

WHITE PAPER

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# Pascal Amplifiers

## Verification Testing

A methodology for repeatable, accurate, and comparable audio amplifier measurements.



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# CONTENTS

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|           |  |    |
|-----------|--|----|
| <b>01</b> | Introduction                               | 3  |
| <b>02</b> | Test Philosophy and Measurement Principles | 3  |
| <b>03</b> | Recommended Test Equipment                 | 4  |
| <b>04</b> | Test Environment and Setup                 | 5  |
| <b>05</b> | Load Considerations and Best Practices     | 5  |
| <b>06</b> | Output Power Testing                       | 6  |
| <b>07</b> | Total Harmonic Distortion (THD+N)          | 7  |
| <b>08</b> | Frequency Response, Gain and Linearity     | 8  |
| <b>09</b> | Noise and Idle Performance                 | 8  |
| <b>10</b> | Crosstalk                                  | 9  |
| <b>11</b> | Output Level (Vrms)                        | 9  |
| <b>12</b> | Measurement Filters and Standards          | 10 |
| <b>13</b> | Common Pitfalls and Measurement Errors     | 10 |
| <b>14</b> | Conclusion                                 | 11 |

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## 01 INTRODUCTION

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This document defines a methodology for testing Pascal amplifiers. It is based on verification procedures and is intended to ensure repeatability, accuracy, and comparability across measurements.

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## 02 TEST PHILOSOPHY AND MEASUREMENT PRINCIPLES

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Audio amplifier testing must separate different performance domains: power capability, distortion, noise, and frequency behavior. These are independent characteristics and must be measured under controlled and clearly defined conditions.

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## 03 RECOMMENDED TEST EQUIPMENT

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### AUDIO ANALYZER

- Audio Precision APx555 / APx525
- Prism dScope Series III
- Rohde & Schwarz UPV

### LOAD EQUIPMENT

- High-power resistive load bank (low inductance)
- Dedicated amplifier test loads (e.g., NH Research, AE Techron)

### POWER SOURCE

- Programmable AC source (e.g., Chroma, Keysight)
- For power testing on high power amplifiers, use 3-phase connected power sources if needed and use an AC power source matched properly with the amplifier's power draw. Ensure facility breakers/fuses are not the limiting factor.

### ADDITIONAL EQUIPMENT

- True RMS multimeters
- Oscilloscope
- Thermal monitoring equipment

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## 04 TEST ENVIRONMENT AND SETUP

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It is recommended to perform tests at  $\leq 25^{\circ}\text{C}$  ambient temperature. The device under test (DUT) should be stabilized at idle temperature before measurements begin. Connections should use balanced cabling.

## 05 LOAD CONSIDERATIONS AND BEST PRACTICES

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Load selection is critical for accurate amplifier testing.

- Use non-inductive, high-power load banks designed for audio testing
- Ensure adequate thermal dissipation
- Avoid small discrete resistors which can introduce inductance and thermal drift

Using inappropriate loads can significantly affect THD measurements, as impedance behavior varies with frequency and temperature.

## 06 OUTPUT POWER TESTING

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Output power is measured at 1 kHz using defined load impedances (e.g., 2 $\Omega$ , 2.7 $\Omega$ , 4 $\Omega$ , 8 $\Omega$ , and equivalent load resistance for constant voltage). Output power may also be tested during different durations; the standard burst duration is 100 ms.

### PROCEDURE

- Apply a sine wave at 1 kHz and record power at the final cycle of the burst duration
- Increase input signal gradually
- Monitor output voltage continuously
- Record power at the specified distortion threshold (e.g., 1%)

### MEASUREMENT CONDITIONS

- Single channel driven
- All channels driven
- Different mains voltages (e.g., 100 VAC, 120 VAC, 230 VAC)

*AES17 filter must be used.*

## 07 TOTAL HARMONIC DISTORTION (THD+N)

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The DUT inputs are connected to the balanced outputs of the Audio Analyzer with XLR cables. The DUT outputs are connected to the hot and cold terminals of the balanced inputs of the Audio Analyzer with XLR cables.

**THD+N:** The distortion is measured at 1.0 kHz with a 1-second average.

**THD vs. Frequency:** The THD performance is measured with a continuous sweep from 20 Hz to 20 kHz, with a sweep time of 5 seconds.

**THD FFT:** The THD is measured with 64K and 10 averages.

The test is performed twice – once into open load at  $-3$  dBFS and once into  $4\ \Omega$  at 1/8th full power.

*AES17 filter must be used.*

## 08 FREQUENCY RESPONSE, GAIN AND LINEARITY

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Test of the DUT's frequency response and gain. The test must cover three measurements: frequency response, gain, and linearity. The test is performed twice – once into open load at  $-3$  dBFS and once into  $4\ \Omega$  at 1/8th full power.

**Frequency Response:** Measured with a continuous sweep from 20 Hz to 20 kHz, with a sweep time of 5 seconds.

**Gain:** Measured at 1.0 kHz – may be derived from the frequency response measurement.

**Linearity:** Measured as the  $\pm$  deviation in dB, referenced to 1.0 kHz – may be derived from the frequency response measurement.

*AES17 filter must be used.*

## 09 NOISE AND IDLE PERFORMANCE

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Noise measurements include:

- RMS noise (A-weighted and unweighted)
- FFT noise spectrum
- Noise vs. time stability

Inputs should be shorted during measurement, and results should be averaged over time.

*AES17 filter must be used.*

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## 10 CROSSTALK

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The DUT input 1 is connected to the balanced output of the Audio Analyzer with XLR cables; input 2 is shorted at the connector. The DUT outputs are connected to the hot and cold terminals of the balanced input of the Audio Analyzer with XLR cables. Channel 1 is also connected to a 4  $\Omega$  load in parallel to the sense cables as a 4-point measurement.

**Crosstalk:** Measured at 1.0 kHz with a 1-second average, referenced to Channel 1.

**Crosstalk vs. Frequency:** Measured using a sweep from 20 Hz to 20 kHz, referenced to Channel 1.

*AES17 filter must be used.*

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## 11 OUTPUT LEVEL (VRMS)

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The DUT inputs are connected to the balanced outputs of the Audio Analyzer with XLR cables. The DUT outputs are connected to the hot and cold terminals of the balanced inputs of the Audio Analyzer with XLR cables.

**Vrms:** The level is measured at 1 kHz. The level is increased and noted when 1% THD+N is reached.

*AES17 filter must be used.*

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## 12 MEASUREMENT FILTERS AND STANDARDS

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All measurements should follow industry standards:

- AES17 filtering for bandwidth limitation
- Defined averaging times
- Consistent FFT sizes and windowing
- Controlled sweep durations

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## 13 COMMON PITFALLS AND MEASUREMENT ERRORS

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- **Using inductive or thermally unstable loads:** Can introduce impedance variation and phase shift, leading to inaccurate power and THD measurements.
- **Improper grounding or cabling:** May introduce hum or measurement errors.

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- **Insufficient averaging:** Leads to noisy data and reduced measurement repeatability.
  - **Ignoring mains voltage influence on performance:** Can cause over- or underestimation of output power and distortion due to supply sag or variation.
  - **Testing at  $\geq 40^{\circ}\text{C}$  ambient temperature:** Can reduce output power and increase distortion due to thermal effects and activation of protection mechanisms.
  - **Not using AES17 filtering:** Can include out-of-band noise in measurements, resulting in artificially elevated THD+N and non-comparable results.

## 14 CONCLUSION

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A structured and standardized approach to amplifier testing ensures reliable and repeatable results. Proper equipment selection and measurement methodology are essential for accurate characterization.