

HARMAN INTERNATIONAL

RELIABILITY TEST PLAN

for

**HARMAN KARDON
INTEGRATED AMPLIFIER**

harman consumer group

Central Quality Group

Release Date: 10/10/00

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1.0 Purpose

The purpose of this test plan is to describe the environmental and functional performance requirements to which the Integrated Amplifier will undergo in order to be validated. The intent of the validation program is to expose the test unit to an accelerated aging process.

2.0 Test Implementation

The Test Sequence consists of the groups listed below. This is a parallel test sequence such that each group is run independently.

Full Qualification Test Sequence

Group	QTY		Test	Spec. Sect. No.
	DV	PV		
A	2	6	Environmental Tests	4.1
			Thermal Profile (2 units)	4.1.5
			Operating Temperature Test	4.1.1
			Operating Temperature at High Humidity Test	4.1.2
			Temperature Storage Test	4.1.3
			Humidity Storage Test	4.1.4
B	2	6	Mechanical/Electrical Tests	4.3/4.2
			Handling (Drop), First Sequence	4.3.1
			Compression Test (Vehicle Stacking Assurance Level II)	4.3.2
			Loose Load Vibration	4.3.3
			Vehicle Vibration	4.3.4
			Handling (Drop), Second Sequence	4.3.5
			Line Drop Out Test	4.2.2
			Line Drop Down Test	4.2.3
			Adjustable Voltage Test	4.2.4
			Dielectric Voltage Withstand Test	4.2.5
			Electrostatic Discharge Test	4.2.1
			C	2
Life Cycle Test	4.4.1			
D	2	10	Remote Control Test	4.5
			Remote Control Drop Test	4.5.1
			Remote Control Chemical Test	4.5.2
E	2	6	Euro 230V	
			Handling (Drop), First Sequence	4.3.1
			Compression Test (Vehicle Stacking Assurance Level II)	4.3.2
			Loose Load Vibration	4.3.3
			Vehicle Vibration	4.3.4
			Handling (Drop), Second Sequence	4.3.5
			Operating Temperature Test	4.1.1
			Line Drop Out Test	4.2.2
			Line Drop Down Test	4.2.3
			Adjustable Voltage Test	4.2.4
			Dielectric Voltage Withstand Test	4.2.5
		(6)	Life Cycle Test (A second group of six units may run concurrent with Electrical/Mechanical testing)	4.4.1

Abbreviated Qualification Test Sequence

Group	QTY	Test	Spec. Sect. No.	
A	6	Operating Temperature Test	4.1.1	
		Operating Temperature at High Humidity Test	4.1.2	
		Temperature Storage Test	4.1.3	
		Humidity Storage Test	4.1.4	
		Dielectric Voltage Withstand Test	4.2.5	
		Electrostatic Discharge Test	4.2.1	
B	6	Handling (Drop), First Sequence	4.3.1	
		Compression Test (Vehicle Stacking Assurance Level II)	4.3.2	
		Loose Load Vibration	4.3.3	
		Vehicle Vibration	4.3.4	
		Handling (Drop), Second Sequence	4.3.5	
		Line Drop Out Test	4.2.2	
		Line Drop Down Test	4.2.3	
		(6) Life Cycle Test (A second group of six units may run concurrent with Electrical/Mechanical testing)	4.4.1	
C	6	Remote Control Test	4.5	
		Remote Control Drop Test	4.5.1	
		Remote Control Chemical Test	4.5.2	

3.0 Functional Performance Test

End User Test

All units should be visually inspected for any appearance defects (i.e. scratches, dents, cracks, mislabeled buttons and input/output terminals), packaging condition as received and completeness of the unit's accessories. An end user verification test should also be performed on a minimum of 6 units.

Functional Performance Evaluation

All units will undergo a functional performance evaluation before and after each test at ambient (room) temperature and humidity unless otherwise specified. The evaluation is to be conducted in accordance to the HCG approved Product Engineering Specification. The testing should be performed with an Audio Precision (AP) or equivalent test system.

