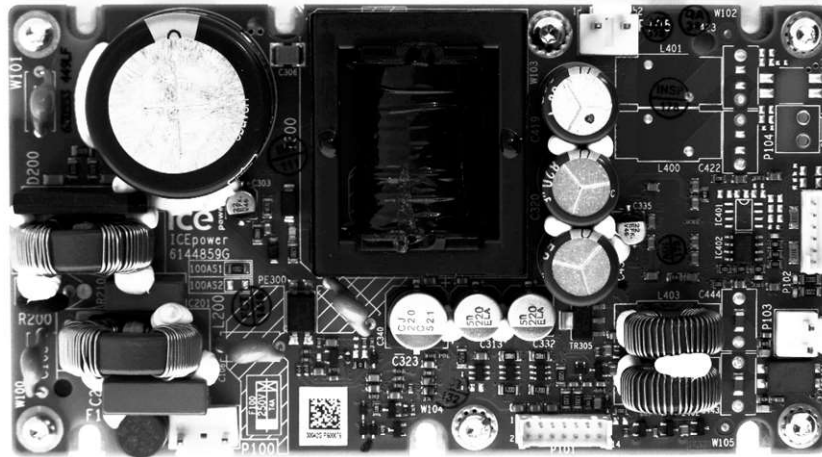
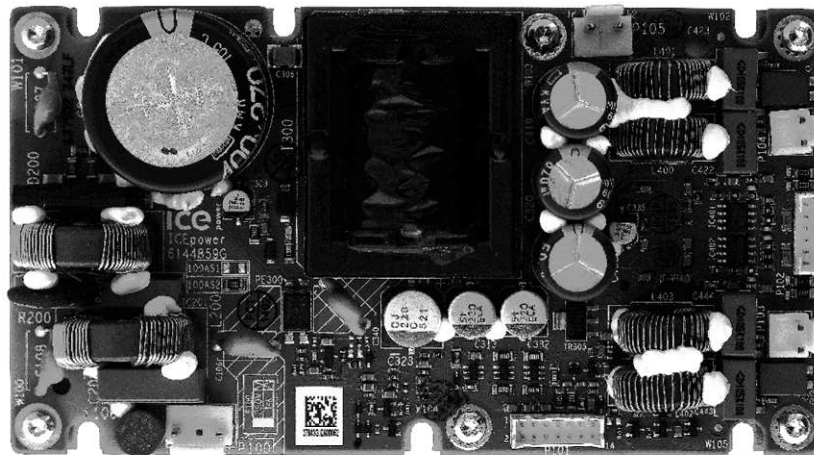


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100AS1



100AS2

# ICEpower100AS1

# ICEpower100AS2

One and Two Channel 100 W ICEpower Amplifiers with Integrated Universal Mains Power Supply

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## 2 General Description

ICEpower100AS1 and ICEpower100AS2 are two fully integrated audio power amplifier modules including universal mains ErP and Energy Star compliant power supply. ICEpower100AS1 is a one-channel module and ICEpower100AS2 is a two-channel module.

ICEpower100AS1/2 provides comprehensive protection and monitoring functions with an easy-to-use control interface.

ICEpower100AS1/2 is designed for very high continuous output power, making it ideal for applications requiring sustaining output power in e.g. bass and guitar amplifier applications.

The integrated aluminum base plate on the ICEpower100AS1/2 acts as both cooling and mechanical interface, enabling easy integration and cooling through the end-product chassis. In most cases, this is sufficient for passive cooling solutions.

ICEpower100AS1/2 are EMC and safety pre-approved enabling fast design-in and minimum time to market.

Features	Benefits
Fully integrated one or two channel amplifier	No need for additional circuits for simple applications
Short circuit and over-current protection	Ensures reliable and robust end-products
Comprehensive temperature monitoring and protection	Keeps track of module temperature and protects the module from overload
Clip monitor and thermal warning outputs	Allows the end-product system to proactively react, preventing system shutdown and enabling Music at All Times
Protect status output	Indicator for module protection shutdown
Auxiliary power supply output	Analog and control supply for e.g. a signal front-end
Standby mode	ErP (1275/2008/EC) and Energy Star® v3.0 compliant
Universal mains	No need for region specific variants
EMC and safety pre-approved	Suitable for CE and FCC approved designs
Simple yet flexible mechanical mounting	Easy mechanical integration and thermal management
ICEpower standard connector and pin definition	Allows reuse of front-end hardware
Low build height	Usable in 1U rack enclosures
Prepared for hanger amplifier modules	Extra audio channels for e.g. 3 way active speakers

### 2.1 Key Specifications

- 1 x 100 W/4  $\Omega$  (100AS1) and 2 x 100 W/4  $\Omega$  (100AS2) @ 1 % THD+N, 1 kHz
- 0.003 % THD+N @ 1 kHz, 10 W/4  $\Omega$
- 50 kHz audio bandwidth
- <77  $\mu$ V A-weighted output noise
- Minimum load impedance at 3  $\Omega$
- Maximum output voltage / current 30 Vp / 12,5 Ap  $\Omega$
- +8 V<sub>DC</sub> and +/-17 V<sub>DC</sub> auxiliary supply outputs
- Universal mains (100 – 240 V, 50 – 60 Hz)
- Size (LxWxH): 140 mm x 77 mm x 36.5 mm (5.51 inch x 3.03 inch x 1.44 inch)

### 3 Document History

Version	Date	Revised by	Changes
1.0	2016-09-22	TOC	Initial release
1.1	2016-11-17	TOC	Minor editorial corrections
1.2	2016-12-19	TOC	Minor editorial corrections Section references corrected Address updated
1.3	2018-06-19	LBH/DIT	Output voltage / current spec. added
1.4	2018-08-13	MGA/DIT	Minor update in chapter 8.4, 11.4.1 and 10.1
1.5	2018-11-05	LBH/DIT	Absolute Maximum Ratings updated
1.6	2020-04-27	LBH/FAA/NKK	Minor update in chapter 8.2

## 4 Getting Started

The 100AS1/2 is a fully self-contained amplifier module and requires no interaction nor control to operate.

For first time use, please connect an audio source to the analog input and loudspeakers to the speaker output connector before applying power to the AC mains input. The 100AS1/2 module will start operating right after mains is applied.

## 5 Block Diagram

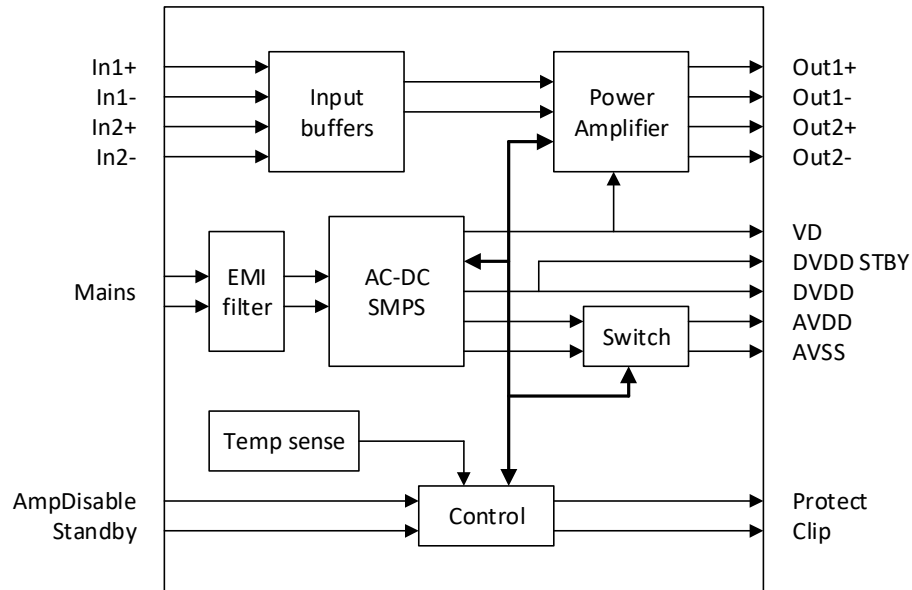


Figure 1: ICEpower100AS1/2 block diagram



9	Clip1	Voltage clip indicator, channel 1	Status output, open collector, active low
10	AmpDisable	Disable amplifier (mute)	Control input, active high
11	Clip2	Voltage clip indicator, channel 2	Status output open collector, active low
12	Protect	Module protection indicator	Status output open collector, active low
13	Reserved	Not connected	N/A
14	GND	Ground	GND

