harman consumer group

Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Model Number:	**1501AL-2**
Part Number:	**320-0050-001**
Division:	**Harman Lifestyle**
Where Used:	**JBL Everest DD67000**
Approved Supplier(s)	**HAdM (Harman Mexico MFG)**
Design Engineer:	**JMoro**

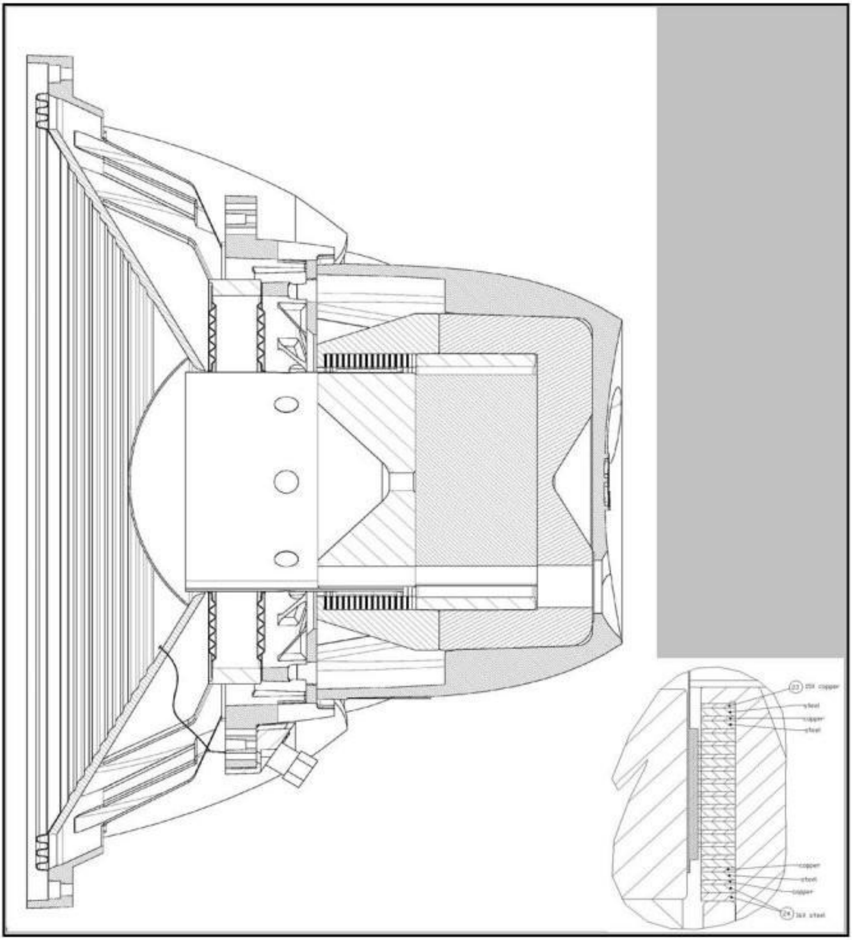
Assembled View:

Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Section View

Model # 1501AL-2 Part # 320-0050-001



15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Document Revision History

Rev #	Date	Description of Change	ECO#	Approval	
				M.E.	T.E.
X1	6/15/2012			n/a	JM
X2	6/22/2012	Update Specs		n/a	JM
X3	7/3/2012	Correct power test spec		n/a	JM
X4	10/18/2012	Update Specs		N/A	JM
A	10/18/2012	Release to production	5846	N/A	JM

Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Transducer Mechanical Characteristics