4.1 Environmental Tests

4.1.1 Operating Temperature Test

The units shall be exposed to the following temperature conditions:

Low Temperature only	0 °C
High Temperature only	45 °C
Exposure Time	4 hours at each temperature
Input Signal	Pink Noise. Dolby DVD Demo and Test Disc Version 1.0, Title 58, Chapter 1
Level	Unit to be calibrated just below clipping.

During each test connect all outputs to their nominal load impedance.

Post Test

The units should be checked for functional performance and external appearance during and after the test. No impaired function or concealed damage is permitted.

4.1.2 Operating Temperature at High Humidity Test

The units shall be exposed to the following conditions:

Temperature and Humidity	45 °C and 90%
Exposure Time	4 hours
Input Signal	Pink Noise. Dolby DVD Demo and Test Disc Version 1.0, Title 58, Chapter 1
Level	Unit to be calibrated just below clipping.

During each test connect all outputs to their nominal load impedance.

Post Test

The units should be checked for functional performance and external appearance during and after the test. No impaired function or concealed damage is permitted.

4.1.3 Temperature Storage Test

The units shall withstand sixteen (16) hours of exposure to -20°C followed by sixteen (16) hours of exposure to +60 °C. The units should not be powered during the test and the test shall be performed on units with the shipping packaging. A 4-hour minimum ramp time between each temperature is required.

Post Test

The units should be checked for functional performance and external appearance after the test. No impaired function or concealed damage is permitted.

4.1.4 Humidity Storage Test

The units shall be exposed to the following conditions:

	Condition
Temperature	40°C +/- 2°C
Humidity	93% -2%/+3%
Exposure Time	48 hours
Stabilization Time After Test*	Minimum of 4 hours
Unit Configuration	With Packaging

*Stabilization Time is referred to as the elapsed time the unit has been out of the environmental chamber and allowed to reach ambient temperature and humidity conditions.

The units should not be powered during the test.

Post Test

The units should be checked for functional performance and external appearance after the test. No impaired function or concealed damage is permitted.

4.1.5 Thermal Profile

Each unit under test (UUT) is to be tested in an environment in which the unit does not experience any laminar or turbulent airflow. The test is to be performed at ambient temperature (25 +/-2 °C). The UUT is to be set up as follows:

Amplifiers: IEC Pink Noise, 9dB Crest Factor, set to deliver 1/8 of its rated power into the nominal resistive load.

Sources: Set to normal playback mode.

During the 180-minute test, temperatures should be measured at the following locations (where applicable): Final amplifier stage output transistors (collector temperature), pre-amp stage output transistors, heat sink (external close to output transistor mounting area), Thermistors, power supply filter capacitors, voltage regulators, and any other high-temperature components. In addition, ambient temperature is to be measured at a location a minimum of 8 inches from any surface of the UUT. During the test period, thermal measurements shall be monitored and recorded at least every 2 minutes.

4.2 Electrical Tests

4.2.1 Electrostatic Discharge Test

The units shall withstand the application of ESD as outlined below. The unit is not powered during this test.

Applied Voltage	15 kV
Capacitance	150pF
Resistance	330 ohms
Number of Applications	20 times (10 positive and 10 negative)
Test Point	Every dischargeable terminal (air gap arc, not contact)

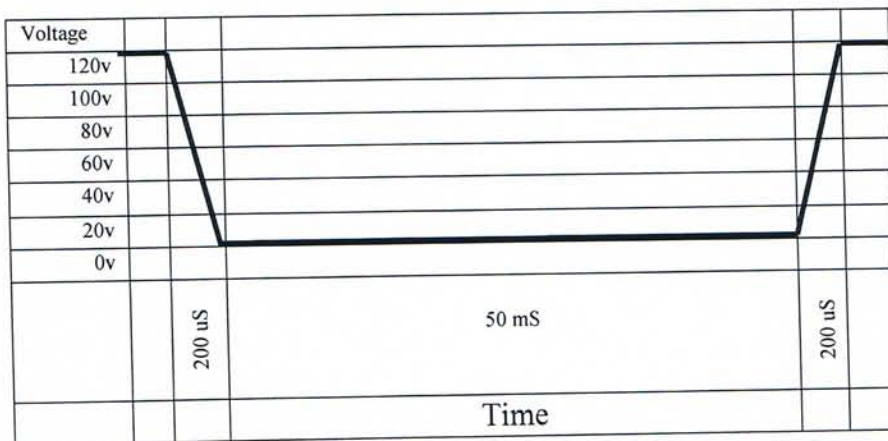
Post Test

The units should be checked for functional performance after the test. No impaired function or concealed damage is permitted.