Table 2: Basic Features Connector

#### 6.4 P102: Audio Input Connector

Type: JST, B6B-PH-K-S (LF)(SN)			
PIN	Function	Description	Type
1	GNDA	Signal shield, channel 1	Analog ground
2	In1+	Non-inverting input signal, channel 1	Analog audio input
3	In1-	Inverting input signal, channel 1	Analog audio input
4	GNDA	Signal shield, channel 2	Analog ground
5	In2+	Non-inverting input signal, channel 2	Analog audio input
6	In2-	Inverting input signal, channel 2	Analog audio input

Table 3: Audio Input Connector

#### 6.5 P103: Channel 1 Loudspeaker Output Connector

Type: JST, B2P-VH (LF)(SN)			
PIN	Function	Description	Type
1	Out1+	Non-inverting output signal	Audio power output
2	Out1-	Inverting output signal	Audio power output

Table 4: Channel 1 Loudspeaker Output Connector

#### 6.6 P104: Channel 2 Loudspeaker Output Connector

Type: JST, B2P-VH (LF)(SN)			
PIN	Function	Description	Type
1	Out1+	Non-inverting output signal	Audio power output
2	Out1-	Inverting output signal	Audio power output

Table 5: Channel 2 Loudspeaker Output Connector

#### 6.7 P105: Hanger Rail Supply Connector

Type: JST, B02P-NV (LF)(SN)			
PIN	Function	Description	Type
1	VD	Positive amplifier DC rail voltage	Power output (Note 1)
2	GND	Ground	GND

Table 6: Hanger Rail Supply Connector

Note 1: As specified in Section 11.5, a 2 A fast acting fuse MUST be included in the supply line on an optional amplifier module connected to the Hanger Rail Supply connector.



## 7 Absolute Maximum Rating

Symbol	Parameter	Min	Max	Units
V <sub>ac</sub>	Mains input voltage (safety test)	85 (Note 2)	264 (Note 2)	V <sub>RMS</sub>
f <sub>mains</sub>	Mains frequency	45	65	Hz
V <sub>audio</sub>	Audio inputs voltage relative to GND (DC+AC)	-8	8	V
V <sub>control</sub>	Control inputs voltage	GND - 0.7	25	V
V <sub>status</sub>	Status output external pull up voltage	GND - 0.7	DVDD + 0.7	V
I <sub>status</sub>	Status output sink current	0	20	mA

Table 7: Absolut maximum ratings

Note 2: The maximum operating/usage mains voltage is 240Vac and the minimum operating/usage mains voltage is 100Vac.

## 8 Electrical Specifications

Unless otherwise specified:

- Specifications are common to 100AS1 and 100AS2.
- T<sub>a</sub> = 25 °C, f = 1 kHz, R<sub>L</sub> = 4 Ω, 230 V / 50 Hz mains, AES17 measurement filter and AP AUX-0025 filter,
- Module mounted centered on a 2 mm x 200 mm x 300 mm aluminum plate.

### 8.1 Audio

Symbol	Parameter	Condition	Min	Typ	Max	Unit
P <sub>o</sub>	100AS1/2 Output power, one channel driven	f <sub>in</sub> = 1 kHz, THD+N = 1 %, R <sub>L</sub> = 4 Ω 230 V <sub>ac</sub> / 50 Hz 115 V <sub>ac</sub> / 60 Hz 100 V <sub>ac</sub> / 50 Hz 85 V <sub>ac</sub> / 50 Hz		110 110 110 110		W
P <sub>o</sub>	100AS1/2 Output power, one channel driven	f <sub>in</sub> = 1 kHz, THD+N = 10 %, R <sub>L</sub> = 4 Ω 230 V <sub>ac</sub> / 50 Hz 115 V <sub>ac</sub> / 60 Hz 100 V <sub>ac</sub> / 50 Hz 85 V <sub>ac</sub> / 50 Hz		135 135 135 135		W
P <sub>o</sub>	100AS1/2 Output power, one channel driven	f <sub>in</sub> = 1 kHz, THD+N = 1 %, R <sub>L</sub> = 8 Ω 85 – 230 V <sub>ac</sub> / 50 – 60 Hz		60		W
t <sub>pmax</sub>	100AS1/2 Duration of power burst at full power, one channel driven	f <sub>in</sub> = 1 kHz, P <sub>o</sub> = 100 W / 4 Ω 85 – 230 V <sub>ac</sub> / 50 – 60 Hz		15		min
P <sub>o-contin</sub>	100AS1/2 Continuous output power without thermal shutdown, one channel driven	f <sub>in</sub> = 1 kHz, THD+N = 1 %, R <sub>L</sub> = 4 Ω 115 – 230 V <sub>ac</sub> / 50 – 60 Hz		95		W
P <sub>o</sub>	100AS2 Output power per channel, both channels driven	f <sub>in</sub> = 1 kHz, THD+N = 1 %, R <sub>L</sub> = 4 Ω 230 V <sub>ac</sub> / 50 Hz 115 V <sub>ac</sub> / 60 Hz 100 V <sub>ac</sub> / 50 Hz 85 V <sub>ac</sub> / 50 Hz		105 105 105 100		W

Symbol	Parameter	Condition	Min	Typ	Max	Unit
P <sub>o</sub>	100AS2 Output power per channel, both channels driven	f <sub>in</sub> = 1 kHz, THD+N = 10 %, R <sub>L</sub> = 4 Ω 230 V <sub>ac</sub> / 50 Hz 115 V <sub>ac</sub> / 60 Hz 100 V <sub>ac</sub> / 50 Hz 85 V <sub>ac</sub> / 50 Hz		130 130 120 105		W
P <sub>o</sub>	100AS2 Output power per channel, both channels driven	f <sub>in</sub> = 1 kHz, THD+N = 1 %, R <sub>L</sub> = 8 Ω 85 - 230 Vac / 50 - 60 Hz		60		W
t <sub>pmax</sub>	100AS2 Duration of power burst at full power, both channels driven	f <sub>in</sub> = 1 kHz, P <sub>o</sub> = 100 W / 4 Ω per channel, 85 - 230 Vac / 50 - 60 Hz		9		min
P <sub>o-contin</sub>	100AS2 Continuous combined output power without thermal shutdown, both channels driven (Note)	f <sub>in</sub> = 1 kHz, THD+N = 1 %, R <sub>L</sub> = 4 Ω 115 - 230 Vac / 50 - 60 Hz		115		W
V <sub>o-max</sub>	Maximum output voltage			30		V <sub>p</sub>
I <sub>o-max</sub>	Maximum output current	(Output current limit)		12,5		A <sub>p</sub>
THD+N	Total harmonic distortion + noise	f <sub>in</sub> = 1 kHz, P <sub>o</sub> = 10 W / 4 Ω 100AS1/2		0.003		%
N	Output noise	20 Hz – 20 kHz, un-weighted 20 Hz – 20 kHz, A-weighted		103 77		μV
DNR	Dynamic range	20 Hz – 20 kHz, un-weighted 20 Hz – 20 kHz, A-weighted		106 109		dB
IMD <sub>3</sub>	3 <sup>rd</sup> order intermodulation	18 kHz + 19 kHz, each -10dB relative to 100 W / 4 Ω 100AS2		-70		dB
	Idle tones	V <sub>in</sub> = 0 V, 0 dB = 100 W / 4 Ω		-135		dB
	Cross talk	f <sub>in</sub> = 1 kHz, P <sub>o</sub> = 10 W / 4 Ω, 0dB rel. P <sub>o</sub> = 100 W / 4 Ω		-100		dB
V <sub>in</sub>	Input sensitivity	f <sub>in</sub> = 1 kHz, P <sub>o</sub> = 100 W / 4 Ω		2.7		V <sub>p</sub>
A <sub>v</sub>	Voltage gain	f <sub>in</sub> = 1 kHz		21		dB
f	Frequency response	f <sub>in</sub> = 20 Hz - 20 kHz, R <sub>L</sub> = 4 - 8 Ω		+/-1		dB
f <sub>u</sub>	Upper bandwidth (-3dB)	R <sub>L</sub> = 4 Ω, no measurement filters		50		kHz
f <sub>L</sub>	Lower bandwidth (-3dB)	R <sub>L</sub> = all loads		3		Hz
Z <sub>o</sub>	Output impedance	f <sub>in</sub> = 1 kHz		180		mΩ
Z <sub>load</sub>	Load impedance		3			Ω
C <sub>load</sub>	Capacitive load				100	nF
Z <sub>in-signal</sub>	Input impedance signal lines	Semi-balanced input configuration, Non-inverting input Inverting input		2.8 1.8		kΩ
Z <sub>in-GNDA</sub>	Input impedance analog ground			22		Ω

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V <sub>clamp</sub>	Audio input clamp voltage			3		V
V <sub>in_CMR</sub>	Input common mode range		-3		3	V
V <sub>o-offset</sub>	Speaker output DC common mode offset			17		V
f <sub>PWM</sub>	Power stage switching frequency			600		kHz

Table 8: Audio performance

**Note:** The continuous combined output power is the sum of the power of the driven channels. This available output power can be distributed evenly or asymmetrically across the channels.

