Audio Power Amplifiers

D. G. Meyer
School of Electrical & Computer Engineering
Outline

• How much power do I need?
• How does loudspeaker cable affect performance?
• Audio Power Amplifier Classes
  – A
  – B
  – AB
  – G
  – H
  – D
  – I
How Much Power Do I Need?

• When SPL goal at a given listening distance known, also need:
  – Sensitivity rating of loudspeaker (typically spec as 1m on-axis with input of 1 electrical watt)
  – Acoustic level change/attenuation between loudspeaker and farthest listening position

• Example: 90 dB program level at listening distance of 32 m outdoors
  – Loudspeaker sensitivity measured as 110 dB
  – Acoustic level change = 20 log (32) ≈ 30 dB
  – Add 10 dB for peak (program level) headroom
  – SPL required at source is 90 + 30 + 10 = 130 dB
  – Need 20 dB above 1 watt, or $10^{(20/10)} = 100$ W
Amplifier Power Required

Equations used to calculate the data:

\[ dBW = L_{req} - L_{sens} + 20 \times \log \left( \frac{D_2}{D_{ref}} \right) + HR \]

\[ W = 10 \text{ to the power of } \frac{dBW}{10} \]

Where:
- \( L_{req} \) = required SPL at listener
- \( L_{sens} \) = loudspeaker sensitivity (1W/1M)
- \( D_2 \) = loudspeaker-to-listener distance
- \( D_{ref} \) = reference distance
- \( HR \) = desired amplifier headroom
- \( dBW \) = ratio of power referenced to 1 watt
- \( W \) = power required

This calculator provides the required electrical power (power output from the amplifier) to produce a desired Sound Pressure Level (SPL) at a given distance, along with an amount of headroom to keep the amplifier(s) out of clip.

Example: You are designing a system where the farthest listening position from the loudspeaker is 100 meters, and the desired Sound Pressure Level is 95 dB SPL. The loudspeaker chosen for the job has a sensitivity rating of 95 dB. With the minimum recommended amplifier headroom of 3 dB, then you need to choose an amplifier that can supply at least 1,995 watts to the loudspeaker.
How Does Loudspeaker Cable Affect Performance?

• Damping is a measure of a power amplifier's ability to control the back EMF motion of the loudspeaker cone after the signal disappears.

• The **damping factor** of a system is the ratio of the loudspeaker's nominal impedance to the total impedance driving it.

• Example: Amplifier with damping factor of 300 (bigger is better) driving an 8Ω load means that the output impedance is 0.027Ω (lower is better).

• Impedance of speaker cable used can significantly reduce the damping factor (larger gauge wire has lower impedance).
Line Loss

[Back to Design Tools]

<table>
<thead>
<tr>
<th>Power Driven on Line</th>
<th>Length of Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 watts</td>
<td>200 ft.</td>
</tr>
<tr>
<td>Voltage level</td>
<td>Wire Gauge</td>
</tr>
<tr>
<td>15 volts</td>
<td>#18 AWG</td>
</tr>
</tbody>
</table>

This calculator provides line loss with 2-conductor cable on a constant voltage line.

Equation used to calculate the data:

\[ P_{loss} = 10 \times \log \left( 1 - \frac{(2 \times RL)}{(2 \times RL + (V/line squared / Prated))} \right) \]
Audio Power Amplifier Classes

• Audio power amplifiers were originally classified according to the relationship between the output voltage swing and the input voltage swing.

• Classification was based on the amount of time the output devices operate during one complete cycle of a signal swing.

• Classes were also defined in terms of output bias current (the amount of current flowing in the output devices with no applied signal).

• For discussion purposes (with the exception of class A), assume a simple output stage consisting of two complementary devices (one positive polarity and one negative polarity) using any type of transistor.
Basic Power Amplifier Output Stage
(Voltage-Follower MOSFET Configuration)

N channel

P channel

Vin  Vout

acts as a current amplifier with high input impedance and very low output impedance
Power Amplifier Classes – “A”

• Class “A”
  – key ingredient of class A operation is that output device is always on
  – single-ended design with only one type polarity output device
  – the most inefficient of all power amplifier designs, averaging only around 20% (large, heavy, and run very hot)
  – are inherently the most linear, with the least amount of distortion
  – impractical for professional audio applications due to inefficiency
Example: Hawk A18 (2x10W)
Power Amplifier Classes – “B”