Model #	1501AL-2	Part #	320-0050-001
Assembly			
Mounting Diameter:	13.75 inches	Mounting Depth:	9.0 inches
Flange Diameter:	15.25 inches	Flange Depth:	0.76 inches
Mounting Detail:	8 recessed holes for #10 Philister head	Overall Depth:	9.875 inches
Other:			
Frame			
Type:	Heavy wall Cast Aluminum	Material:	380 aluminum alloy
Color:	Dark Gray	Finish:	Textured Poweder Coat
Other:	Frame ID modified with chamfer for additional cloth edge roll clearance on downward travel.		
Diaphragm			
Type:	3-Layer Sandwich cone	Material:	Paper skins with Injection Foam core
Color:	Black	Finish:	Ribbed cone surface - smooth back
Other:	DKN paper pulp for front and back side skins with Polyurethane Injection foam core (about 2mm thk.)		
Surround			
Type:	5 roll accordian cloth edge	Material:	Polyester/Cotton blend (50/50%)
Color:	Black	Finish:	Airflex400 edge treat damping
Other:	Airflex400 Adhesive - 1 Dip, 2 Revolution process		
Spider			
Type:	Equal roll (5) cloth spider	Material:	Hakken Nomex (N-24) with A/0.91 resin
Weave:	********	Color:	Brown
Other:	New taller sinusiodal roll design. Two spiders used with top spider inverted		
Front Gasket			
Material:	None	Color:	N/A
Rear Gasket			
Material:	None	Color:	N/A
Voice Coil			
I.D.:	3.904 inches	Max. O.D.:	4.025
Wire Type:	Aluminum Ribbon, Edge wound	Wire Size:	1.270mm x 0.13378mm
Wire Turns:	168	Wire D.C.R.:	9.2
Winding Width:	25.4 mm (1.0 inch)	Winding layers:	1
Former:	7 mil FQG (Goto)	Wrapper:	2 layers of 5 mil NEC (Goto)
Other:	Used with Goto High Temperature Adhesive (type PRO-1)		
Magnet			
Material:	Alnico 5DG	Thickness:	2.0 inches
O.D.:	3.82 inches - incldg 3 vents on O.D.	I.D.:	None
Other:			

Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Transducer Mechanical Characteristics (Motor)

Model # 1501AL-2 Part # 320-0050-001

Top Plate

Material:	Low Carbon Steel (1215 or Equiv.)	Thickness:	1.60 inches
O.D.:	Tappered from 4.9 (at top) to 6.0 inches	I.D.:	4.079 inches
Other:	Special laminate configuration of 16 steel (.064" thk) and 15 copper (.032" thk) alternating layers		

Pole Piece

O.D.:	Low Carbon Steel (1215 or Equiv.)	Copper Cap:	none
Vent:	JBL "VCG" style Vented Gap Cooling (3 vents @120 degrees on O.D.)		
Other:	3.879 inch Pole O.D.		

Back Plate

Material:	Low Carbon Steel (1215 or Equiv.)	Thickness:	0.9 inch (back wall of Pot)
O.D.:	6.0 inches	I.D.:	4.578 / 4.556 inch
Other:	This is the POT or return circuit of Insider Alnico motor structure (see assembly drawing)		

Bucking Magnet

Material:	N/A	Thickness:	******
O.D.:	******	I.D.:	******
Other:			

Shielding Can

Material:	N/A	Thickness:	*****
Other:			

Misc

Terminal Size / Type:	5-Way Binding Posts (Red / Black)	Polarity:	E.I.A.
SFG Configuration:	Underhung Motor Topology (Long 1.6 inch Gap / Short 1.0 inch Coil)		
Flux Stabilizing Ring:	2 inch tall, Aluminum Conductive ring at motor base and 15 copper rings inside coil gap (on O.D. of coil)		
Tinsel Lead Type:	Silver Plated Copper - Twister topology		
Tinsel Lead Attach.:	Soldered to terminal and cone eyelets		
Other:			

Notes:

Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Model # 1501AL-2 Part # 320-0050-001

Transducer Electro-Mechanical Parameters

Fundamental Resonant Frequency (Hz):	Fs	30	+/-	10%
Transducer Direct Current Resistance (Ohms):	DCR	9.2	+/-	3%
Total Driver Q at Fs, Considering all driver Resistance:	Qts	0.30	+/-	5%
Moving Mass (g):	Mms	135	+/-	5%
Motor Strength (T*m):	Bl	27	+/-	5%
Voltage Sensitivity(2.83V@1 meter)	SPL	91dB,200Hz	+/-	1dB
Radiation Area	Sd	865.7sq.cm.		

