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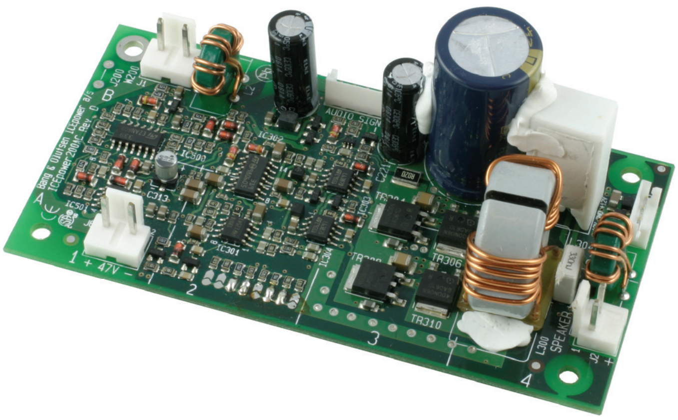


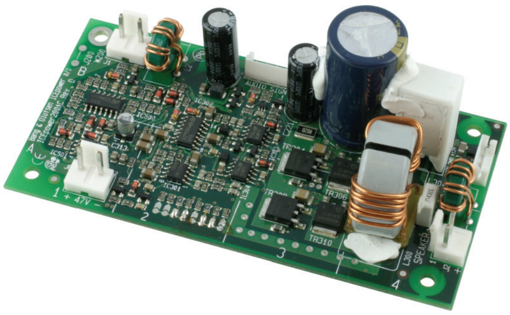
ICEpower200AC
200W ICEpower Amplifier

Version 1.1

General Description

The ICEpower200AC is an intelligent 200W audio amplifier module designed particularly for highly competitive consumer, professional and multimedia audio applications. The ICEpower200AC can be used separately or as a supplement to ICEpower modules with integrated power supply to make compact multi-way or multi-channel solutions. Key benefits of the ICEpower200AC include:

- ICEpower's patented COM modulation and MECC control techniques ensure excellent audio performance.
- Comprehensive protection scheme ensures reliable operation in any application.
- Highly efficient ICEpower analogue technology eliminates the need for heat sinks and EMI shields.



Dimensions: 10.7 x 5.5 x 3.3 cm.

The ICEpower200AC can be powered from the ICEpower200ASC, ICEpower250ASP and ICEpower500ASP amplifiers with integrated power supplies. The ICEpower200AC is pre-approved for safety and EMC to reduce design-in cost and shorten time-to-market.

Key Specifications

- 200W @ 0.2% THD+N (10Hz – 20kHz, 4Ω)
- 110dBA dynamic range (200W @ 4Ω)
- THD+N = 0.006% (1W, 8Ω,1kHz)
- THD+N < 0.2% (0.01 – 200W, 4Ω)
- CCIF Intermodulation distortion = 0.0005% (10W, 4Ω, 14kHz/15kHz)
- 89 % total efficiency @ 200W, 4Ω
- Damping factor = 4000 (100Hz, 8Ω)

Key Features

- Rugged construction
- Suitable for CE approved designs
- Thermal protection
- Overcurrent protection
- Sound optimized soft clip
- Low pop
- Safety conforms to: UL6500 and others
- EMI conforms to: EN55013 and others

Block Diagram

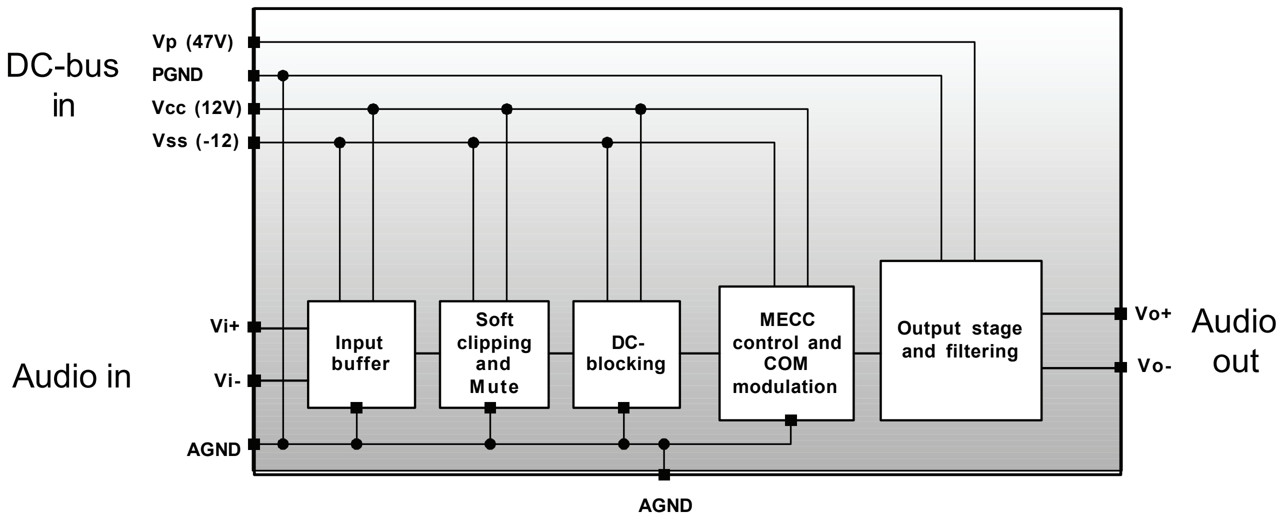


Figure 1: ICEpower200AC block diagram

Connection Diagram

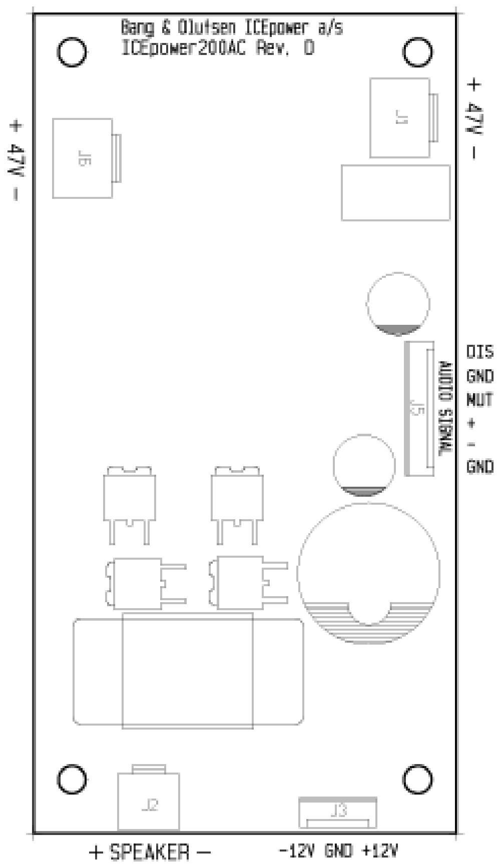


Figure 2: ICEpower200AC connections

The plug interface of the ICEpower200AC module has five industry standard connectors selected for long-term reliability.