- Class “B”
  - opposite of class A: both output devices are never allowed to be on at the same time
  - each output device is on for exactly one half of a complete sinusoidal signal cycle
  - class B designs show high efficiency but poor linearity around the crossover region (due to the time it takes to turn one device off and the other device on, which translates into extreme crossover distortion)
  - class B designs restricted to low power applications, e.g., battery operated equipment, such as communications audio
Class A vs. Class B
Power Amplifier Classes – “AB”

• Class “AB”
  – intermediate case: both devices are allowed to be on at the same time, *but just barely*
  – output bias is set so that current flows in a specific output device appreciably more than a half cycle but less than the entire cycle (enough to keep each device operating *so they respond instantly* to input voltage demands)
  – the inherent non-linearity of class B designs is eliminated, without the gross inefficiencies of the class A design
  – combination of good efficiency (around 50%) with excellent linearity that makes class AB the most popular consumer audio amplifier design
Class AB
Example: Class AB
Power Amplifier Classes – “G”

• Class “G”
  – operation involves changing the power supply voltage from a lower level to a higher level when larger output swings are required
  – common for pro audio designs
  – several ways to do this:
    • simplest involves a single class AB output stage that is connected to two power supply rails by a diode or transistor
      – for most musical program material, the output stage is connected to the lower supply voltage
      – automatically switches to the higher rails for large signal peaks (thus the nickname rail-switcher)
    • Another approach uses two class AB output stages, each connected to a different power supply voltage
      – the magnitude of the input signal determines the signal path
      – use of two power supplies improves efficiency enough to allow significantly more power for a given size/weight
Class G
Example: Class G

MAX9730
2.4W, Single-Supply Class G Power Amplifier

Highest Output Power Speaker Amplifier From a Battery

The MAX9730 features a mono Class G power amplifier with an integrated charge-pump power supply. The charge pump can supply up to 150mA of peak output current over a 2.7V to 5.5V supply voltage range, guaranteeing up to 2.4W output power into an 8Ω load. The 2.4W output power allows for transient audio content to remain undistorted as the battery rail collapses over time.

The MAX9730 maximizes battery life by offering high-performance efficiency. Maxim’s proprietary output stage provides efficiency levels greater than Class AB devices without the RFI penalties commonly associated with Class G amplifiers. High efficiency allows the MAX9730 to be packaged in a WLP package without derating the output power handling capability.

The device utilizes fully differential inputs and outputs, comprehensive click-and-pop suppression, shutdown control, and soft-start circuits. The MAX9730 is fully specified over the -40°C to +85°C extended temperature range and is available in ultra-small, lead-free, 20-pin WLP (2mm x 2.5mm) and 26-pin TQFN (4mm x 4mm) package.

Key Features:
- 2.7V to 5.5V Operation
- Integrated Charge-Pump Power Supply
- 63% Efficiency (VCC = 5V, Pout = 1W)
- 2.4W Output Power into 8Ω at VCC = 5V
- Up to 2.4W Instantaneous Output Power into 8Ω
- Clickless/Popless Operation
- Small Thermally Efficient Packages
- 2mm x 2.5mm 20-Bump WLP
- 4mm x 4mm 26-Pin TQFN

Applications/Uses:
- Cellular Phones
- Handheld Gaming Consoles
- MP3 Players
- Notebooks/Computers
- Personal Media Players
- Smartphones

Key Specifications: Speaker Amplifiers

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Class</th>
<th>SPEAKER Amp.</th>
<th>VCC (V)</th>
<th>SPEAKER Amp.</th>
<th>VCC (V)</th>
<th>Pout into 8Ω (W)</th>
<th>Pout into 6Ω (W)</th>
<th>Output Voltage Swing (Up)</th>
<th>Speaker Amp.</th>
<th>External Gain</th>
<th>Speaker Amp.</th>
<th>External Gain</th>
<th>Speaker Amp.</th>
<th>External Gain</th>
<th>Speaker Amp.</th>
<th>External Gain</th>
<th>Speaker Amp.</th>
<th>External Gain</th>
<th>Speaker Amp.</th>
<th>External Gain</th>
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<tbody>
<tr>
<td>MAX9730</td>
<td>Class</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Notes:
- This pricing is BUDGETARY. For comparing similar parts, prices are in U.S. dollars and subject to change. Quantity pricing may vary substantially and international prices may differ due to local duties, taxes, fees, and exchange rates. For volume-specific prices and delivery, please see the price and availability pages or contact an authorized distributor.