Method

Software:	Smith & Larson Audio Woofer Tester
Mass Loading:	150 grams
Misc.:	

Magnetic Flux Information (For Engineering Reference Only)

Total flux lines intercepted by coil windings [Maxwell Turns]:	411,700
Conversion to flux density [Tesla]:	0.517
Flux lines throughout gap thickness [Maxwell Turns]:	674,632
Conversion to flux density [Tesla]:	0.528

Notes

Parameters provided are nominal values which are closest to the Engineering Referance Standard

Voltage Sensitivity takes precedence over possible T/S combinations that would produce SPL

Magnetic Flux data measured with a 3.925 inch diameter, One-turn Search coil

Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Transducer Test Specifications

production testing quantities per HCG QA AQL

Model # 1501AL-2   Part # 320-0050-001

Polarity Test

Polarity: EIA STANDARD

Dynamic Test

Sine Sweep Voltage: 28 vrms (Audible rubb&buzz)
Frequency Range: 16 Hz to 400 Hz
Sweep Duration: 4 seconds

Power Test

Signal Pink Noise, 50-500Hz, 6dB Crest Factor, 69vrms
Duration: 8 + 92 hours

Impedance

DC Resistance: 9.2 Ohms
Min. Impedance @ Frequency 12.0 Ohm @ 177 Hz

Frequency Response

Freq. Response:

Window	Averaging	Slope
60 - 700 Hz +/- 1.0 dB	1/3 Octave	36 dB / Octave
700 - 900 Hz +1.0 dB / -2.0 dB	1/3 Octave	36 dB / Octave
900 - 2000 Hz + 2.0dB / - 3.0dB	1/3 Octave	36 dB / Octave
	1/3 Octave	36 dB / Octave
	1/3 Octave	36 dB / Octave
	1/3 Octave	36 dB / Octave
	1/3 Octave	36 dB / Octave
	1/3 Octave	36 dB / Octave
	1/3 Octave	36 dB / Octave
	1/3 Octave	36 dB / Octave

Notes:

Power test specification above must be EPR qualified at 100 hours.

2nd Harmonic Distortion to be about +/-5dB from 2nd Harmonic of authorized Line/QA Production Standard. This is to monitor off-center voice coils in magnetic gap or poor spider positioning.

Engineering Standard Measured Parameters	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Model # 1501AL-2 Part # 320-0050-001

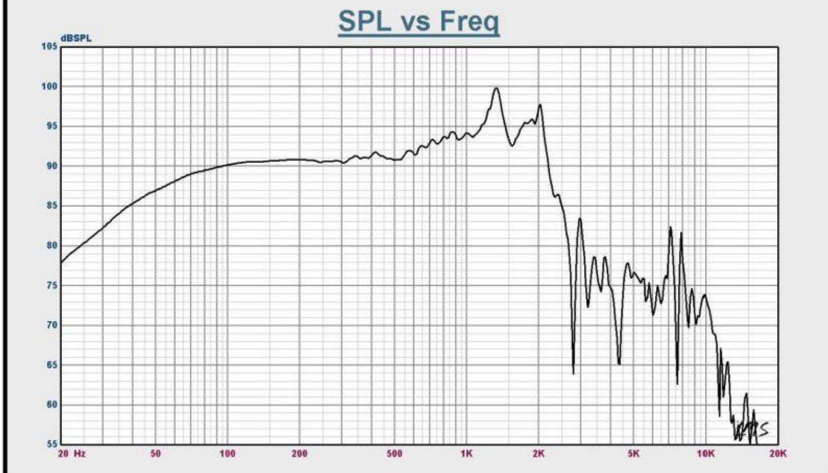
```
                              1501Al-2 Rev M #4.log
1501AL-2 REV M #4                                                  Ver 5.00
Completed: Tue May 08 07:44:12 2012
Drive level  35.000 % [  1.227 mA]
Sine,LoZP(LV/LA)->Vas,20 pts
;-----------------------------------------------------------------------
Re          =    9.6094 ohms
Fs          =   29.6900 Hz
Zmax        =  253.9704 ohms
Qes         =    0.3189
Qms         =    8.1099
Qts         =    0.3069
Le          =    1.0692 mH  (at 1 kHz)
Diam        =  332.0000 mm  ( 13.0709 in  )
Sd          =86569.7190 mm^2(134.1833 in^2)
Vas         =  222.5018 L   (  7.8576 ft^3)
BL          =   27.8000 N/A
Mms         =  137.4934 g
Cms         =  208.9955 uM/N
Kms         = 4784.7910 N/M
Rms         =    3.1627 R mechanical
Efficiency =     1.7157 %
Sensitivity=    94.3624 dB @1W/1m
Sensitivity=    93.5663 dB @2.83Vrms/1m
Krm         =  27.667E-03 ohms     Freq dependent resistance
Erm         = 612.566E-03          Rem=Krm*(2*pi*f)^Erm
Kxm         =  30.552E-03 Henries  Freq dependent reactance
Exm         = 678.062E-03          Xem=Kxm*(2*pi*f)^Exm
;-----------------------------------------------------------------------
Ftest                        =    20.532 Hz
Ftest/Fms                    =    0.6916
Test Mass used               =  150.0000 g (Equal to 30.0 nickels)
Test Mass (Ft=Fms*0.90) =         32.252 g (Add -117.748g for Ft=26.721)
Test Mass (Ft=Fms*0.75) =        106.939 g (Add -43.061g for Ft=22.268)
```