+47V Header (J6)

Type: JST B02P-NV			
PIN	**Function**	**Description**	**Type**
1	47V	Power supply +47V	Input
2	GND	Ground terminal for the power section	Input

Table 1: 47V connector specification

+47V Bypass Header (J1)

Type: JST B02P-NV			
PIN	**Function**	**Description**	**Type**
1	+47V	Power supply +47V for additional ICEpower200AC	Output
2	GND	Ground terminal for the power section	Output

Table 2: 47V bypass connector specification

Speaker Header (J2)

Type: JST B 2P-VH			
PIN	**Function**	**Description**	**Type**
1	Vo+	“Hot” balanced audio power output terminal.	Output
2	Vo-	“Cold” balanced audio power output terminal.	Output

Table 3: Speaker connector specifications.

Signal Header (J5)

Type: JST B6B-EH-A			
PIN	**Function**	**Description**	**Type**
1	GND	Ground terminal for the signal section.	GND
2	Vi-	Negative input (balanced input buffer).	Audio Input
3	Vi+	Positive input (balanced input buffer).	Audio Input
4	Mute	Control pin for input signal mute (w/ int. pullup)	Input
5	GND	Ground terminal for the signal section.	GND
6	Disable	Control pin for disabling output stage (w/ int. pullup)	Input

Table 4: Signal connector specification.

+/-12V Supply Header (J3)

Type: JST B3B-EH-A			
PIN	**Function**	**Description**	**Type**
1	-12V	Power supply -12V	Input
2	GND	Ground terminal for the signal section.	GND
3	+12V	Power supply +12V	Input

Table 5: +/-12V connector specification.

Absolute Maximum Ratings

Absolute maximum ratings indicate limits beyond which damage may occur.

+47V Input Section

Symbol	Parameter	Value	Units
V_{max}	Maximum supply voltage	50	V_{DC}
V_{min}	Minimum supply voltage	22[1)]	V_{DC}

Table 6: Absolute maximum ratings power supply input section.

1) The ICEpower200AC will shut off if the voltage is too low.

+/-12V Input Section

Symbol	Parameter	Value	Units
+12V	Maximum supply voltage	14	V_{DC}
-12V	Maximum supply voltage	-14	V_{DC}

Table 7: Absolute maximum ratings DC-bus.

Input Section

Symbol	Parameter	Value	Units
Vin+ , Vin-	Maximum voltage range on pin	±12	V
Mute	Maximum voltage range on pin	0-12	V
Disable	Maximum voltage range on pin	0-12	V

Table 8: Absolute maximum ratings input section.

Output Section

Symbol	Parameter	Value	Units
R_{load}	Minimum load	3	Ω
I_{out}[2)]	Maximum current draw from amplifier output	12.5	A
C_L	Maximal pure capacitive loading	330	nF

Table 9: Absolute maximum ratings output section.

2) The overcurrent protection will act to protect the amplifier. (See the section "Protection features")

Thermal Section

Symbol	Parameter	Value	Unit
T_a	Max. operating ambient temperature (tropical conditions)	45	^{O}C

Table 10: Absolute maximum ratings thermal section.

Power Specifications

Unless otherwise specified. $T_a = 25\,^{O}C$, f = 1kHz, $R_L = 4\Omega$, Supplies = 47V and +/-12V

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{Pmax}	Time of maximum rated output power	200W out. No preheating.	-	120	-	s
P_T	Continuous output power[4)] without thermal shutdown. 0 - 8kHz[5)]	Thermal stab. @ $T_a = 25\,^{O}C$	-	50	-	W
P_T	Continuous output power[4)] without thermal shutdown.	Thermal stab. @ $T_a = 50\,^{O}C$	-	25	-	W
P_{FTC}	FTC rated output power 0 - 12kHz[5)]		-	70	-	W
I_q	Quiescent current consumption 47V	Po = 0 W	-	30	-	mA
I_q	Quiescent current consumption +12V	Po = 0 W	-	70	-	mA
I_q	Quiescent current consumption -12V	Po = 0 W	-	20	-	mA
$P_{q\ dis}$	Quiescent power consumption, disabled	Disable pin low	-	0.8	-	W
η	Power efficiency	Po = 200W, $R_L = 4\Omega$ Po = 100W, $R_L = 8\Omega$	-	87 89	-	%

Table 11: Power specifications

4) The module is mounted vertically in free air.
5) The power bandwidth is limited due to the output Zobel-network. (See further details on page 11-12)

Audio Specifications

$V_p = 47V$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
P_O	Output power @ 0.2%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 4\Omega$	-	200	-	W
P_O	Output power @ 0.2%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 8\Omega$	-	100	-	W
P_O	Output power @ 1%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 4\Omega$	-	210	220	W
P_O	Output power @ 10%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 4\Omega$	-	290	-	W

Table 12: Audio specifications 47V.

$V_p = 50V$

Symbol	Parameter	Conditions	Min	Typ	Max	Units
P_O	Output power @ 0.2%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 4\Omega$	-	210	220	W
P_O	Output power @ 0.2%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 8\Omega$	-	110	-	W
P_O	Output power @ 1%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 4\Omega$	-	230	240	W
P_O	Output power @ 10%THD+N 10Hz < f < 20kHz (AES17 measurement filter) [6)]	$R_L = 4\Omega$	-	310	-	W

Table 13: Audio specifications 50V.

6) An Audio Precision AES17 20 kHz 7th order measurement filter is used for measurements. The frequency 6.67kHz corresponds to the worst-case situation where both 2nd and 3rd harmonics are within the audio band.

General Audio Specifications

Unless otherwise specified, f = 1kHz, P_O = 1W, T_a = 25 °C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
THD+N	THD+N in 4Ω (AES17 measurement filter) [6)]	f = 100Hz, P_O =1W	-	0.008	0.02	%
$V_{N,O}$	Output referenced idle noise	A-weighted 10Hz < f < 20kHz	75	90	125	μV
A_V	Nominal Voltage Gain	f = 1 kHz	26.3	26.8	27.3	dB
f	Frequency response	20Hz - 20kHz, All loads	-	±0.5	±1.0	dB
f_u	Upper bandwidth limit (-3dB)	R_L = 8Ω R_L = 4Ω	- -	68 50	- -	kHz kHz
f_l	Lower bandwidth limit (-3dB)	R_L = All loads	-	3.5	-	Hz
Z_o	Abs. output impedance	f = 1kHz	-	10	20	mΩ
Z_L	Load impedance range		3	4	∝	Ω
D	Dynamic range	A-weighted at 200W@4Ω	107	110	111	dB
IMD	Intermodulation (CCIF)	f =14kHz, 15kHz, P_O =10W	-	0.0005	-	%
TIM	Transient intermodulation (TIM)	f_1 = 3.15kHz square, f_2 = 15kHz, P_O =10W	-	0.004	-	%

Table 14: General audio specifications

6) An Audio Precision AES17 20 kHz 7th order measurement filter is used for measurements. The frequency 6.67kHz corresponds to the worst-case situation where both 2nd and 3rd harmonics are within the audio band.