Asymmetrical loading of the channels can be caused by e.g. differences in signal level or program material in bass and treble in an active speaker or due to differences in speaker impedances.

## 8.2 Control and Status

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V <sub>control</sub>	Control input voltage range		0		DVDD	V
V <sub>control_low</sub>	Control input low threshold				0.8	V
V <sub>control_high</sub>	Control input high threshold		2.5			V
Z <sub>control</sub>	Control input impedance	Internal pull down		50		kΩ
V <sub>status</sub>	Status output voltage range	Open collector, external pull up	0		DVDD	V
V <sub>status_low</sub>	Status output low	I <sub>out</sub> = 1mA		0.5		V
I <sub>status</sub>	Status output sink current		0		20	mA
Z <sub>status</sub>	Status output series impedance			240		Ω
T <sub>Amp-OT-warning</sub>	Amplifier temperature warning			125		°C
T <sub>Amp-OT-limit</sub>	Amplifier over temperature limit			150		°C
T <sub>Amp-OT-reset</sub>	Amplifier over temperature reset			120		°C

Table 9: Control and Status specifications

## 8.3 Timing

For detailed description of the below listed timing values, please consult Section 11 of this datasheet.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t <sub>Mains-Audio-set</sub>	Mains input – audio output delay			500		ms
t <sub>Mains-Audio-hold</sub>	Mains input – audio output hold time	1/8 P <sub>o</sub> into 4 Ω		200		ms
t <sub>Mains-Aux-set</sub>	Mains input – aux supply delay			50		ms
t <sub>Mains-Aux-hold</sub>	Mains input – aux supply hold time			200		ms
t <sub>Stby-Audio-set</sub>	Standby mode set delay			5		ms
t <sub>Stby-Audio-release</sub>	Standby mode release delay			500		ms
t <sub>Stby-AVDD-AVSS-hold</sub>	Standby mode AVDD/AVSS hold time			2		ms
t <sub>Stby-AVDD-AVSS-release</sub>	Standby mode AVDD/AVSS release time			1		ms
t <sub>Stby-Idvdd-delay</sub>	Standby mode – I <sub>DVDD</sub> delay			500		ms

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{\text{AmpDis-Audio-set}}$	AmpDisable set delay			10		ms
$t_{\text{AmpDis-Audio-release}}$	AmpDisable release delay			200		ms
$t_{\text{Aux-OC-detect}}$	Aux OC detect delay			10		ms
$t_{\text{Aux-OC-recovery}}$	Aux OC recovery delay			5		s
$t_{\text{Amp-OC-detect}}$	Amplifier OC detect delay			15		ms
$t_{\text{Amp-OC-recovery}}$	Amplifier OC recovery delay			3		s
$t_{\text{Amp-OT-recovery}}$	Amplifier OT recovery delay			5		s

Table 10: Timing specifications

## 8.4 Power Supply

Symbol	Parameter	Condition	Min	Typ	Max	Unit
$V_{\text{DVDD}}$	100AS1 Control aux supply output voltage	$P_{\text{out\_audio}} = 100 \text{ W}$ , no aux load Idle and $I_{\text{DVDD}} = 0.7 \text{ A}$ Amp disabled and $I_{\text{DVDD}} = 0.7 \text{ A}$	6.5	10.2 7.1 6.9	13	V
$V_{\text{DVDD}}$	100AS2 Control aux supply output voltage	$P_{\text{out\_audio}} = 200 \text{ W}$ , no aux load Idle and $I_{\text{DVDD}} = 0.7 \text{ A}$ Amp disabled and $I_{\text{DVDD}} = 0.7 \text{ A}$	6.5	10.2 7.2 7.2	13	V
$I_{\text{DVDD}}$	Control aux supply output current	Normal operation Standby mode			700 20	mA
$I_{\text{DVDD\_prot}}$	Control aux current protection limit			1		A
$C_{\text{DVDD}}$	DVDD external decoupling capacitor				470	$\mu\text{F}$
$V_{\text{AVDD}}$	100AS1 Positive analog auxiliary supply output voltage	$P_{\text{out\_audio}} = 100 \text{ W}$ , no aux load Idle and $I_{\text{AVDD}} = 0.15 \text{ A}$		20.7 16.3		V
$V_{\text{AVDD}}$	100AS2 Positive analog auxiliary supply output voltage	$P_{\text{out\_audio}} = 200 \text{ W}$ , no aux load Idle and $I_{\text{AVDD}} = 0.15 \text{ A}$		21.0 16.3		V
$I_{\text{AVDD}}$	Positive analog auxiliary supply output current				150	mA
$I_{\text{AVDD\_prot}}$	Positive analog aux current protection limit			250		mA
$C_{\text{AVDD}}$	AVDD external decoupling capacitor				33	$\mu\text{F}$
$V_{\text{AVSS}}$	100AS1 Negative analog auxiliary supply output voltage	$P_{\text{out\_audio}} = 100 \text{ W}$ , no aux load Idle and $I_{\text{AVDD}} = 0.15 \text{ A}$		-20.4 -16.3		V
$V_{\text{AVSS}}$	100AS2 Negative analog auxiliary supply output voltage	$P_{\text{out\_audio}} = 200 \text{ W}$ , no aux load Idle and $I_{\text{AVDD}} = 0.15 \text{ A}$		-20.5 -16.3		V
$I_{\text{AVSS}}$	Negative analog auxiliary supply output current				-150	mA
$I_{\text{AVSS\_prot}}$	Negative analog aux current protection limit			-250		mA
$C_{\text{AVSS}}$	AVSS external decoupling capacitor				33	$\mu\text{F}$
$V_{\text{VD}}$	Positive hanger supply output voltage	$P_{\text{out\_audio}} = 100 \text{ W}$ , no aux load Idle and $I_{\text{DVDD}} = 0.7 \text{ A}$		32 34		V
$I_{\text{VD}}$	Positive hanger supply output current ( <b>Note</b> )	Output not over-current protected			1	$A_{\text{rms}}$

Symbol	Parameter	Condition	Min	Typ	Max	Unit
C <sub>VD</sub>	VD external decoupling capacitor				1000	μF
P <sub>idle</sub>	Module idle consumption, amp enabled	100AS1, P <sub>aux</sub> = 0 W 100AS2, P <sub>aux</sub> = 0 W		6.5 5.5		W
P <sub>amp_disabled</sub>	Module idle consumption, amp disabled	100AS1, P <sub>aux</sub> = 0 W 100AS2, P <sub>aux</sub> = 0 W		4.5 4.3		W
P <sub>standby</sub>	Module standby consumption	230 V <sub>ac</sub> / 50 Hz, I <sub>DVDD</sub> = 0 mA 115 V <sub>ac</sub> / 60 Hz, I <sub>DVDD</sub> = 0 mA		280 240		mW
η	Module power efficiency	P <sub>aux</sub> = 0 W, 100AS1, P <sub>out_audio</sub> = 100 W 100AS2, P <sub>out_audio</sub> = 2 x 100 W		70 72		%

Table 11: Power specifications

**Note:** As specified in Section 11.5, a 2 A fast acting fuse MUST be included in the supply line on an optional amplifier module connected to the Hanger Rail Supply connector.