Engineering Standard
Frequency Response

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Date	Rev #	Document Number
10/18/2012	A	9990036

Model #	Part #
1501AL-2	320-0050-001



Map: — 43: 1501AL-2 DV#3 (2.83 v)_Freq Resp

Notes: Measured in Half-Space Anechoic Chamber at 1M

LMS 4.6.0.371 May/29/2007	Person: Company:	Project: File: 1501AL-1.lib	Jun 15, 2012 Fri 3:44 pm	LINEARX SYSTEMS

Engineering Standard

Distortion (Low Level)

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

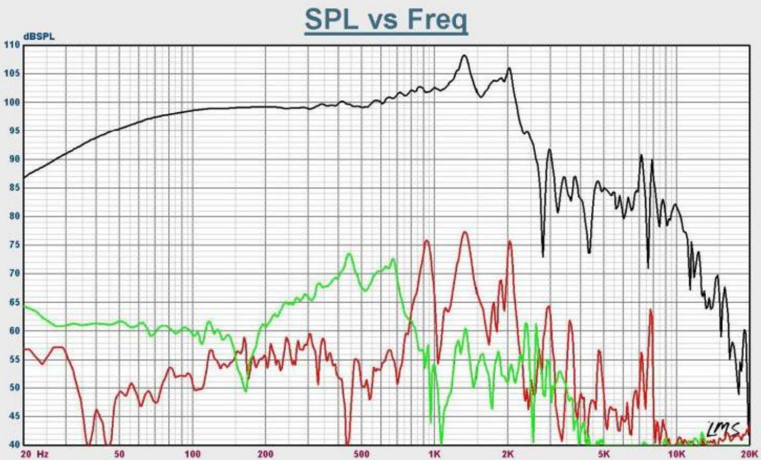
Date: 10/18/2012

Rev #: A

Document Number: 9990036

Model #: 1501AL-2

Part #: 320-0050-001



Map

44: 1501AL-2 DV#3(7.53 v)_Fund

45: 1501AL-2 DV#3(7.53 v)_D2+20dB

46: 1501AL-2 DV#3(7.53 v)_D3+20dB

Notes

Measured in Half-Space Anechoic Chamber at 1M

LMS 4.6.0.371 May/29/2007 | Person: Company: | Project: File: 1501AL-1.lib | Jun 15, 2012 Fri 3:47 pm | LINEAR X SYSTEMS

Engineering Standard
Distortion (High Level)

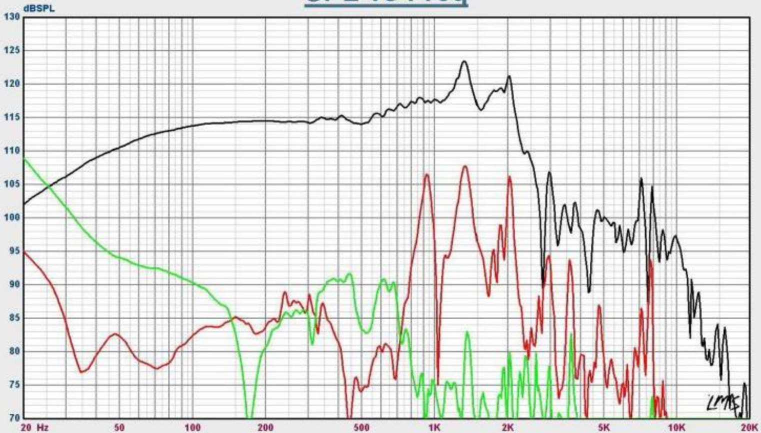
15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Date	Rev #	Document Number
10/18/2012	A	9990036