Electrical Specifications

Unless otherwise specified, V_P = 47V, T_a=25 °C.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
f_o	Idle switching frequency	Idle	440	470	510	kHz
f_s	Switching frequency range	Idle to full scale variation	40	-	510	kHz
$V_{OFF,Diff}$	Differential offset on output terminals	Input terminated	-	-	±30	mV
$V_{OFF,CM}$	Common mode offset on output terminals	Input terminated	-	23.5	-	V

Table 15: Electrical specifications

Timing Specifications

Symbol	Parameter	Condition	Min	Typ	Max	Unit
t_{sd}	Switching delay at start up	Time from when all power supplies are good to start of signal amplification	-	4.5	-	s

Table 16: Timing specifications.

Mechanical Specifications

During development the ICEpower200AC has been tested thoroughly to ensure high reliability.

Test	Acceleration	Amount
Unpowered tests: The unit is powered up after the test to verify functionality.		
Random vibration	$2g_{RMS}$	3x20min
Bump	10g/16ms, 2-4 Hz	1000 bumps in each of 6 directions[7)]
Shock	70g/12ms	3 shocks in each of 6 directions[7)]
Powered tests: The unit is tested with power applied.		
Sinusoidal vibrations	2.5mm, 5-10Hz 1g, 10-100Hz	2 hours in each of 3 directions[7)]
Random vibrations	0.01g, 10-20Hz $0.7g_{RMS}$ –3dB/oct, 20-150Hz	2 hours in each of 3 directions[7)]

Table 17: Mechanical tests

7) 6 directions: (up, down, left, right, forward and backward). 3 directions: (up and down, left and right, forward and backward)

Typical Performance Characteristics

Frequency Response

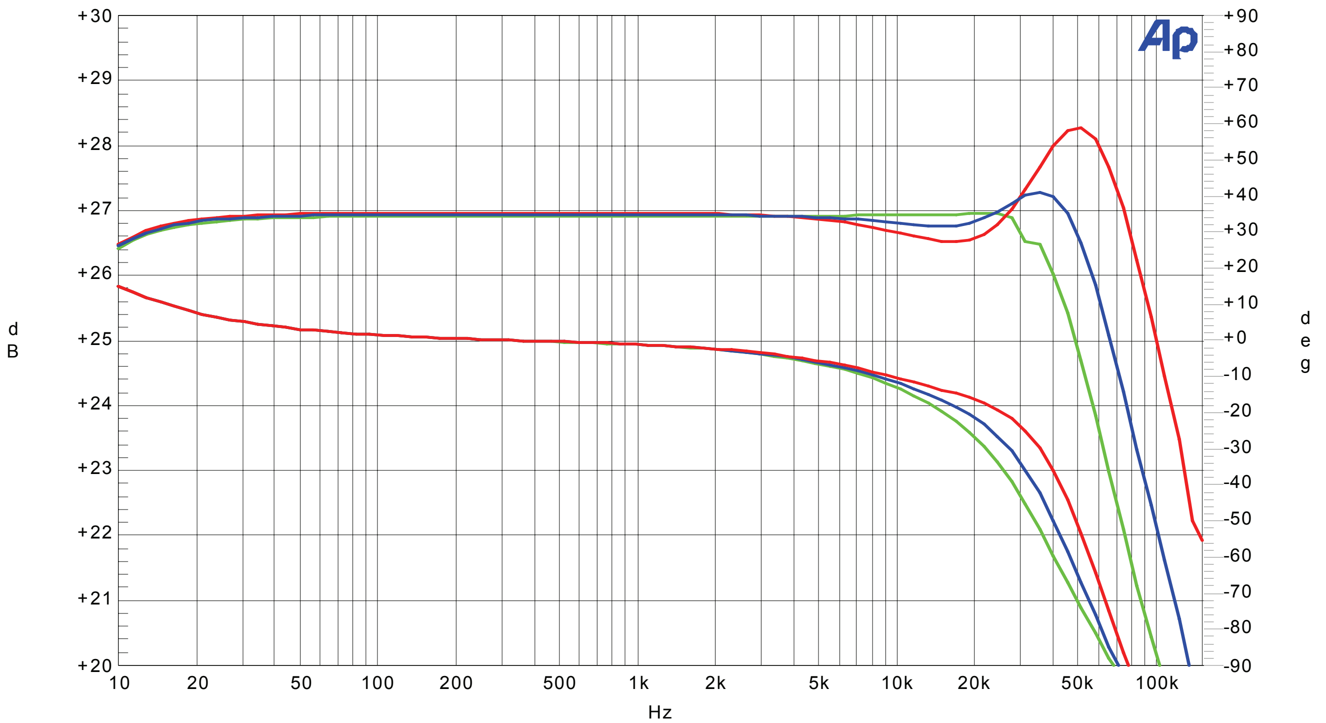
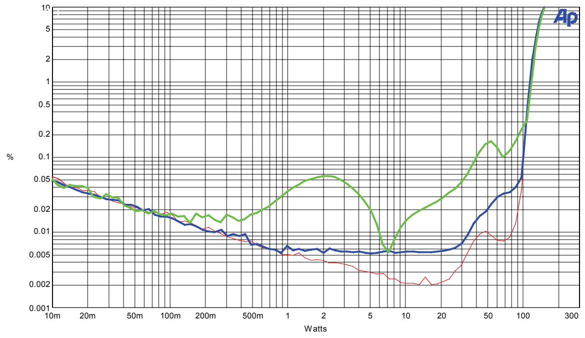
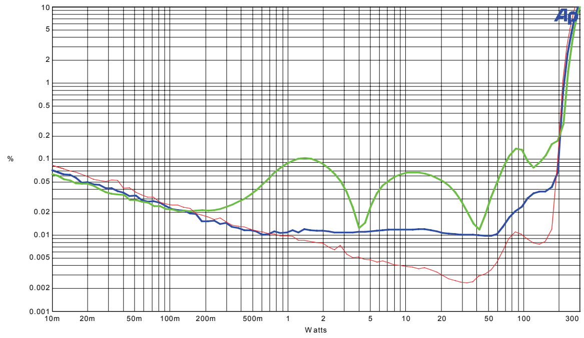


Figure 3: Frequency response in 4Ω (green), 8Ω (blue) and open load (red). Top – amplitude. Bottom – phase.