Didn't Find What You Needed?
- Next Day Product Selection Assistance from Applications Engineers
- Parametric Search
- Applications Help
Power Amplifier Classes – “H”

• Class “H”
  – takes the class G design one step further and actually modulates the higher power supply voltage by the input signal
  – allows the power supply to track the audio input and provide just enough voltage for optimum operation of the output devices (thus the nickname *rail-tracker* or *tracking power amplifier*)
  – the efficiency of class H is comparable to class G designs
Class H

Ampl class H

U (V)

+ Vss
+ Vs
0
- Vs
- Vss

Vss
Vs

Class H
Example: Class H

A line of amplifiers that define high impact. Up to 3,000 watts in a 2 rack unit chassis that’s only 13” deep and 21” lbs. We included our exclusive PowerLight® Technology used in our award-winning PowerLight Series for chest-rumbling bass and crystal-clear highs. It also features hum-free noise floor and a distortion of less than 0.01%. To keep it running under the most demanding conditions, we’ve added our Advanced Thermal Management System. PLX series offers the reliability of a company that's been building professional amplifiers for over 30 years.

PLX Series amplifiers are no longer being manufactured, please see the PLX Series Amplifiers for equivalent replacements.

SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
<th>PLX1202</th>
<th>PLX1602</th>
<th>PLX2402</th>
<th>PLX3002</th>
<th>PLX3402</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEREO MODE</td>
<td>8 ohms</td>
<td>4 ohms</td>
<td>4 ohms</td>
<td>2 ohms</td>
<td>2 ohms</td>
</tr>
<tr>
<td>8 ohms (20 Hz-20 kHz, 0.00% THD)</td>
<td>200 W</td>
<td>300 W</td>
<td>425 W</td>
<td>550 W</td>
<td>700 W</td>
</tr>
<tr>
<td>4 ohms (20 Hz-20 kHz, 0.01% THD)</td>
<td>325 W</td>
<td>500 W</td>
<td>700 W</td>
<td>900 W</td>
<td>1100 W</td>
</tr>
<tr>
<td>2 ohms (1 kHz 1% THD)</td>
<td>600 W</td>
<td>800 W</td>
<td>1200 W</td>
<td>1500 W</td>
<td>1700 W</td>
</tr>
<tr>
<td>BRIDGE MONO MODE</td>
<td>16 ohms</td>
<td>8 ohms</td>
<td>4 ohms</td>
<td>4 ohms</td>
<td>4 ohms</td>
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<tr>
<td>16 ohms (20 Hz-20 kHz, 0.01% THD)</td>
<td>400 W</td>
<td>650 W</td>
<td>850 W</td>
<td>1100 W</td>
<td>1400 W</td>
</tr>
<tr>
<td>8 ohms (20 Hz-20 kHz, 0.01% THD)</td>
<td>700 W</td>
<td>1100 W</td>
<td>1600 W</td>
<td>2000 W</td>
<td>2200 W</td>
</tr>
<tr>
<td>4 ohms (1 kHz 1% THD)</td>
<td>1300 W</td>
<td>1850 W</td>
<td>2400 W</td>
<td>3000 W</td>
<td>3400 W</td>
</tr>
<tr>
<td>Signal to Noise (20 Hz-20 kHz)</td>
<td>&lt; -106 dB</td>
<td>&lt; -107 dB</td>
<td>&lt; -106 dB</td>
<td>&lt; -107 dB</td>
<td>&lt; -107 dB</td>
</tr>
<tr>
<td>Input Sensitivity @ 8 ohms</td>
<td>1.4 Vrms</td>
<td>1.7 Vrms</td>
<td>1.3 Vrms</td>
<td>1.7 Vrms</td>
<td>1.3 Vrms</td>
</tr>
<tr>
<td>Input Sensitivity @ 4 ohms</td>
<td>0.8 Vrms</td>
<td>1.1 Vrms</td>
<td>0.9 Vrms</td>
<td>1.1 Vrms</td>
<td>0.9 Vrms</td>
</tr>
<tr>
<td>Voltage Gain</td>
<td>40x (32 dB)</td>
<td>40x (32 dB)</td>
<td>40x (32 dB)</td>
<td>40x (32 dB)</td>
<td>40x (32 dB)</td>
</tr>
<tr>
<td>Output Circuitry</td>
<td>AB</td>
<td>AB</td>
<td>AB</td>
<td>AB</td>
<td>AB</td>
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<tr>
<td>Power Requirements</td>
<td>9A</td>
<td>15A</td>
<td>8A</td>
<td>10A</td>
<td>12A</td>
</tr>
</tbody>
</table>