4.2.2 Line Drop Out Test

The unit shall be powered to its rated AC voltage +/- 2%. The voltage shall be dropped to 0V for a total of 3 cycles (US 50mS, EU 60mS). The transient time between voltage levels must be 200 uS (+/- 100 uS), as shown in the diagram below. The unit shall continue to operate with no degradation in performance during the period of the test. All output channels shall monitored and recorded to determine if there are any transients generated by this test condition. This test must be performed in all DSP modes (such as Dolby Digital, ProLogic, and AC-3) as well as in stereo mode. In addition, this test must be performed using each different input signal type (Analog, Coax, and Optical).

Line Drop Out (diagram not to scale)



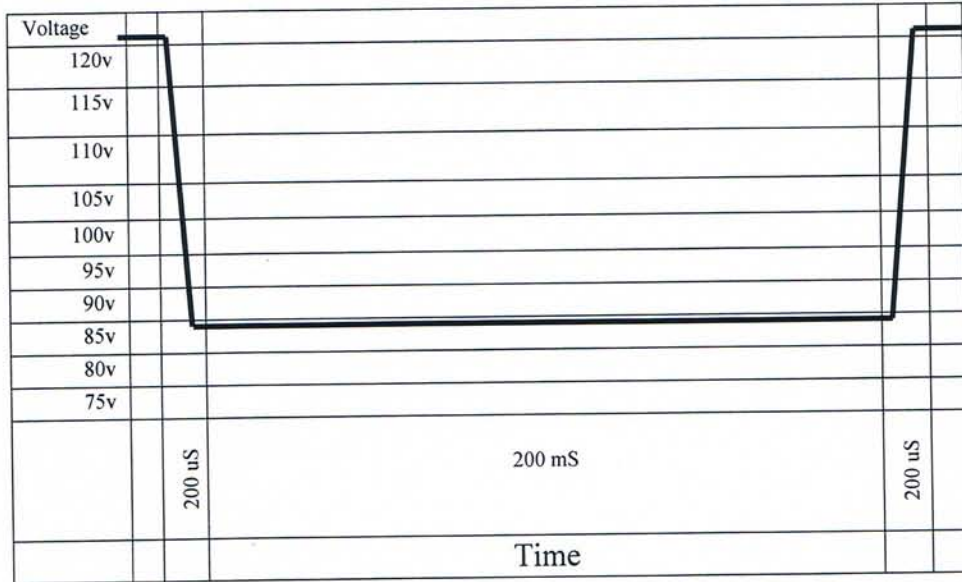
Post Test

The units should be checked for functional performance after the test. No impaired function or concealed damage is permitted.

4.2.3 Line Drop Down Test

The units shall be powered 30% below its rated AC voltage (US 84v/60Hz, EU 161v/50Hz) for a period of 200 mS. The transient time between voltage levels must be 200 uS (+/- 100 uS), as shown in the diagram below. The unit shall continue to operate with no degradation in performance during the period of the test. All output channels shall monitored and recorded to determine if there are any transients generated by this test condition. This test must be performed in all DSP modes (such as Dolby Digital, ProLogic, and AC-3) as well as in stereo mode. In addition, this test must be performed using each different input signal type (Analog, Coax, and Optical).

Line Drop Down (diagram not to scale)



Post Test

The units should be checked for functional performance after the test. No impaired function or concealed damage is permitted.

4.2.4 Adjustable Voltage Test

The units shall be powered for 1 hour at each line voltage level outlined below. During the test, verify that there is no transformer hum noise and that the circuit does not become unstable.

	Vac-Low	Vac-Nominal	Vac-High
USA	108v	120vac/60Hz	132v
Japan	90v	100vac/50Hz	108v
Europe	207v	230vac/50Hz	253v

Post Test

The units should be checked for functional performance after the test. No impaired function or concealed damage is permitted.