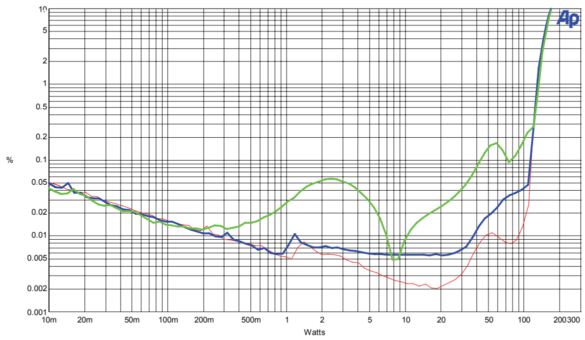
Harmonic Distortion & Noise



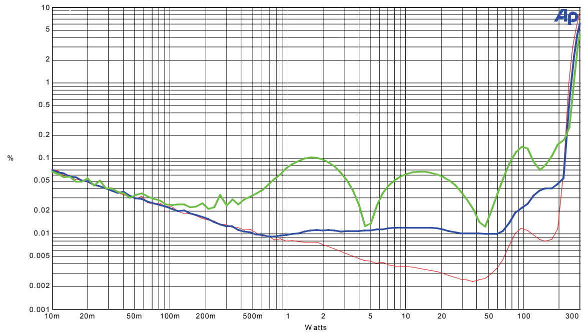
THD+N vs. Po 100Hz, 1kHz and 6.67kHz [8)] (8Ω), 47V



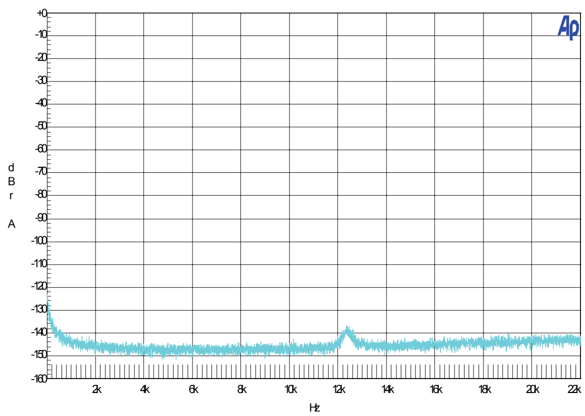
THD+N vs. Po at 100Hz, 1kHz and 6.67kHz [8)] (4Ω), 47V



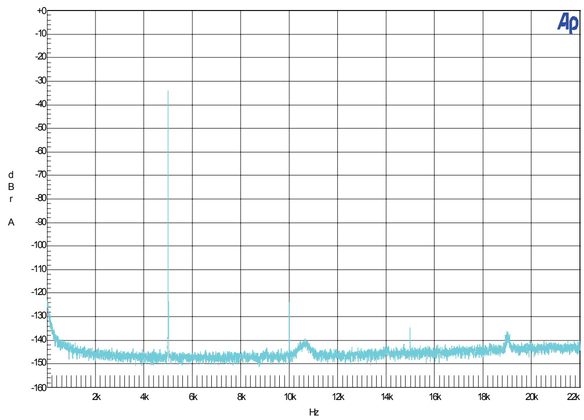
THD+N vs. Po at 100Hz, 1kHz and 6.67kHz [8)] (8Ω), 50V



THD+N vs. Po at 100Hz, 1kHz and 6.67kHz [8)] (4Ω), 50V



Idle noise (16K FFT). Residual = 90µV(A).

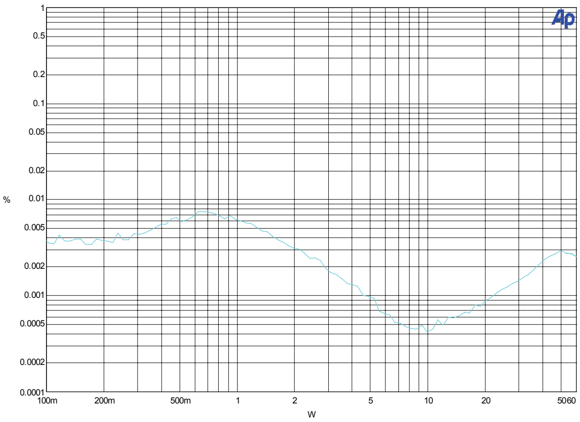


f = 5kHz. Po = 100mW. 4Ω loading.

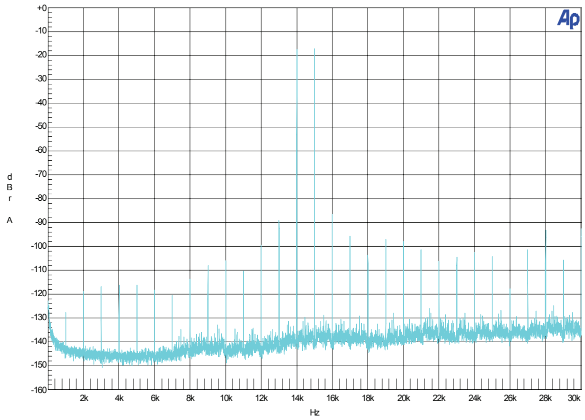
Figure 4: Total harmonic distortion & noise, ref. voltage (0 dB) 33.23Vrms.

8) An Audio Precision AES17 20 kHz 7th order measurement filter is used for measurements. The frequency 6.67 kHz corresponds to the worst-case situation where both 2nd and 3rd harmonics are within the audio band.

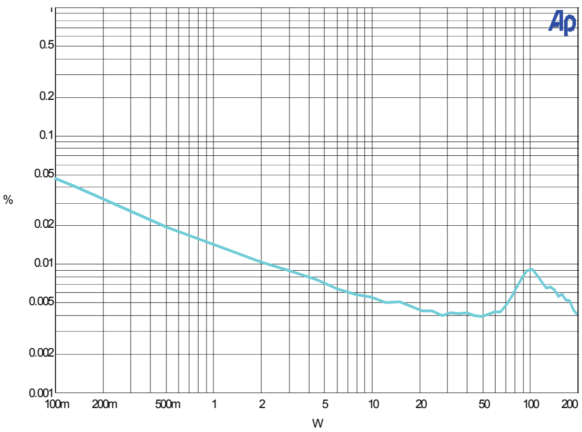
Intermodulation Distortion (CCIF & TIM)



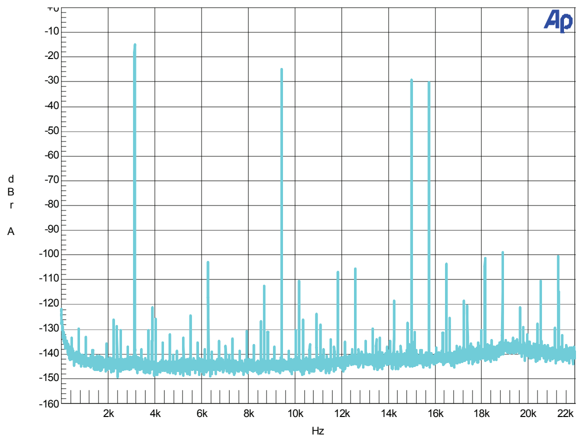
CCIF IMD vs. P_O, R_L = 4Ω, f_1 =14kHz, f_2 = 15kHz.



CCIF IMD analysis. R_L = 4Ω, P_O =10W, IMD = 0.0005%.



TIM vs. output power. R_L = 4Ω.