ALL MODES

| Distortion (EIA) | Less than 0.01% |
| Distortion (Typical) | Less than 0.01% |
| 20 Hz-20 kHz, 1 dB below rated power | Less than 0.01% |
| 1.0 kHz and below, full rated power | Less than 0.01% |
| Frequency Response | 20 Hz-20 kHz, +/- 0.25 dB (1 kHz-60 kHz, +/- 3 dB) |
| Damping Factor | Greater than 500 |
| Input Impedance | 8k ohm, unbalanced, 12k ohm balanced |
| Input Clipping | 10 Vrms (+20 dB) |
| Cooling | Variable-speed fan, rear-to-front air flow |
| Connector, each channel | Input: 3-pin XLR & 1/4” TRS balanced |
| | Output: XLR & 1/4” TRS balanced |
| | Balanced Output: Neutrik® Speaker and hard-wired binding posts |
| Amplifier Protection | Full short circuit, open circuit, thermal, ultrasonic, and RFI protection |
| | Stands into reactive or mismatched loads |
| Load Protection | On/off muting, DC-fault power supply shutdown |
| Dimensions | 19” (48.3 cm) radii mounting, 3.5” (9.9 cm) tall (2 rack spaces) |
| | 13.25” (33.7 cm) deep (front panel mounting rails) |
| Gain | 40x (32 dB) |
| Weight | 21 lbs (9.5 kg) net, 27 lbs (12.3 kg) shipping |

FEATURES

- Exclusive PowerLight® power supply for superior bass and lighter weight
- Ultra-low distortion (0.03% THD at 8 ohms) & studio-quality noise floor (1.07 dB)
- LED indicators include bridge mono and parallel input modes
- Compact 2RU, 11 lbs. and 13” deep chassis fits into any rack
- Class H output reduces AC power draw and heat by 40% (2400, 3000, & 3400)
- Selectable dip limiters and subsonic filters reduce distortion and protect speakers
- Variable-speed fans for low noise and solid 2 ohm performance
- Both 1/4” TRS & XLR inputs, Ground® and shock-proof binding post outputs
- 3-year warranty plus optional 3-year extension available
More Efficient Linear Designs

G2

G3

AB

H

wasted power
Power Amplifier Classes

• Class “D”
  – operation is switching, hence the term *switching power amplifier*
  – output devices are rapidly switched on and off at least twice for each cycle
  – the output devices are either completely on or completely off so theoretically they do not dissipate any power
  – class D operation is theoretically 100% efficient, but this requires zero on-impedance switches with infinitely fast switching times
  – practical designs do exist with true efficiencies approaching 90%
  – Class D is at least as old as 1954 (U.S. Patent 2,821,639: solid-state full-bridge servo amplifier)
Basic Class D Principle

Natural sampling → PWM

Audio input

Triangle waveform

Switch

Low-pass filter

Audio output
Power Amplifier Classes – “D”

- Class “D” – Complications
  - need to operate at high switching speed (e.g., 250 KHz) for full audio bandwidth (20 KHz) reproduction with low distortion
  - traditional design requires “dead time” between positive and negative polarity phases (to avoid destruction of output switching devices) – introduces additional distortion
  - quality of switching devices (“on” resistance, switching speed) limit efficiency/performance
Example: Class D

DA Series
Multi-channel Digital Amplifiers

Also see the new 9880 Series Digital Matrix Mixer/Ampifiers.

The DA Series multi-channel digital power amplifiers are ideal for multi-zone distributed speaker systems and professional audio applications.