Model # 1501AL-2

Part # 320-0050-001

SPL vs Freq



Map

- 50: 1501AL-2 DV#3(44.85 v)_Fund
- 51: 1501AL-2 DV#3(44.85 v)_D2+20dB
- 52: 1501AL-2 DV#3(44.85 v)_D3+20dB

Notes

Measured in Half-Space Anechoic Chamber at 1M

LMS 4.6.0.371 May/29/2007	Person: Company:	Project: File: 1501AL-1.lib	Jun 15, 2012 Fri 4:13 pm	LINEAR X SYSTEMS

Engineering Standard

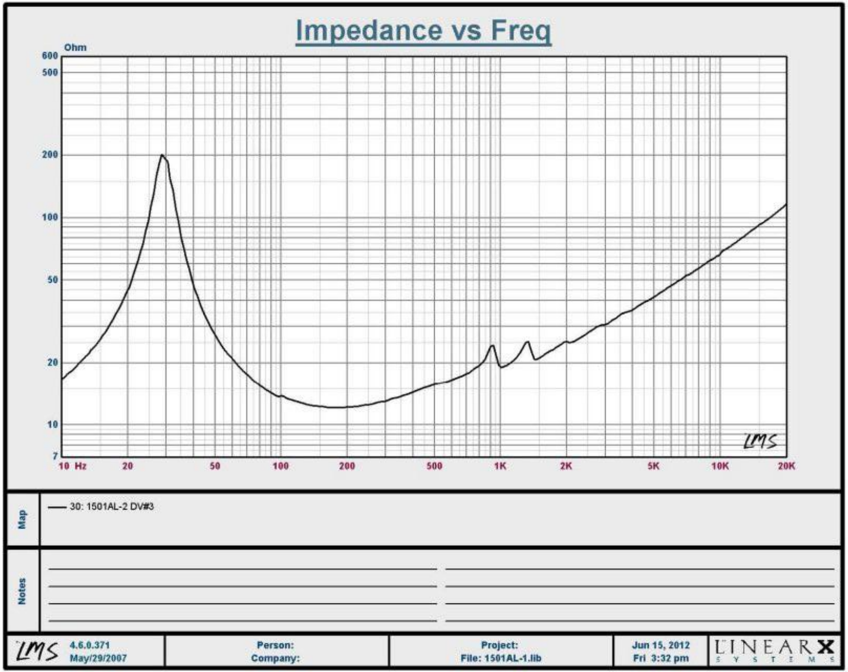
Impedance

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Date	Rev #	Document Number
10/18/2012	A	9990036

Model # 1501AL-2

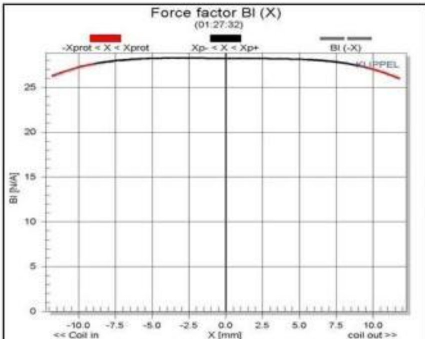
Part # 320-0050-001

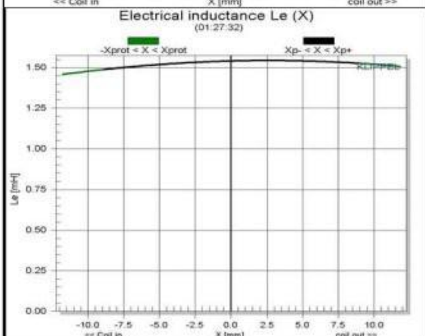


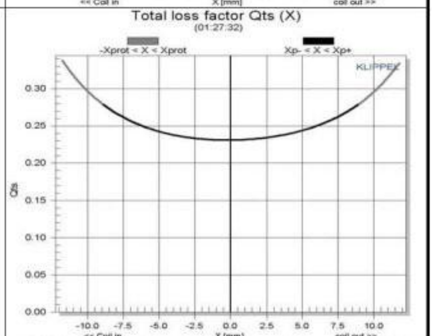
Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