TIM FFT analysis. R_L = 4Ω, P_O =10W, TIM = 0.004%

Figure 5: Intermodulation distortion

Power vs. Frequency

Due to the compensating Zobel network in the output stage, the maximum allowable short-term output power is frequency-dependant. The short-term output power is defined as the maximum undistorted (THD+N < 0.2%) output power until thermal shutdown occurs.

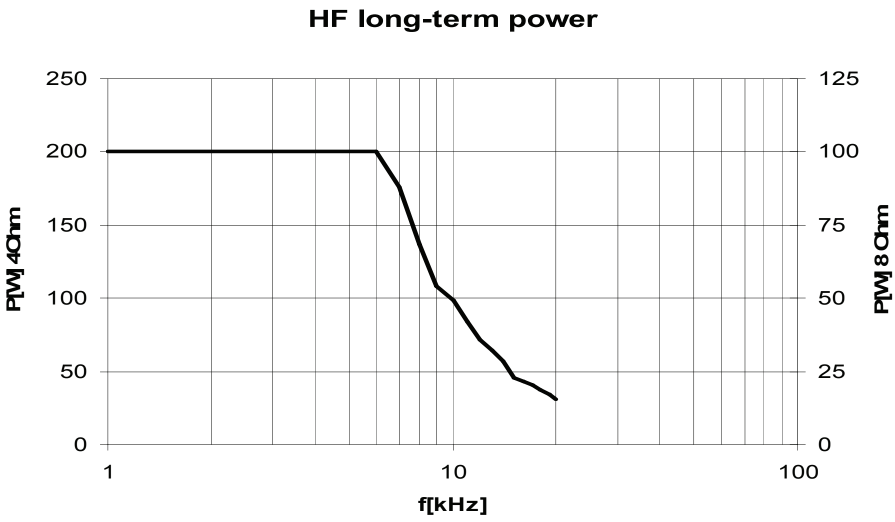


Figure 6: HF Long-term output power

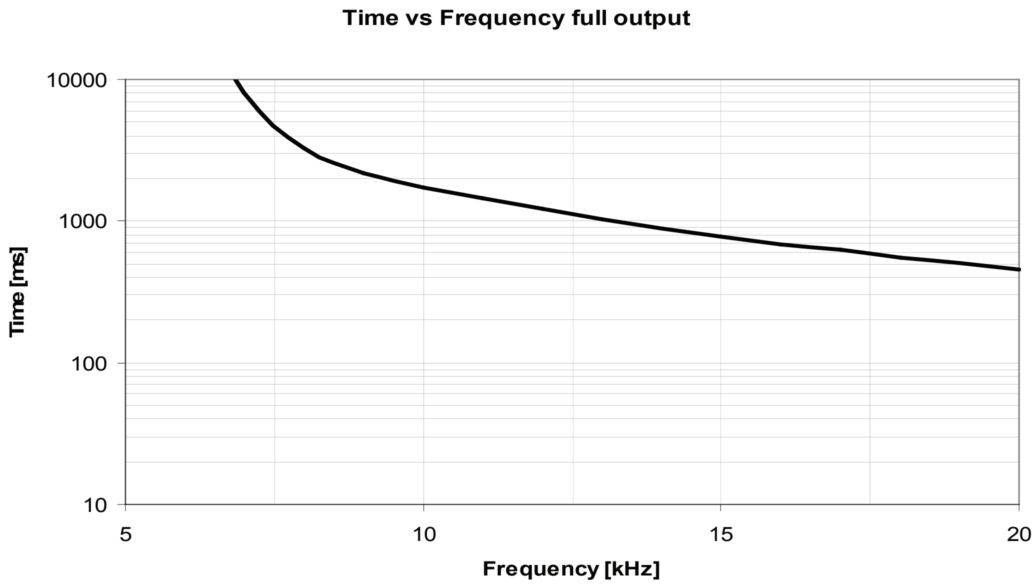


Figure 7: Time at full output vs. frequency

Note that this limitation will never cause any problems when the amplifier is fed a music signal at the input, but the limit must be taken into consideration when the amplifier is tested under laboratory conditions using sine waves or noise signals.

Output Impedance

The output impedance is measured by feeding $1A_{RMS}$ into the output of the amplifier and measuring the voltage on the output. The voltage then corresponds to the output impedance. The output impedance is measured directly on the terminals on the PCB.

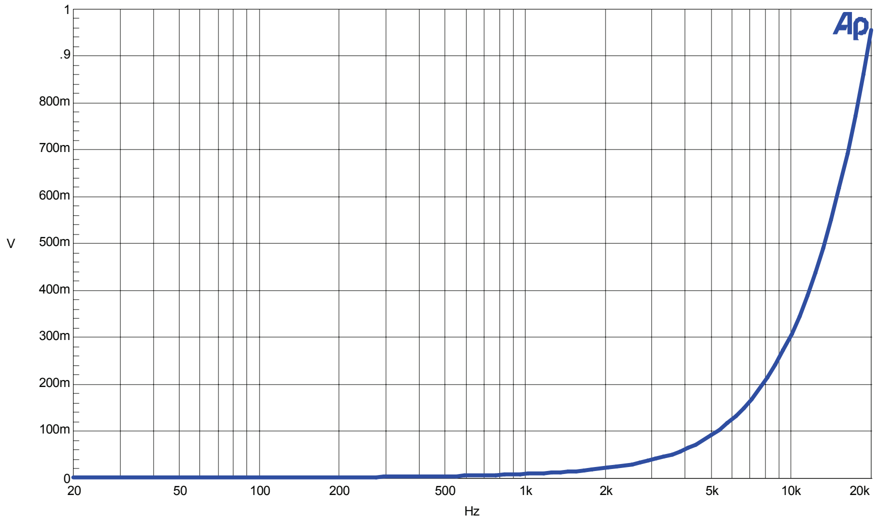


Figure 8: Measured voltage at output terminals while feeding $1A_{RMS}$ into the output of the amplifier.

The figure below shows a zoom of the output impedance from 20Hz – 5kHz.

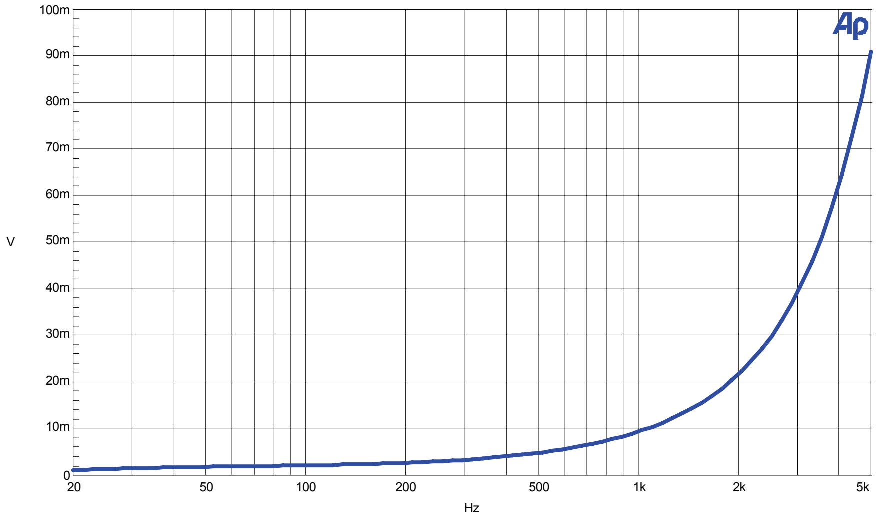


Figure 9: Measured voltage at output terminals while feeding $1A_{RMS}$ into the output of the amplifier.