Engineered with Class D technology, the new DA Series amplifiers operate at 95 percent efficiency and consume almost one-third less power than conventional analog amplifiers. The compact and lightweight single or dual rack-space design and ultra-low heat dissipation allow designers to rack-mount up to five units without open space between units.

The DA Series is comprised of high-end low-impedance four-channel models, each equipped with an independent power supply for each channel to assure continuous operation and unmatched reliability and performance. Other features include recessed slotted ventilators for precise heat calibration, removable dust filters for easy maintenance, and optional isolation transformers.

Competitively priced, the new DA Series multi-channel power amplifiers are backed by TOA’s five-year warranty.

<table>
<thead>
<tr>
<th>Model</th>
<th>Power Output</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA-2500**</td>
<td>2x150W (4 ohms) 2x170W (8 ohms)</td>
<td></td>
</tr>
<tr>
<td>DA-2500H</td>
<td>2x200W (70V) 1x300W bridged (140V)</td>
<td></td>
</tr>
<tr>
<td>DA-250F</td>
<td>4x 250W (4 ohms) 2x 170W (8 ohms) 2x 50W bridged (8 ohms)</td>
<td>Now Shipping!</td>
</tr>
<tr>
<td>DA-250FH</td>
<td>4x 250W (70V) 2x 500W bridged (140V)</td>
<td></td>
</tr>
<tr>
<td>DA-500F-HL</td>
<td>4x 500W (70V) 2x 1000W bridged (140V) 4x 50W (8 ohms) 4x 110W (4 ohms) 2x 110W (8 ohms)</td>
<td>Now Shipping!</td>
</tr>
<tr>
<td>DA-550F</td>
<td>4x 550W (4 ohms) 4x 150W (8 ohms) 2x 1100W bridged (8 ohms) 2x 700W bridged (16 ohms)</td>
<td></td>
</tr>
</tbody>
</table>
Example: Class D

PowerLight 3 Series
Professional Power Amplifiers

### PowerLight 3 Power Amplifiers

**Specifications**: PL330, PL340, PL360

**Watts at Clipping**

- PL330: 300, 600, 1200
- PL340: 600, 1200, 3000
- PL360: 2600, 5600, 4000

**Features**:
- Bass mode testing required due to AC input current
- S-shaped power ratings with explanations can be found in the following document: [PowerLight 3 Series Specifications](#)

**Architects & Engineers**

**Specifications**

- PL325
- PL340

**Accessories**

- BZU

### PowerLight 3 Series

#### Technical Specifications

- **Input Impedance**: +10x times balanced, or unbalanced
- **Coaxial**: 
- **Power Controls**:
  - **Front Controls**:
    - **Control**:
      - **Input**: Bridge (Yellow), Stereo (Green), or Parallel (Orange)
      - **Gain**: Stereo (Green), or Parallel (Orange)
      - **Input**: Sereo (Green), or Parallel (Orange)

- **Amplifier and Load Protection**:
  - Short circuit, open circuit, thermal, overvoltage, shorting, DC fault shutdown,

### PowerLight 3 Series

#### Power Specifications

- **Input**: 240V AC
- **Output**: 240V AC
- **RMS**: 8 Ohm, 4 Ohm
- **THD**:
  - PL330: 0.03%
  - PL340: 0.02%
  - PL360: 0.01%

### PL3 Series

- **Input**: 240V AC
- **Output**: 110V AC
- **RMS**: 8 Ohm, 4 Ohm
- **THD**:
  - PL330: 0.02%
  - PL340: 0.01%
  - PL360: 0.005%
Power Amplifier Classes – “S”

- Class “S”
  - first invented in 1932
  - used for both amplification and amplitude modulation
  - similar to Class D except the rectangular PWM voltage waveform is applied to a low-pass filter that allows only the slowly varying DC or average voltage component to appear across the load
  - essentially this is what is called “Class D” today
Relative Efficiency

- Class D
- Class H
- Class G3
- Class G2
- Class AB
Power Amplifier Classes – “I”

- Class “I”
  - based on patent U.S. 5,657,219 covering opposed current converters
  - "I" is short for "interleave" as this is the only four-quadrant converter known that uses two switches yet that has an interleave number of 2
  - when used with fixed-frequency naturally sampled two-sided PWM it forms a theoretically optimum converter having the least unnecessary/undesirable PWM spectra
  - also called a “balanced current amplifier”
Balanced Current Switching Amplifier