## 9 Mechanical Specification

### 9.1 Dimensions

Symbol	Parameter	Condition	Min	Typ	Max	Unit
L	Module length			140		mm
W	Module width			77		mm
H	Module height				36.5	mm
Mass	Weight	100AS1 100AS2		290 315		g
H <sub>Base</sub>	Base plate thickness		1.9		2.1	mm
H <sub>M3</sub>	Mounting hole depth	M3 threads on module base plate			4.0	mm
T	Mounting torque	M3 threads on module base plate			0.8	Nm

Table 12: Mechanical dimensions

### 9.2 Mounting Holes

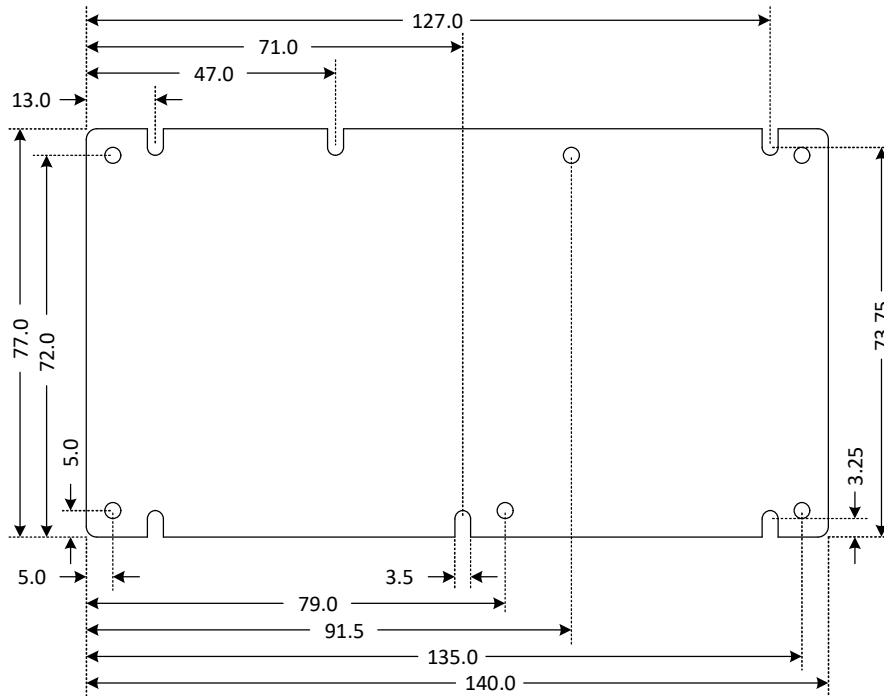


Figure 3: ICEpower100AS1/2 baseplate mechanical dimensions in mm seen from top side

### 9.3 Environmental Specifications

Symbol	Parameter	Conditions	Min	Typ	Max	Units
T <sub>operating</sub>	Ambient temperature, operating		0		50	°C
T <sub>storage</sub>	Ambient temperature, storage		-40		70	°C
T <sub>shelf</sub>	Ambient temperature, shelf		0		60	°C
RH	Relative humidity	Non-condensing			85	%
	Altitude, operating				2000	m

Table 13: Environment specifications

### 9.4 Mechanical and Environmental tests

ICEpower100AS1/2 has sustained extensive environmental testing to ensure module robustness.

Test	Acceleration	Amount
Random vibration	2.1 g <sub>rms</sub> , random profile composed of 5 frequencies in the range 5 Hz to 275 Hz	3 perpendicular directions 3 x 20 min. + 3 x 10 min. + 3 x 10 min.
Shock	40 g / 26 ms to 70 g / 12 ms in steps of 10 g	6 directions, 3 shocks per direction

Table 14: Mechanical tests

Additionally, the ICEpower100AS1/2 has undergone Highly Accelerated Life Test (HALT) in order to ensure robustness and reliability. During HALT, the module was powered up and exposed to temperatures from -60 °C to 90 °C as well as random vibrations at levels up to 60 g.

To ensure overall product robustness, ICEpower recommends vibration test of the final product including the 100AS1/2 module. Excess vibration caused by e.g. insufficiently damped resonances in a mechanical chassis or extensive exposure to high sound pressure level audio from a speaker unit can damage the module in the long term.

## 10 Typical Performance Characteristics

Typical performance data for 100AS2 are shown in the following graphs. Performance is similar between channel 1 and 2 and between 100AS1 and 100AS2.

Unless otherwise specified  $T_a = 25^\circ\text{C}$ , 230 V / 50 Hz mains, module mounted centered on a 2 mm x 200 mm x 300 mm aluminum plate. Audio Precision AUX0025 and AES17 20 kHz filter.

### 10.1 Frequency response

Measurement bandwidth: 0 – 500 kHz.  $P_o = 1\text{ W}/4\ \Omega$

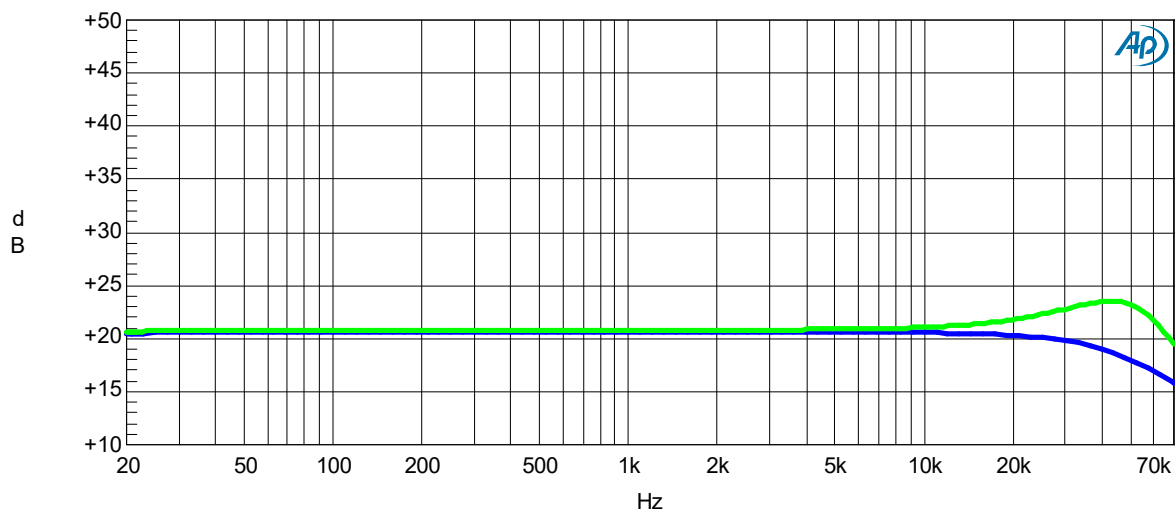


Figure 4: Amplitude vs frequency @  $R_L = 4\ \Omega$  (blue) and  $R_L = 8\ \Omega$  (green). For more details see ICEpower100AS1/100AS2/200AS1/200AS2 Application Note.



## 10.2 Total harmonic distortion

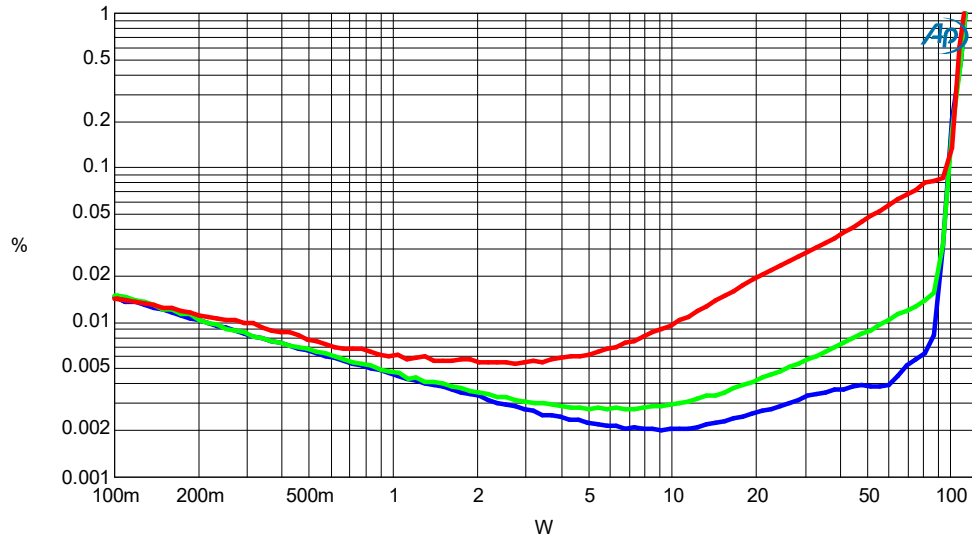


Figure 5: THD+N vs power @ 100 Hz (blue), 1kHz (green), 6.66kHz (red),  $R_L = 4 \Omega$