Damping Factor

The damping factor is calculated as the ratio between the output impedance of the amplifier and the load impedance.

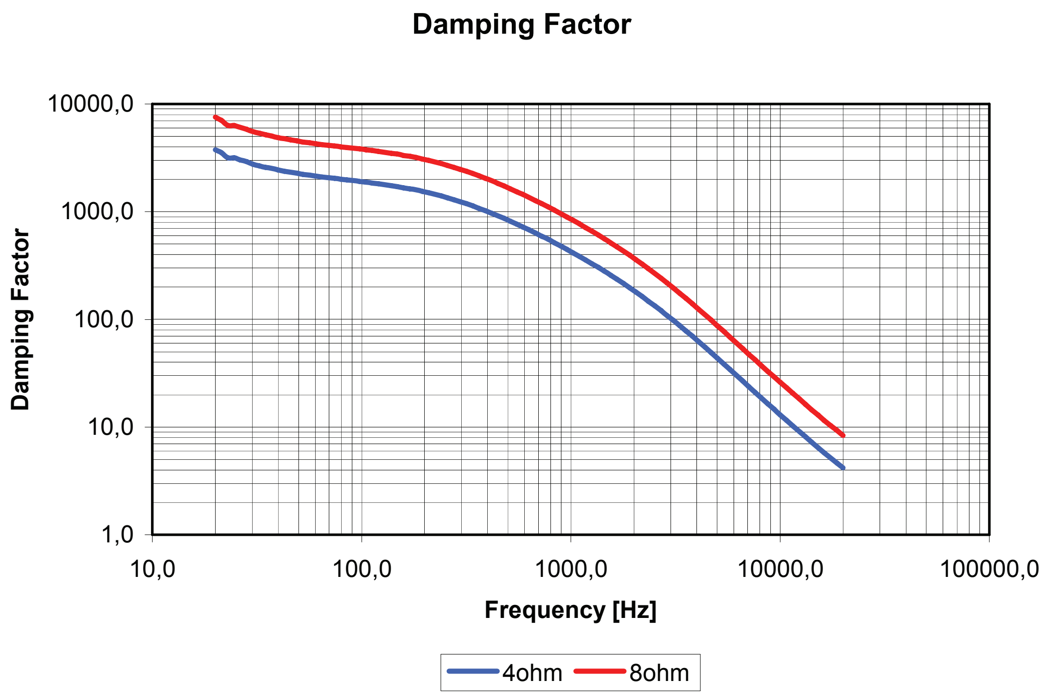


Figure 10: Damping factor vs. frequency

Loading

With its low output impedance, the ICEpower200AC is designed to be unaffected by loudspeaker loading characteristics. However, care should be taken with *purely* capacitive loads.

Traditionally amplifiers have been tested extensively in laboratories with purely capacitive loads. This was done to test the amplifier's stability and performance but it does not relate to any normal speaker load as even electrostatic speakers do not present a purely capacitive load to the amplifier but include a resistive part as well. The maximum purely capacitive load allowed is 330nF.

Features

The ICEpower200AC has some useful features that are described below.

Mute

The audio signal can be muted before the output stage.
This is done by pulling pin 4 (header J5) low.

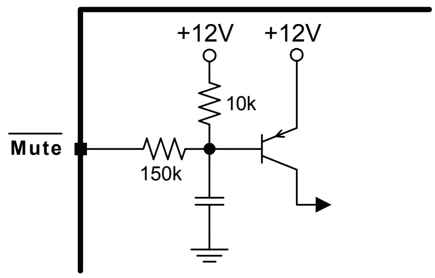


Figure 11: Mute-pin input interface

Disable

The amplifier output stage can be disabled to reduce power consumption when the amplifier is idle.
This is done by pulling pin 6 (header J5) low.

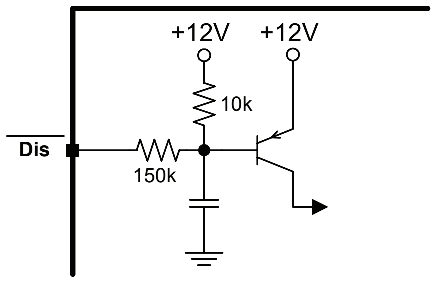


Figure 12: Disable-pin input interface

Protection Features

The ICEpower200AC is equipped with several protection features for surviving overload without damage. The schematic below illustrates the different protection features.

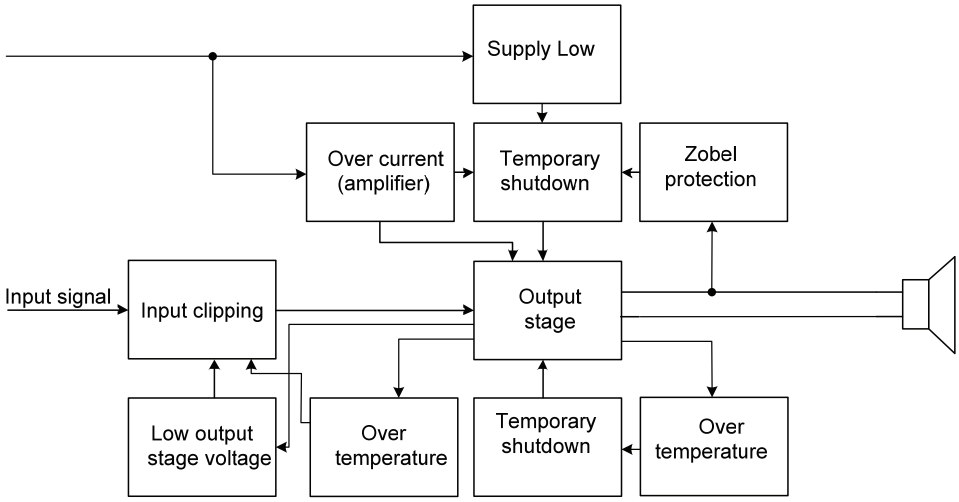


Figure 13: Block diagram of protection features.

Over-current Protection

This feature protects the amplifier in case the output current exceeds the maximum permitted value. When this happens the amplifier will be briefly disabled and then automatically restart. Upon restarting, if the current still is too high the amplifier is disabled again. This means that the amplifier will perform automatic current clipping.