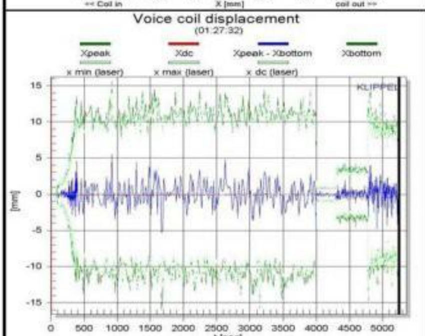
15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

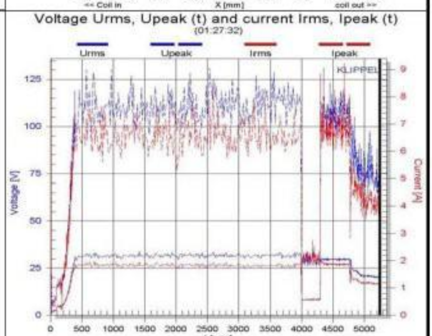
Model # 1501AL-2 Part # 320-0050-001







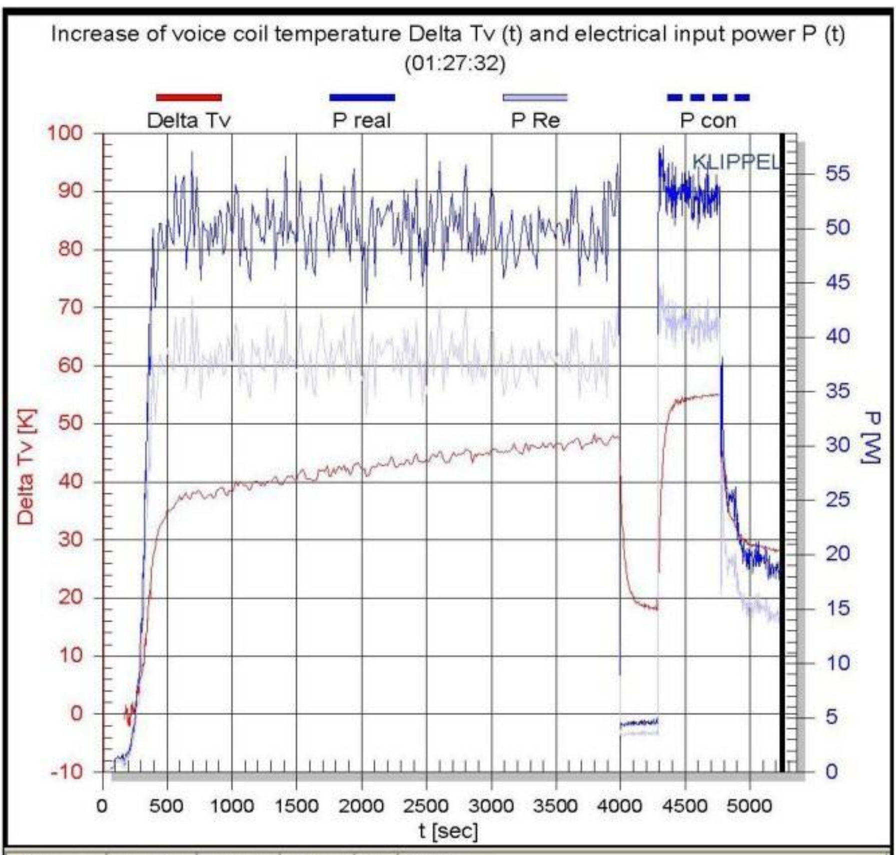




Engineering Design Specification	Date	Rev #	Document Number
	10/18/2012	A	9990036