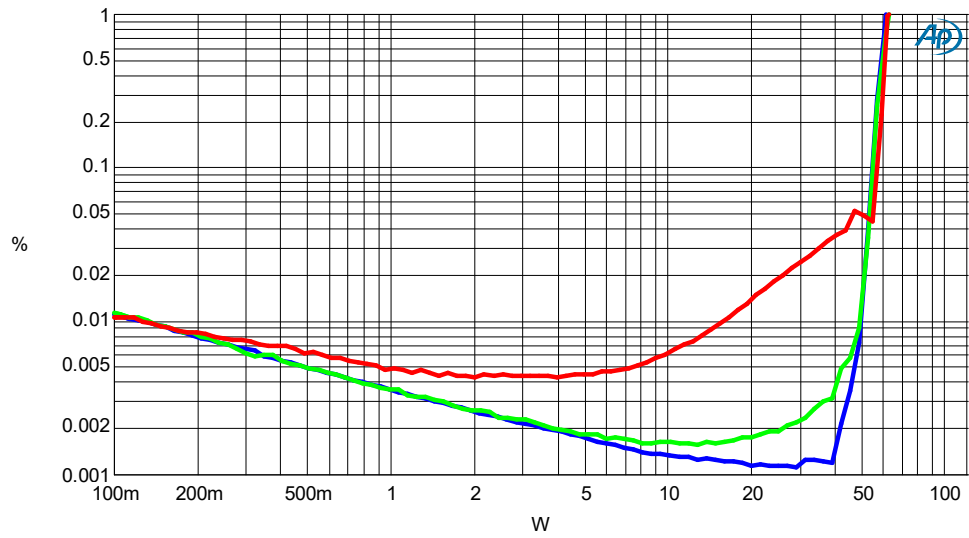


Figure 6: THD+N vs power @ 100 Hz (blue), 1kHz (green), 6.66kHz (red),  $R_L = 8 \Omega$

### 10.3 Idle noise

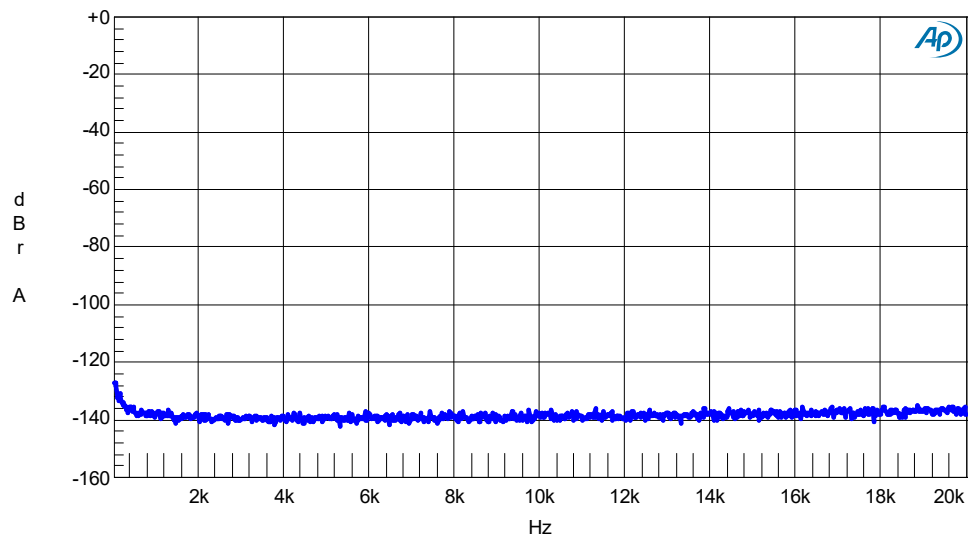


Figure 7: Idle noise (16kFFT) 0-20kHz @ 0dB = 100 W/4 Ω

### 10.4 Intermodulation

Test signal: 18 kHz + 19 kHz both -10dB relative to 100 W/4 Ω.

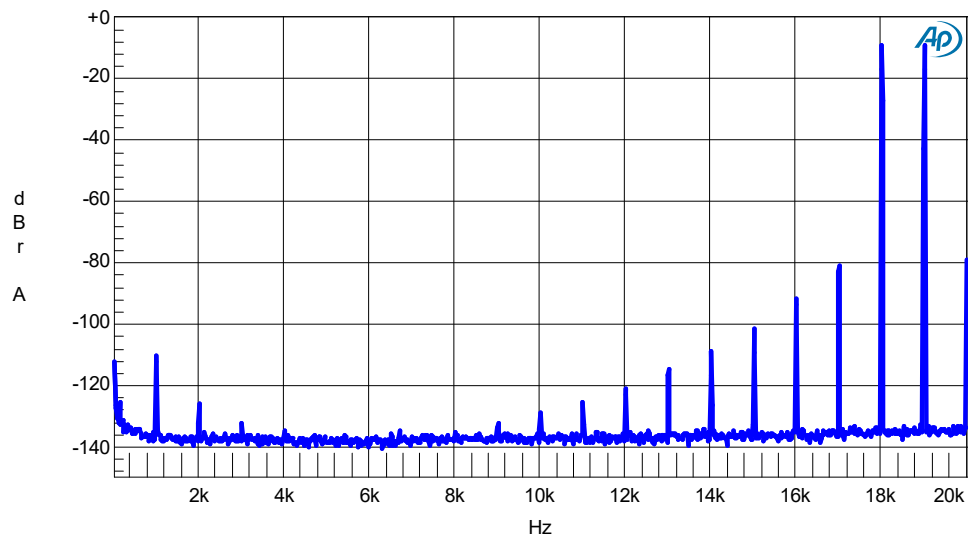


Figure 8: Intermodulation (16kFFT) 0-20kHz @ 0dB = 100 W/4 Ω

## 10.5 Channel separation

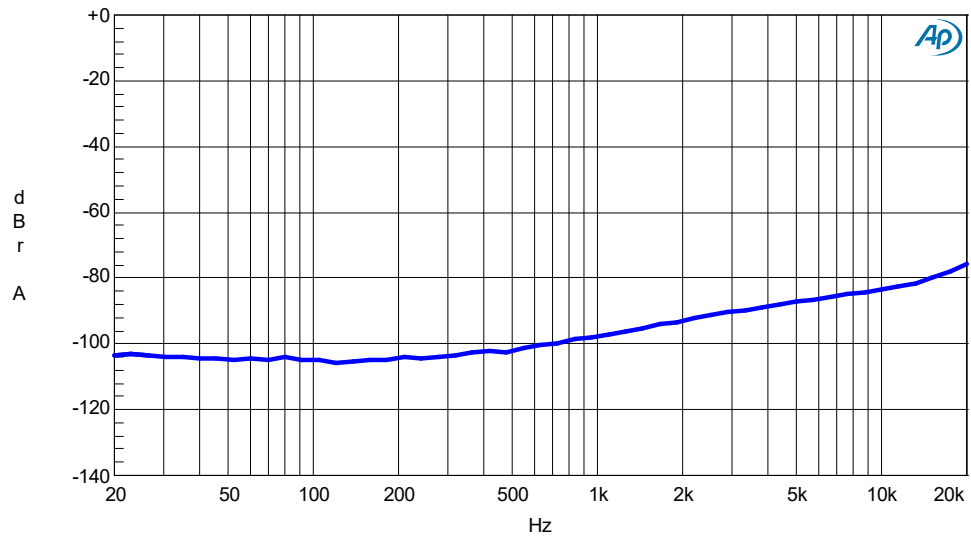


Figure 9: Typical channel separation 20-20kHz, 0 dB @  $P_o = 12.5 \text{ W} / 4 \Omega$

## 10.6 Output impedance

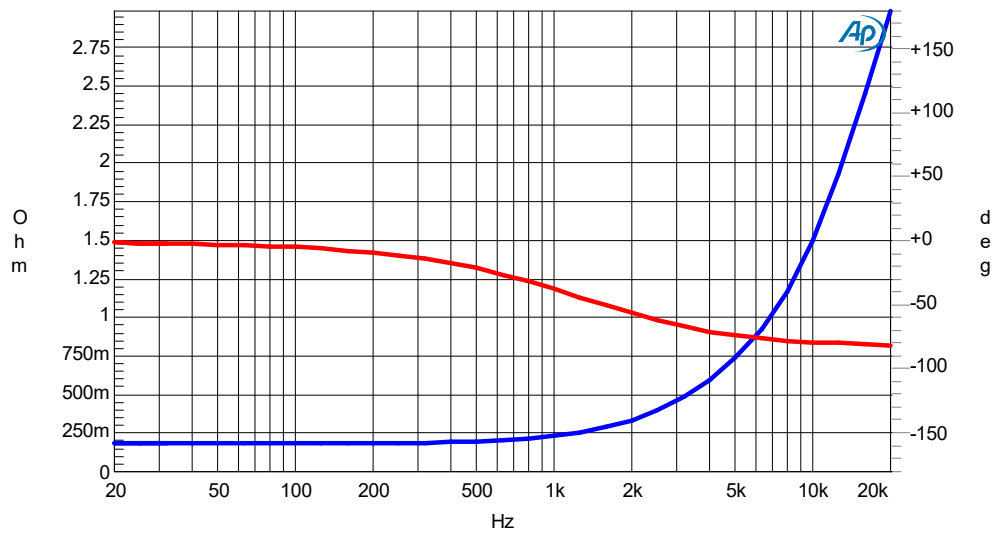


Figure 10: Output impedance vs frequency 20-20kHz (blue), phase (red)