In case of a short circuit of the output terminals while an input signal is fed to the amplifier, the amplifier will shut down for about 5 seconds and then restart automatically as described above. Note that shorting one of the output terminals to GND, either on the module itself or on an external part such as a shielding box, will cause irreparable damage to the module.

Thermal Protection

The ICEpower200AC is equipped with thermal protection of the output stage. The protection circuit monitors the temperature around the output transistors and disables the amplifier if the temperature becomes too high. The amplifier will recover automatically and restart when the temperature has decreased to within acceptable limits.

Zobel Protection

In the ICEpower200AC the demodulation LC filter on the output is compensated with an RC network in order to minimize performance change due to variations in the load. This RC network is physically placed across the speaker output terminals (ref. figure 15), and thus the power dissipated in the resistor is dependant on the signal level as well as the signal frequency. When the module is handling normal music or film material without any significant high-frequency energy content very little power is dissipated in the resistor. However, if the module is subjected to a high level, high frequency input test signal the power dissipated in the Zobel resistor may become excessive. This might be the case when testing the power bandwidth of the amplifier or if a microphone system makes acoustical feedback and goes into oscillation on a very high frequency. To protect the Zobel resistor from damage the ICEpower200AC module has a monitoring circuit, which shuts down the amplifier in case of overload.

Input/Output Interface

Input Stage

The balanced input section provides signal buffering and anti-aliasing filtering. The balanced configuration helps to avoid hum and noise pick-up from poorly shielded cables. An unbalanced input can be obtained by applying a short between Vi- and AGND. This does not affect the overall gain. The input impedance of the input section is approximately 10kΩ over the audio bandwidth, which is an acceptable loading condition for most pre-amps, active crossover outputs etc.

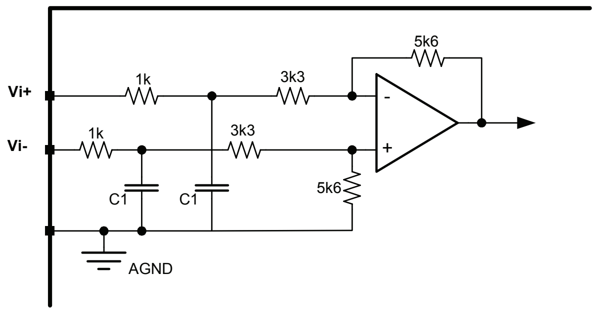


Figure 14: Balanced input buffer.

Output Stage

The output stage is a full bridge topology with a 2^{nd} order filter, thus the power output on the terminals Vo+ and Vo- is balanced. The filter design is a part of the proprietary ICEpower MECC topology and has been chosen as a compromise between demodulation characteristics, efficiency and filter compactness.
The essential output characteristics are:

- The switching residual on the output consists primarily of a single frequency component at the carrier fundamental f_s.
- The system bandwidth is 68 kHz in 8Ω.

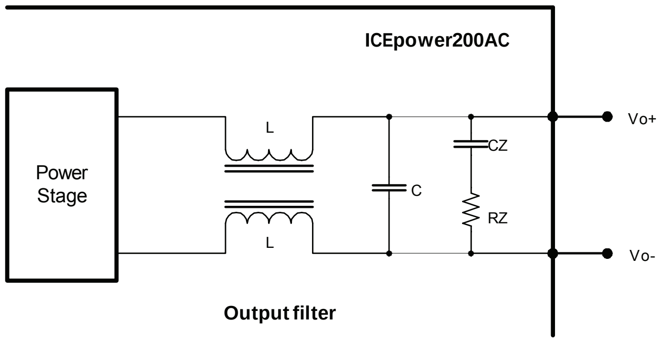


Figure 85: Output filter section with compensating Zobel network.

Warning! The balanced speaker outputs are both "hot" with a common-mode DC level equal to $V_p/2$. Shorting one of the terminals to GND will cause irreparable damage to the module. Balanced probes should always be used for monitoring and measurements.

Operational Timing Diagram

The following diagrams show selected signals during power up/down.

Timing Power Up/Down

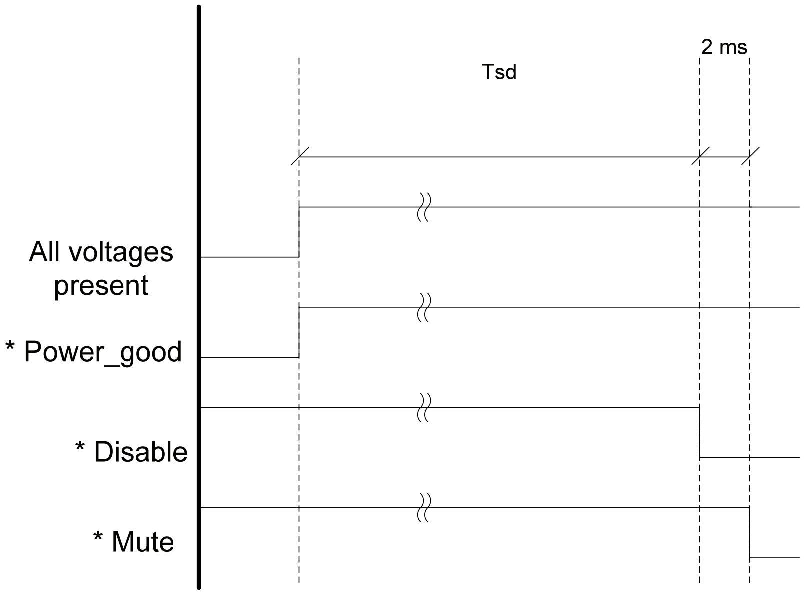


Figure 16: Power up when all voltages are present. *denotes an internal signal.

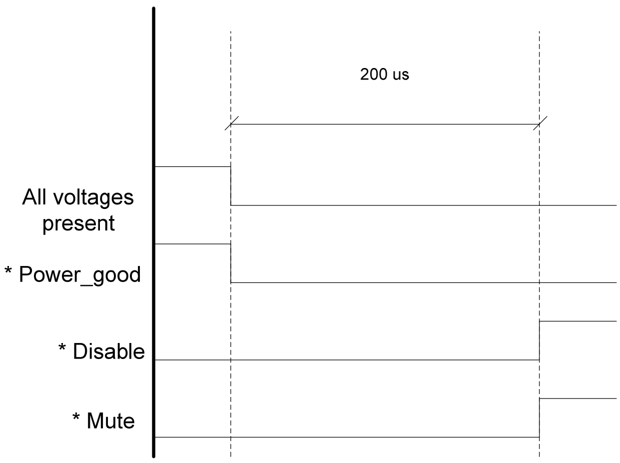


Figure 17: Power down after all voltages off. *denotes an internal signal.