15 inch woofer, Cloth Edge, Alnico, High Power and very Low Distortion

Model #	1501AL-2	Part #	320-0050-001



Symbol	Large + Warm	Large + Cold	Small Signal	Unit	Comment
Delta Tv = Tv-Ta	28	0	-0	K	increase of voice coil temperature during the measurement
Xprot	11.8	11.8	1.5	mm	maximal voice coil excursion (limited by protection system)
Re (Tv)	10.80	9.74	9.74	Ohm	(imported) voice coil resistance considering increase of voice coil temperature Tv
Le (X=0)	1.54	1.54	1.49	mH	voice coil inductance at the rest position of the voice coil
L2 (X=0)	1.06	1.06	1.03	mH	para-inductance at the rest position due to the effect of eddy current
R2 (X=0)	7.01	7.01	6.79	Ohm	resistance at the rest position due to eddy currents
Cmes (X=0)	274	274	237	µF	electrical capacitance representing moving mass
Lces (X=0)	212.58	212.58	135.38	mH	electrical inductance at the rest position representing driver compliance
Res (X=0)	124.20	124.20	126.71	Ohm	resistance at the rest position due to mechanical losses
Qms (X=0, Tv)	4.46	4.46	5.30		mechanical Q-factor considering Rms only
Qes (Tv)	0.24	0.22	0.30		electrical Q-factor considering Re (Tv) only
Qts (X=0, Tv)	0.23	0.21	0.28		total Q-factor considering Re (Tv) and Rms only
fs	20.8	20.8	28.1	Hz	driver resonance frequency
Rtv	0.913	0.913		K/W	thermal resistance of path from coil to magnet structure
Rtm	0.453	0.453		K/W	thermal resistance of magnet structure to ambient air
Ctv	36.607	36.607		J/K	thermal capacitance of voice coil and nearby surroundings
rc	n/a	n/a	n/a		(cannot be calculated)
Mms	137.370	137.370	137.370	g	(imported) mechanical mass of driver diaphragm assembly including voice-coil and air load
Rms (X=0)	4.034	4.034	4.573	kg/s	mechanical resistance of total-driver losses
Cms (X=0)	0.42	0.42	0.23	mm/N	mechanical compliance of driver suspension at the rest position
Bl (X=0)	28.24	28.24	28.24	N/A	(imported) force factor at the rest position (Bl product)
Vas	448.3344	448.3344	246.8981	l	equivalent air volume of suspension
N0	1.598	1.771	1.771	%	reference efficiency (2Pi-sr radiation using Re)
Lm	94.2	94.6	94.6	dB	characteristic sound pressure level
Sd	865.70	865.70	865.70	cm²	diaphragm area

Symbol	Value	Unit	Comment
Mode	Thermal Mode 6(7)		
Record	714/714		
Laser	signal reliable		
t	01:27:32	h:min:s	measurement time
Ei (t)	4.1	%	error current measurement
Ex (t)	2.9	%	error laser measurement
Eu (t)	33.8	%	error amplifier check
Delta Tv (Delta Tlim)	27.8 (100.0)	K	increase of voice coil temperature (limit)
Blmin (Bllim)	92.8 (25.0)	%	minimal force factor ratio (limit)
Cmin (Clim)	62.8 (20.0)	%	minimal compliance ratio (limit)
P (Plim)	19.27 (50.00)	W	real electrical input power (limit)
Lmin	94.9	%	minimal inductance ratio
Pn	34.41	W	nominal electrical input power
P Re	14.92	W	Power heating voice coil
P con		W	deducted power due to convection cooling
Glarge (Gmax)	18.9 (26.0)	dB	gain of the excitation amplitude increased in the large signal domain (maximum)
Mech. system		abs.	import used to identify mechanical system in absolute quantities
Xdc	-0.0	mm	dc component of voice coil excursion measured in the last update intervall
Xpeak	9.1	mm	positive peak value of voice coil excursion measured in the last update intervall
Xbottom	-8.3	mm	negative peak value (bottom) of voice coil excursion measured in the last update intervall
Xp+	8.9	mm	upper limit of displacement range (99% probability)
Xp-	-8.9	mm	lower limit of displacement range (99% probability)
Xprot	11.8	mm	maximal voice coil excursion allowed by protection system
v rms	0.37	m/s	voice coil velocity
Irms	1.176	A	rms value of the electrical input current
Urms	20.319	V	rms value of the electrical voltage at the transducer terminals
Ipeak	3.874	A	peak value of the electrical input current
Upeak	81.546	V	peak value of the electrical voltage at the transducer terminals
PC	0.89	dB	thermal power compression factor
Db	0.9	%	distortion factors representing contribution of nonlinear force factor
Dl	0.3	%	distortion factor representing contribution of nonlinear inductance
Dc	4.5	%	distortion factor representing contribution of nonlinear compliance
R tc (v)		K/W	
R th total	1.86	K/W	Delta Tv / P Re