## 10.7 Damping factor

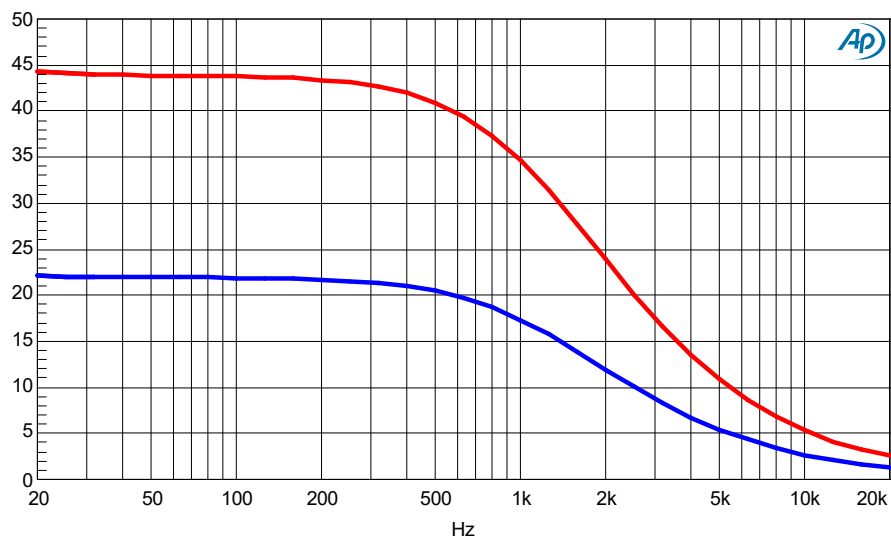


Figure 11: Damping factor vs frequency 20-20kHz, 4Ω (blue), 8Ω (red)

## 10.8 Output Power vs. Mains

ICEpower100AS1

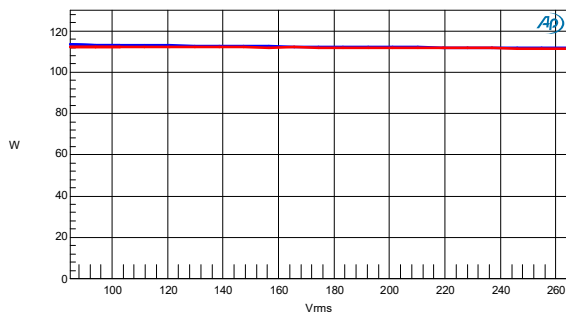


Figure 12: Output power vs mains, 50Hz (blue), 60Hz (red)

ICEpower100AS2

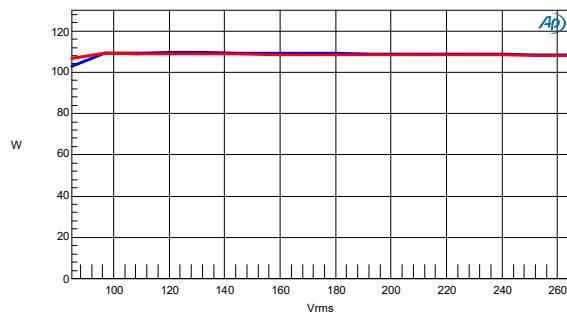


Figure 13: Output power per channel vs mains, 50Hz (blue), 60Hz (red)

## 10.9 Power efficiency

ICEpower100AS1

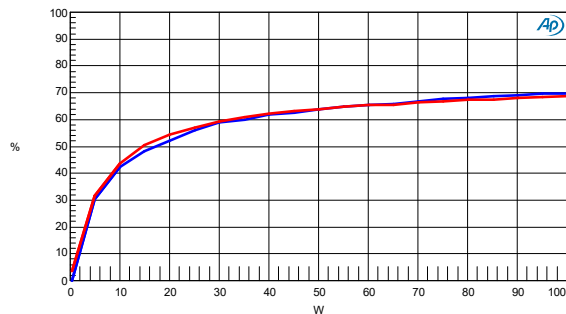


Figure 14: Power efficiency vs. output power, 230V/50Hz (blue), 115V/60Hz (red)

ICEpower100AS2

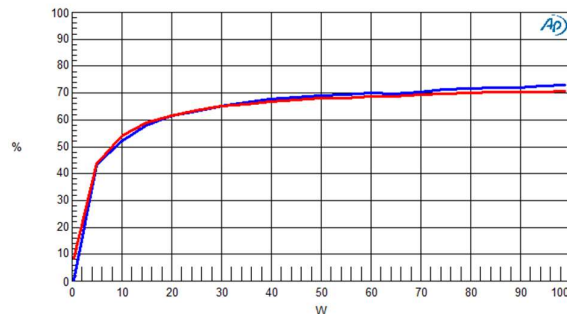


Figure 15: Power efficiency vs. output power per channel, 230V/50Hz (blue), 115V/60Hz (red)

## 10.10 Dissipated power

ICEpower100AS1

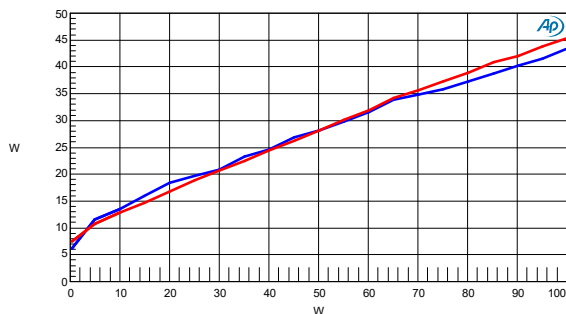


Figure 16: Dissipated power vs. output power, 230V/50Hz (blue), 115V/60Hz (red)

ICEpower100AS2

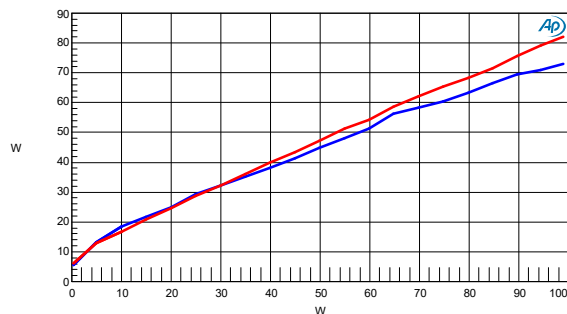


Figure 17: Dissipated power vs. output power per channel, 230V/50Hz (blue), 115V/60Hz (red)

## 11 Functional description

The ICEpower 100AS1/2 will start operating when power is applied to the module and therefore no special control is needed for simple applications. However, for more advanced applications, a wide set of control, status and monitoring inputs and outputs are available all through a connector following the ICEpower Standard Interface definition.

In general, the 100AS1/2 module will keep on operating under all conditions, but in case of potentially destructive error situations, the built in protection systems will shut down the module. After a short delay, the module will attempt a restart, as it should according to ICEpower's Music at All Times philosophy.

Additionally, auxiliary power supply outputs are provided for signal and control front-ends as well as power for an optional amplifier module.

In the following subsections, a description is given for all features available in the 100AS1/2 module organized per the connector in which the corresponding input or output is located.

### 11.1 Audio input

The audio inputs of the 100AS1/2 are semi-balanced inputs including a non-inverting and inverting signal input and a signal ground.

The recommended use of this input is to connect the non-inverting input to a single ended signal source and use the inverting input as ground sense on the front-end PCB. The signal ground should also be connected to ground on the front-end PCB. To prevent ground loop related noise and hum problems, the signal ground is fitted with low ohm series resistors on the module i.e. the signal ground wire must not carry any additional current. The recommended connection to the audio input is shown on Figure 24 in Section 12.

To get best possible suppression of noise and mains related hum in the end-product, proper attention must be put into signal source output impedance in both the non-inverting signal and the ground sense wires.

Should a fully balanced input be required, the audio input of the 100AS1/2 can support this as well.

