$R_{ap}(V)$	Acoustic resistance of air in port (vented box system), dependent on velocity in vent	SIM	kg/s
r_b	convection cooling parameter describing the dependence of R_{tt} from cone velocity	SIM	
R_e	Electric input resistance of voice coil	LPM	Ω
$R_e(t)$	Electric input resistance of voice coil, time dependent due to heating	LSI, SIM	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	LPM	Ω
R_{es} (x)	Electrical resistance representing mechanical losses, nonlinear parameter due to Bl(x) dependency on x. (Bl(x): transformation parameter to convert mechanical parameters in the electrical domain)	LSI, SIM	Ω
R_{es} (x_{rel})	Electrical resistance representing mechanical losses, nonlinear parameter due to Bl(x) dependency on relative displacement x. No absolute displacement information available. (Bl(x): transformation parameter to convert mechanical parameters in the electrical domain)	LSI, SIM	Ω
$R_{es}(x=0)$	Electrical resistance representing mechanical losses R_{es} (x), nonlinear parameter due to Bl(x) dependency on x, value at the rest position	LSI, SIM	Ω
R_{ms}	Mechanical resistance due to mechanical losses	LPM	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	%
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	
R_{tg}	thermal resistance of path from pole tips to magnet and frame	SIM	

$R_{th\ total}$	estimate of total thermal resistance = $\Delta T/P_{RE}$	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	
R_{tv}	Thermal resistance of voice coil structure, Thermal Parameter	LSI, SIM	K/W
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_v	convection cooling parameter describing the dependence of R_{tc} from cone velocity	SIM	
r_x	convection cooling parameter considering the effect of cone displacement	SIM	

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_dV	Volume velocity equals product of effective area and velocity	SIM	m^3/s
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	cm^2
$S_{tweeter}$	Gain control for high frequency channel (added to woofer channel)	AUR	dB

T

Symbol	Description	Module	Unit
T_a	ambient temperature	LSI,SIM	K
T_m	temperature of magnet structure	LSI, SIM	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
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	K
$T_v(t=0)$	Voice coil temperature at start of the measurement	LSI, SIM	K

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 hard-ware)	DIS, SIM	V
U_{end}	end value of amplitude sweep	DIS, SIM	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 of amplitude sweep	DSI, SIM	V

V

Symbol	Description	Module	Unit
V_{ab}	Volume of air in enclosure	SIM	l (dm^3)
V_{as}	Equivalent air volume of suspension	SIM	l (dm^3)
$V_{as}(t)$	Equivalent air volume of suspension, considering time dependency, e.g. aging, break in	SIM	l (dm^3)
V_b	Volume of sealed enclosure	SIM, LPM	l (dm^3)
V_r	Volume of rear enclosure in bandpass systems	SIM	l (dm^3)
V(t)	Velocity of voice coil	SIM	m/s

X

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

$x_{dc}(t)$	Integrated displacement (DC component) vs. Measurement time	LSI	mm
$x_{dc\ max}(t)$	Maximal DC-value in voice coil excursion $x_{DC\ max}(t)=(x_{peak}(t)+x_{bottom}(t))/2$	LSI	mm
x_{head}	Headroom in x(t) measurement	LPM	dB
$x_{p-} < x < x_{p+}$	confidential range $x_{p-} < x < x_{p+}$ of the nonlinear parameter measurement	LSI	mm
x_{pp}	Peak-to-peak value of displacement x(t)	LPM	mm
x_{peak}	positive peak values of displacement	LSI	mm
$x_{peak}(t)$	positive peak values of displacement vs. Measurement time	LSI	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	

Z

Symbol	Description	Module	Unit
Z(f)	Electrical impedance , Z(f)= U(f)/I(f)	LPM	Ω
Z_{Max}	Maximum variation of Inductance allowed at X_L	LSI	
Z_N	Nominal Impedance of the driver	DIS	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

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