4.2.5 Dielectric Voltage Withstand (Hi-Pot) Test

Each appliance shall withstand the application of a potential not less than the specified voltage between parts involving a risk of electric shock and accessible conductive parts.

The following parameters should be specified for the unit under test:

Voltage (V); Maximum Leakage Current (I); and Duration (S)

In the absence of a provided specification, the unit should pass the following minimum conditions:

Voltage (US Units): 1080 V RMS, Frequency = 60 Hz
Voltage (EU Units): 3000 V RMS, Frequency = 50 Hz.
Duration: 1 second
Current: 9 mA

US Ref: UL1270, Par 77
EU Ref: IEC 60065

4.3 Mechanical Tests

4.3.1 Schedule A–Manual Handling, First Sequence

For purposes of this procedure, the bottom of a small parcel is the surface on which the parcel rests in its most stable orientation. Recommended drop heights, the number of drops, the sequence of drops, and the shipping unit orientation at impact are as follows:

<u>Shipping Weight, lb (kg)</u>	<u>Drop Height, in. (mm)</u>
0 to 20 (0 to 9.1)	24 (610)
20 to 40 (9.1 to 18.1)	21 (533)
40 to 60 (18.1 to 27.2)	18 (457)
60 to 80 (27.2 to 36.3)	15 (381)
80 to 100 (36.3 to 45.4)	12 (305)
100 to 200 (45.4 to 90.7)	10 (254)

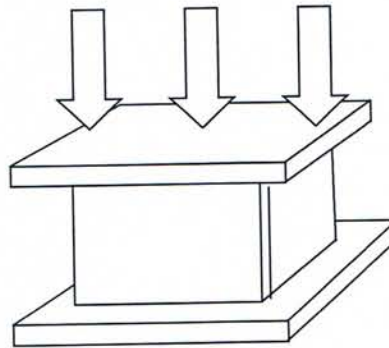
Number of Impacts At Specified Height	Impact Orientation –First Sequence of Distribution Cycle
One	top
Two	adjacent bottom edges
Two	diagonally opposite bottom corners
One	bottom

Ref: ASTM D 4169 - 99

4.3.2 Compression Test: Vehicle Stacking Assurance Level II

Schedule B – Warehouse Stacking and Vehicle Stacking

This test is intended to determine the ability of the shipping unit to withstand the compressive loads that occur during warehouse storage or vehicle transport. The formula calculates the compressive load over the largest footprint of the package using a shipping density factor. A safety factor is used to take into effect time in storage, stacking pattern, variables in container strength and atmospheric conditions (temperature, humidity). The test is to be conducted by loading the shipping unit to the computed load value, as calculated below. The compressive load is to be uniformly distributed about its largest footprint. Remove the load within 3 seconds after reaching the specified value.



Formula:

$$L = Mf * J * ((l * w * h) / K) * ((H - h) / h) * F$$

- L = Minimum Required Test Load = lb or N
- Mf = Shipping Cargo Density factor = 10.0 lb/ft³ or 160 kg/m³
- J = conversion factor = 1 lbf/lb or 9.8 N/kg
- l = length of shipping unit = in or m
- w = width of shipping unit = in or m
- h = height of shipping unit = in or m
- K = conversion factor = 1728 in³/ft³ or 1 m³/m³
- H = maximum stack height = 108.0 in or 2.7m
- F = factor to account for individual factors described above = 7

Acceptance Criteria:

1. No visible damage
2. Product intact internally
3. Packaging components able to provide further protection
4. Compression test cannot cause the outer shipping container to crease, split or tear at the joint.

Test Conditioning: 73.4°F (+/-2°F) [23°C (+/-1°C)] and 50% (+/-2%) relative humidity in accordance with practice **D 4332**.