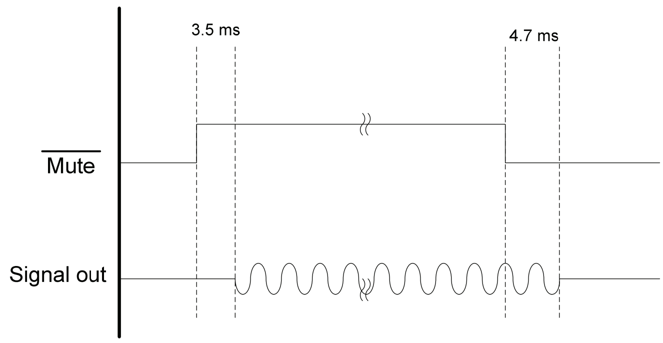


Figure 8: Mute Timing

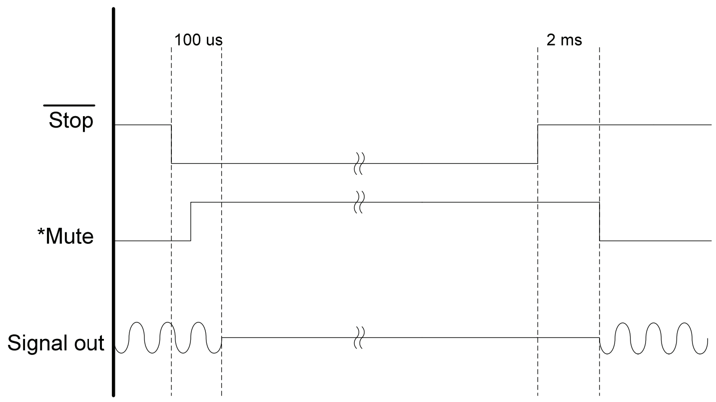


Figure 19: Disable Timing. *denotes an internal signal.

Thermal Design

Thermal design is generally a great challenge in power amplifier systems. Linear amplifier designs operating in class A or AB are normally very inefficient and therefore equipped with extensive heat sinking to keep the transistor junction temperature low. The ICEpower200AC is based on highly efficient ICEpower switching technology providing high overall efficiency characteristics at all levels of operation.

Part of the "component" philosophy of the AC–series is to provide a self-cooled component thus eliminating the need for special attention to thermal design.

The ICEpower200AC module is designed for music reproduction, which means that the output power of the amplifier will never be continuous. If the average power exceeds 40W @ 4Ω (typical) for a long time at 25°C ambient temperature, the module will reach its maximum allowable temperature and the temperature protection will be activated. At 50°C ambient temperature more than 25W @ 4Ω (typical) average power will activate the temperature protection.

Physical Dimensions

All dimensions are in mm.

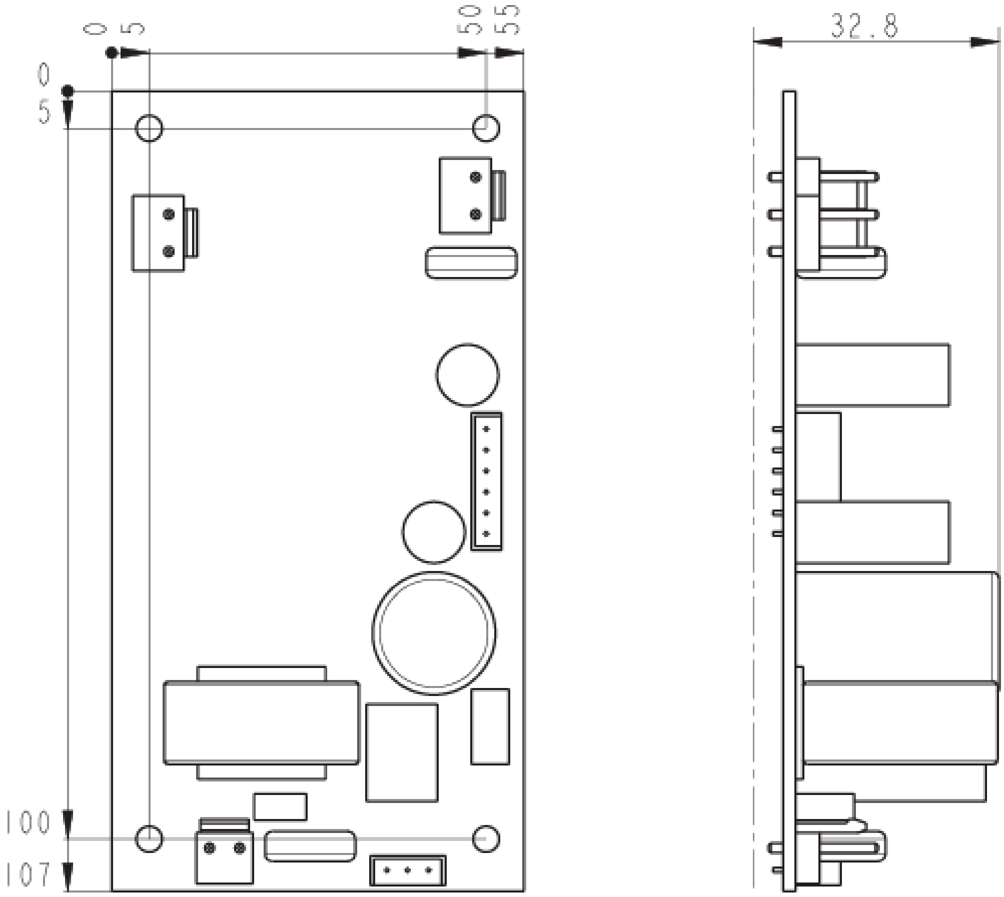


Figure 20: Physical dimensions in mm.

Note: A clearance of 12 mm. around and above the module is required for safety and ventilation.

Safety Standards

The ICEpower200AC has been safety approved by CSA to ease the design-in procedure. The ICEpower200AC complies with the following standards:

Europe: IEC60065 7th ed. (2001)
US: UL6500 2nd ed.
Canada: E60065 6th ed.

ESD Warning

Bang & Olufsen ICEpower products are manufactured according to the following ESD precautions:

- IEC 61340-5-1: Protection of electronic devices from electrostatic phenomena. General Requirements.
- IEC 61340-5-2: Protection of electronic devices from electrostatic phenomena. User Guide.
- ANSI/ESD-S20.20-1999: Protection of Electrical and Electronic Parts, Assemblies and Equipment.

Further handling of the products should comply with the same standards.

The general warranty policy of Bang & Olufsen ICEpower a/s does not cover products damaged by ESD due to improper handling.

Packaging and Storing

Package	Quantity	Dimensions (w x d x h)	Gross Weight
Carton	56 pcs.	42 x 39 x 27 cm	12 kgs.
Pallet	336 pcs. (6 cartons)	80 x 60 x 93 cm	85 kgs.

ESD safe cardboard is used for wrapping.

Storage Humidity

Do not expose the pallets or cartons to rain or humidity levels higher than 85%.

Storage Temperature

The cartons and pallets are to be stored at temperatures between 0°C and 70°C.

Stacking

Pallets may not be stacked on top of each other.

Notes

For additional information about the ICEpower® technology from Bang & Olufsen ICEpower a/s, visit our web site or contact us.

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