Class-I Switches, Positive Signal

Class-I Switches, Signal at Zero Amplitude

Class-I Switches, Negative Signal
Example: Class I

I-Tech Series

Front and Back Panel Views
(Open a 4x6 window)

Specifications
- Date Sheet
- Operation Manual
- Service Brochure
- Specifications
- Application Guide
- Quick Start Guide
- I-Tech FAQ
- New Features
- Class A/B Paper

Software Services & Tutorials
- Downloads
- Community Discussions

Technical Specifications

LT4000 AC & Thermal Info
LT6000 AC & Thermal Info
LT8000 AC & Thermal Info

LT4000 AES Special
LT6000 AES Special
LT8000 AES Special

Crown System Design Tools
(Windows application)

Stay up to date with firmware and software releases by subscribing to the Crown Mailing List.

For product availability and pricing please contact your local dealer.

<table>
<thead>
<tr>
<th>Performance</th>
<th>I-T4000</th>
<th>I-T6000</th>
<th>I-T8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Sensitivity (volts RMS) for rated output</td>
<td>Adjustable in 0.1V steps from 0.6V to 7.5V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage Gain at full rated power at 5 ohms</td>
<td>37.1 dB to 22.3 dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.9 dB to 20.0 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.9 dB to 25.0 dB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency Response (at 1 watt, 100 Hz - 20 kHz)</td>
<td>± 0.25 dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal to Noise Ratio below rated full bandwidth power, unweighted</td>
<td>&gt; 105 dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Harmonic Distortion (THD) at full rated power</td>
<td>&lt; 0.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermodulation Distortion (IMD) 60 Hz and 7 kHz at 1 kHz, from full rated output to 35 dB</td>
<td>&lt; 0.05%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Input Level</td>
<td>+15 dBu or -21 dBV, depending on setting of maximum input level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latency (analog, digital inputs)</td>
<td>Analog: 1.5 ms, Digital: 3.0 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latency (analog, digital inputs)</td>
<td>Latency Table below</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A/D, D/A Converters</td>
<td>24-bit 192 kHz, 32-bit 96 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Input</td>
<td>AES/EBU, 24-bit, 96-96 kHz, Optical and coaxial input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td>Onboard Ethernet and TCP/IP, compatible with standard 100Base Ethernet hardware</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Note</td>
<td>Actual operation with TEC 41, cascaded I-Tech preamplifier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attenuator</td>
<td>Speed sensitive rotary encoders, 0.5 dB steps, range 0 to -40 dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Damping Factor (at 8 ohms): 20 kHz to 100 Hz</td>
<td>&gt; 5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crosstalk (below rated power, 20 kHz to 1 kHz)</td>
<td>&gt; 80 dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Mode Rejection (CMR) (20 kHz to 1 kHz)</td>
<td>&gt; 80 dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC Output Offset (shorted input)</td>
<td>&lt; 3 mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Impedance (unbalanced)</td>
<td>20 Khm balanced, 10 Khm unbalanced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Impedance (note: Safe with all types of loads)</td>
<td>20 to 40 Ohms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge Mode</td>
<td>2:1, 4:1, 8:1, 16:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required AC Power</td>
<td>Universal AC Input, 100-240VAC at 50 Hz, 60 Hz, Max. AC mains voltage 277VAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Line Connector</td>
<td>USA, Europe, Australia, India</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Construction

All Models

| Ventilation | Flow-through ventilation from front to back |
| Cooling | Dual-zone, microprocessor controlled, continuously variable speed fans |
| Dimensions | 9U Standard 19" rack mount width (AR RB-250), 2.25"H, 15"W (41.4 cm) height, 45.7 cm depth, front bevelled corner surface |
| Weight | 26 pounds (11.2 kg) |
| Shipping | 36 pounds (16.3 kg) |
Industry Trends

• Analog amplifier ("Class AB") market share $2-3B in 2003 (Class D market share was only 2-3%)
• By 2006, digital amplifier ("Class D") market share rose to 15% and by 2008 to 30%
• By 2011, Class D market share predicted to be 67%
• Conclusion: Class D is here to stay!