The two audio signal inputs share the same connector on the 100AS1/2 module. In the single channel version 100AS1, the channel 2 inputs are left unconnected.

### 11.2 Speaker outputs

The speaker output of the 100AS1/2 module is a balanced output with two active signal lines capable of driving complex speaker loads. As the speaker output is already in a balanced configuration, bridging of two channels is not possible.

The speaker outputs are fully overload and short circuit protected. In case of an overload or short circuit event, the module will shut down and resume operation when the overload or short circuit has been removed.

Due to the single supply amplifier circuit on the module, a common mode DC offset is present on the speaker outputs. It is therefore not possible to connect one of the outputs to ground. The module is protected against such an event, and the module will not start if a short to ground is detected.

On the 100AS1 module, only channel 1 output is mounted.

### 11.3 AC Mains input

The 100AS1/2 mains input is a universal input operating on all common mains supplies. No switching between low and high mains is required.

The power up and power down timing is shown in Figure 18 and specific timing values are available in Section 8.3.

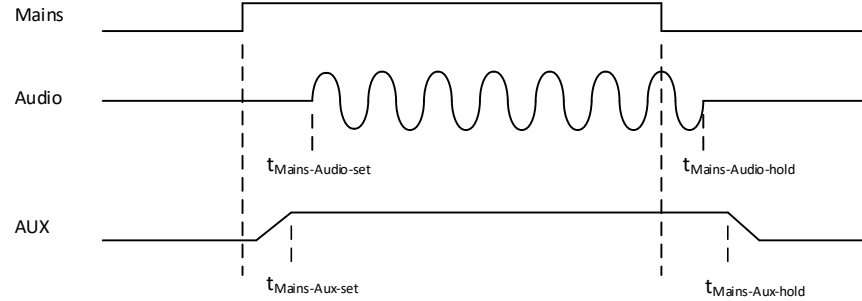


Figure 18: Power up timing

The 100AS1/2 module is fitted with a non-replaceable fuse on the mains input. In case of a burned fuse, the module is defective and must be replaced.

## 11.4 Basic Control and Status

The Basic Control and Status connector includes auxiliary power supply outputs for e.g. a signal front-end PCB and the following features:

- Standby input
- AmpDisable input
- Clip1 and Clip2 output
- Protect output

The recommended connection to the control input and status outputs are shown on Figure 25 and Figure 26 in Section 12.

### 11.4.1 Standby input

The Standby input brings the 100AS1/2 in standby mode when pulled high. An internal pull down ensures normal operation mode if the Standby input is left unconnected.

In standby mode, the amplifier section of the 100AS1/2 will shut down leaving only the power supply operating in a low power mode. To reduce power consumption in the overall system including an external signal front end, the positive and negative auxiliary supply outputs AVDD and AVSS are shut off while the control supply DVDD is kept running in a low power mode. In this low power mode, DVDD and DVDD\_STBY can deliver a reduced amount of current for e.g. a front-end system microcontroller. Timing of the Standby input is shown in Figure 19 and specific timing values are available in Section 8.3.

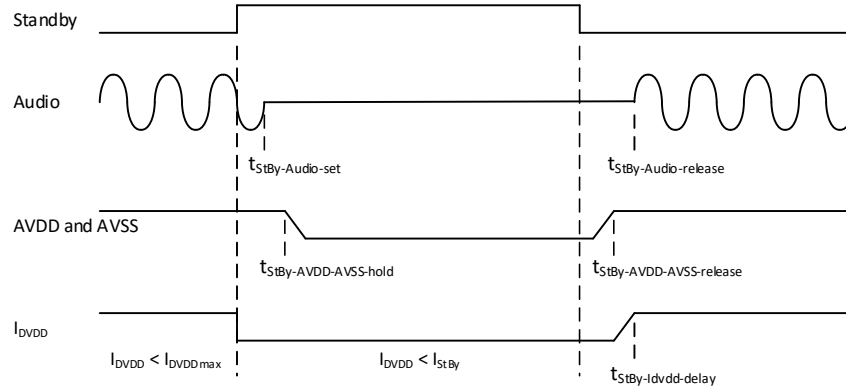


Figure 19: Standby timing on auxiliary supplies

Before bringing the 100AS1/2 in Standby mode, it is important to reduce the current consumption on DVDD supply output to a value below the specified maximum Standby mode current.

When changing between Standby mode and On mode a minimum period of 1 second is recommended before changing back to previous mode.

#### 11.4.2 AmpDisable input

The AmpDisable input shuts down the 100AS1/2 amplifier section when pulled high. An internal pull down ensures normal operation if the AmpDisable input is left unconnected. In AmpDisable mode, all power supplies are left running including all auxiliary supply outputs.

This feature can be used in e.g. applications where a front-end needs time to boot a DSP based systems at power up before enabling the amplifier.

Timing of the AmpDisable inputs shown in Figure 20 and specific timing values are available in Section 8.3.

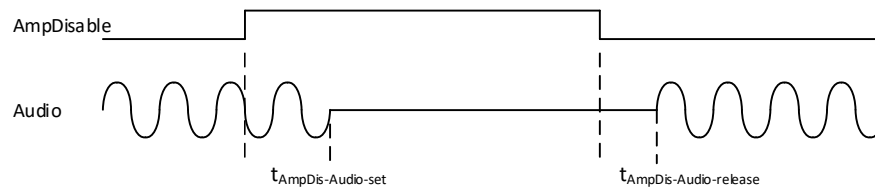


Figure 20: Standby and AmpDisable timing

Advanced pop and click reduction mechanisms are built into the 100AS1/2 leaving almost no audible artifacts when operating the Standby and AmpDisable inputs. Should further pop and click reduction be required in a specific application, a dedicated mute circuit is recommended on the front end PCB.

#### 11.4.3 Clip1 and Clip2 output

The Clip1 and Clip2 outputs are multi-purpose outputs indicating:

- Audio signal voltage clipping
- Audio signal current clipping
- Power stage over-temperature warning

Voltage and current clipping events are reported as a low pulse once per PWM cycle on the Clip1 and Clip2 outputs. On the 100AS1/2, the two outputs indicate the same signal and there is therefore no specific information per channel.



In case of an over-temperature situation, the Clip1 and Clip2 outputs are pulled low continuously if the amplifier power stage is above the thermal threshold  $T_{\text{Amp-OT-warning}}$ . Both Clip outputs are automatically released when the temperature is below the threshold again.

The Clip1 and Clip2 outputs are open drain outputs pulled high by external pull-up resistors. Interface schematics can be found in Section 12.3.

#### 11.4.4 Protect output

In case of potentially destructive overload situations, the 100AS1/2 will shut down and resume operation after a short delay or after the overload-condition has been removed. These events are reported by a low level on the Protect output.

Events that will trigger the Protect output are:

- Severe amplifier overcurrent conditions and short circuit in the amplifier section
- Overcurrent conditions on the auxiliary power supply outputs, DVDD, DVDD STBY, AVDD and AVSS
- Over-temperature errors in the module

In the first two cases, the 100AS1/2 module will resume operation shortly after the error condition has been removed. For the over-temperature case, it is also required that the module temperature is brought below the temperature reset threshold  $T_{\text{Amp-OT-reset}}$  again.

The protection events listed above are all related to secondary side of the 100AS1/2 power supply. Protection events related to the primary side of the module power supply are not reported.

The Protect output is an open-drain output pulled high by an external pull up resistor. Interface schematics can be found in Section 12.3.

Timing of the protection events are shown in Figure 21 through Figure 23 and specific timing values are available in Section 8.3.