Ref: ASTM D 4169

4.3.3 Loose Load Vibration: Method A1—Repetitive Shock Test

Place the test specimen on the test machine platform in its normal shipping orientation. Attach restraining devices to the platform to prevent the specimen from moving horizontally off the platform and to prevent excessive rocking, without restricting the vertical movement. Adjust the restraining devices to permit free movement of the specimen of approximately 10 mm (0.4 in.) in any horizontal direction from its center position. Start the vibration of the platform at a frequency of about 2 Hz and steadily increase the frequency until some portion of the test specimen repeatedly leaves the test surface. To ensure that the test specimen receives a continuing series of repetitive shocks, a shim with a 1.6 mm (1/16 -in.) thickness and a width of 50 mm (2.0 in.) shall be used to determine when the test specimen is leaving the test platform by inserting it under the package a minimum of 100 mm (4.0 in.) and moving it intermittently along one entire length of the package. Continue the test at this frequency for a period of 1 hour. The test may be stopped momentarily to inspect for damage.

If the container might possibly be transported in any other orientations, test at least one container in each possible orientation for the full-specified test duration. Inspect the container and its contents and record any damage or deterioration resulting from the test.

Ref: ASTM D 4169 – 99, ASTM D 999 – 96

4.3.4 Schedule E-Vehicle Vibration

Perform the test for each possible shipping orientation. Recommended intensities and durations for the random tests are given below.

Random Test:

The following power spectral densities (as defined by their mode of transport, frequency and amplitude breakpoints) and test durations are recommended:

Air: Assurance Level I

<u>Frequency, Hz</u>	<u>Power Spectral Density Level, g²/Hz</u>
2	0.0004
12	0.02
100	0.02
300	0.00002
Overall, g rms	1.49
Duration, min ^B	180

^B For vehicle vibration tests in multiple shipping unit orientations, the total duration should be distributed evenly between the orientations tested.

Ref: ASTM D 4169 - 99

4.3.5 Schedule A–Manual Handling, Second Sequence

For purposes of this procedure, the bottom of a small parcel is the surface on which the parcel rests in its most stable orientation. Recommended drop heights, the number of drops, the sequence of drops, and the shipping unit orientation at impact are as follows:

<u>Shipping Weight, lb. (kg)</u>	<u>Drop Height, in. (mm)</u>
0 to 20 (0 to 9.1)	24 (610)
20 to 40 (9.1 to 18.1)	21 (533)
40 to 60 (18.1 to 27.2)	18 (457)
60 to 80 (27.2 to 36.3)	15 (381)
80 to 100 (36.3 to 45.4)	12 (305)
100 to 200 (45.4 to 90.7)	10 (254)

Number of Impacts At Specified Height	Impact Orientation –Second Sequence of Distribution Cycle
One	vertical edge
Two	adjacent side faces
Two	one top corner and one adjacent top edge
One	The drop should be in the impact orientation most likely for a drop to occur, usually the largest face or the bottom. For distribution cycles where any drop orientation is possible (i.e., a small parcel environment), this drop should be in the most critical or damage-prone orientation.

Ref: ASTM D 4169 – 99

Post Test

The units should be checked for functional performance after the test. No impaired function or concealed damage is permitted. Packaging will also be inspected. End pads may be cracked, but not broken.

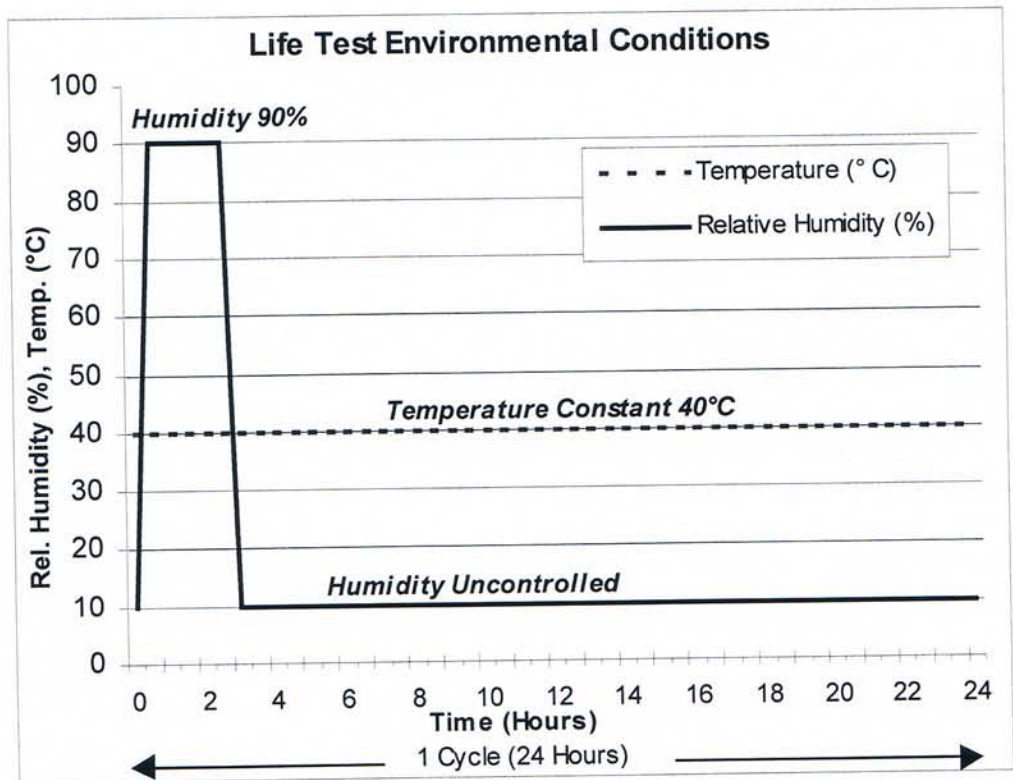
4.4 Life Test

4.4.1 Reliability Aging Test

The units shall be exposed to the following conditions in order to simulate accelerated aging. Life of the units is considered to be 2.5 years. Usage per day is assumed to be 2 hours per day or 1825 hours per 2.5 years of life.

The conditions are as follows:

Section	Mass Production
Rated AC Voltage	+/- 10 %
Load	Minimum rated load impedance
Input	Amplifier shall be adjusted to 1/8 of rated power with 9dB crest factor IEC noise driving all channels.
Number of Cycles	12



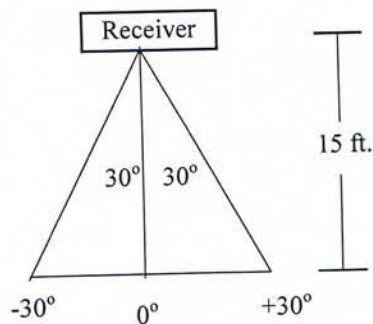
Post Test

During and after the test, the units must be checked for functional performance and external appearance at least 2 times (or at 50% and 100% of test completion). No impaired function or concealed damage is permitted.

4.5 Remote Control Test

Functional Check

The remote units are to be checked for functional performance to ensure that all functions in the keypad operate according to specification. The functional test is to be conducted at 3 points at a distance of 15 ft. from the receiver (0° , $+30^\circ$, -30°).



4.5.1 Remote Control Drop Test

The remote control is to be dropped from a height of 36 inches (3 ft) in the sequence outlined below followed by a functional test. This is to be repeated three times on three different kinds of floor surfaces (vinyl, carpet, and concrete) so that the remote control will undergo a total of 30 drops.

Drop Sequence:

- 1, 2, 3, 4 corner (4 corners)
- 5, 6, 7, 8 sides (4 sides)
- 9, 10 faces (2 faces)

Post Test

After the test, the units must be checked for functional performance and external appearance. Cosmetic defect is acceptable (e.g. battery cover damaged, housing cracked) and parts may pop off; however, the unit should be fully functional when reassembled after the test. The front button panel should **not** come off or glass display crack.

4.5.2 Remote Control Chemical Test

Spill the chemicals listed below on the button area of the remote control (3 remote control units per chemical). Let the chemical stay for at least 60 seconds and then dry with cotton balls. The remote control should meet all the functional requirements after the test.

Chemicals: Coke, water, milk, and coffee.

Post Test

After the test the units must be checked for functional performance and external appearance. Malfunction of the remote control buttons is acceptable during the test. The unit should be cleaned before post-functional test is performed.