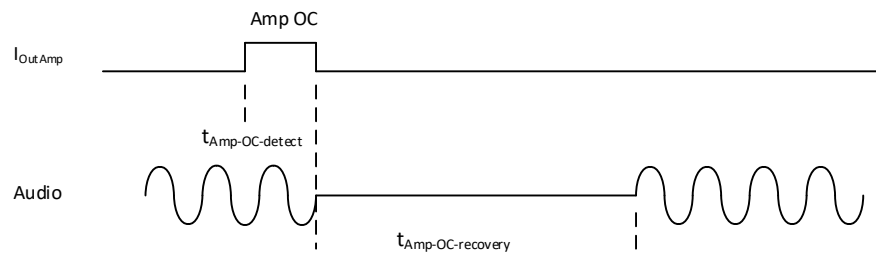


Figure 21: Speaker output overcurrent timing

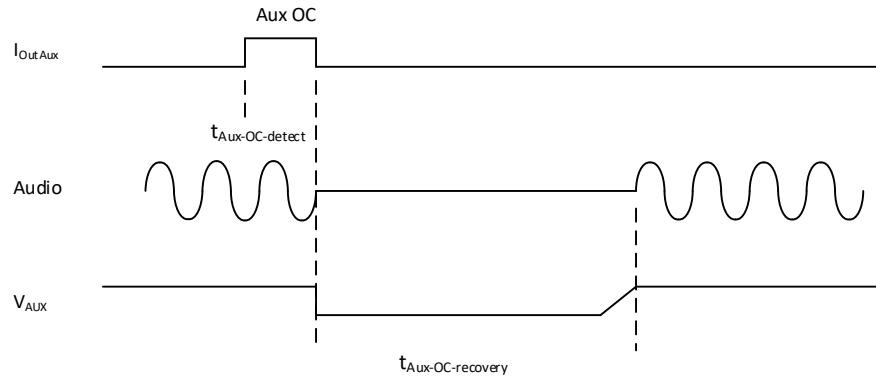


Figure 22: Auxiliary supply overcurrent timing

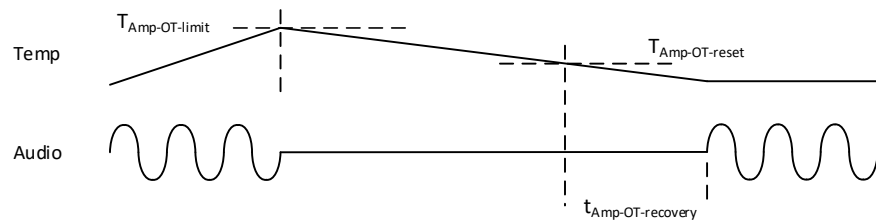


Figure 23: Temperature protection timing

#### 11.4.5 DVDD and DVDD STBY power supply output

The DVDD and DVDD STBY outputs are power supply outputs intended for control circuits on a front-end board e.g. microcontrollers and DSPs.

According to the ICEpower Standard Interface, circuits operating in Standby Mode must be supplied from DVDD STBY output whereas the remaining frontend control circuits can be supplied from the DVDD output. Because of the minimalistic design approach in the 100AS1/2, the 100AS1/2 has been fitted with only one power supply unit capable of operating in both Standby Mode and in normal operation mode. Therefore, on the 100AS1/2, the DVDD STBY and DVDD are connected in parallel. To ensure best possible compatibility with other products following the ICEpower Standard Interface, it is recommended to connect control circuits as intended by the standard.

The DVDD and DVDD STBY supply outputs are loosely regulated. They may require additionally voltage regulators on a front-end board depending on the type of circuit supplied by these pins.

The DVDD and DVDD STBY outputs are overcurrent protected. An overload of these outputs will cause all auxiliary power supply outputs including AVDD and AVSS to turn off. After a short delay, the auxiliary output will automatically restart.

Timing of the DVDD and DVDD STBY overcurrent event is shown in Figure 22 and specific timing values are available in Section 8.3.

#### 11.4.6 AVDD and AVSS power supply output

The AVDD and AVSS outputs are positive and negative power supply outputs intended for analog circuits on a front-end board e.g. analog buffers and speaker crossover filters.

To ensure proper suppression of supply related noise and hum, it is important to have all supply related current draw through the GND connections in the power supply interface. The analog signal ground available in the audio interface connector must not carry any supply related current. For proposed grounding scheme details, please see Section 13.1

The AVDD and AVSS supply outputs are loosely regulated. They may require additionally voltage regulators on a front-end board depending on the type of circuit supplied by these pins.

The AVDD and AVSS outputs are overcurrent protected. An overload of these outputs will cause all auxiliary power supply outputs including DVDD and DVDD STBY to turn off. After a short delay, the auxiliary output will automatically restart.

Timing of the AVDD and AVSS overcurrent event is shown in Figure 22 and specific timing values are available in Section 8.3.

### 11.5 Hanger Power

To supply an optional amplifier channel on the 100AS1/2 module, the amplifier positive supply line VD and GND is available in the Hanger Power connector.

**WARNING:** As this VD power output is not over-current protected, a 2 A fast acting fuse **MUST** be included in the supply line on the hanger amplifier PCB. Failing to comply with this requirement is a violation of the ICEpower warranty policy.

## 12 Interface schematics

In the following sub-sections, proposed interface schematics are shown. These schematics should be seen as assistance to the design process, and they represent the recommended interface to the 100AS1/2 module.

### 12.1 Audio input

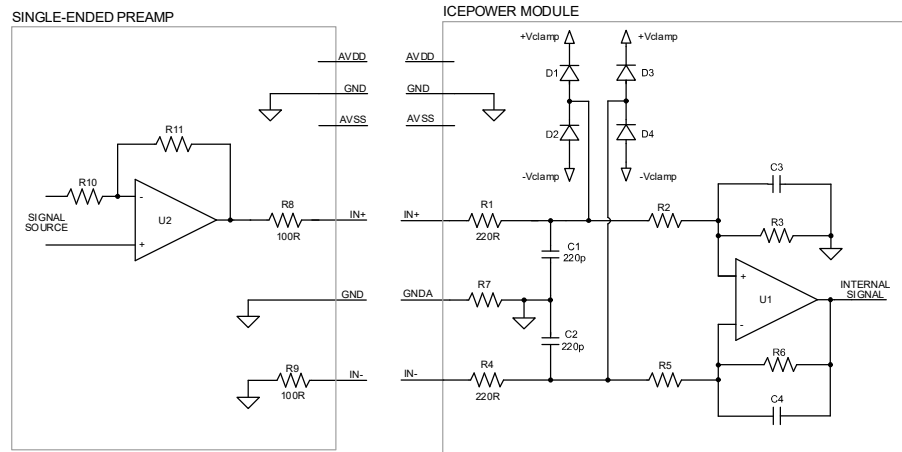


Figure 24: Analog input interface schematics

### 12.2 Control input

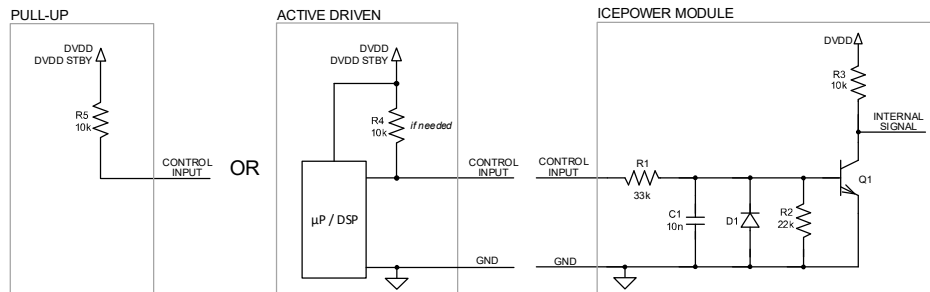


Figure 25: Control input interface schematics

### 12.3 Status output

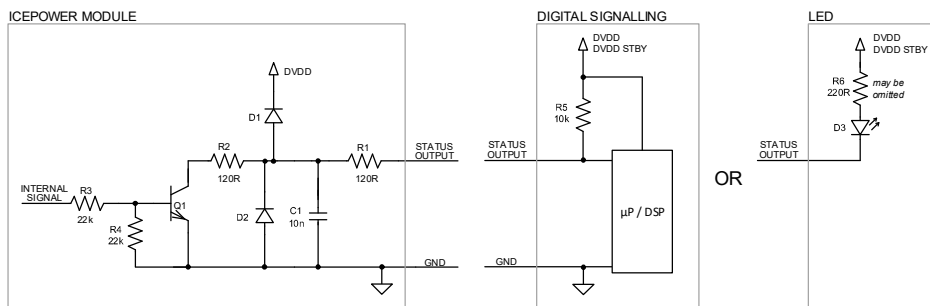


Figure 26: Status output interface schematics

## 13 Integration guidelines

The 100AS1/2 module is designed with ease of integration in mind. This includes both electrical, EMC, thermal and mechanical integration. In the following sub-sections, recommendations will be given to assist the end-product design process.

### 13.1 Grounding scheme

Depending on the complexity of the end-product several grounding schemes can be used. On Figure 27 an example of the grounding scheme usable on the 100AS1/2 module is shown for a simple setup including a front-end PCB.

The two low  $\Omega$  resistors included in the AGND signal grounds prevents ground loops between the 100AS1/2 module and the front-end PCB. To prevent similar ground loops between the PCBs and the chassis, it is recommended not to connect the audio input connectors to the chassis but to have them grounded on the front-end PCB.

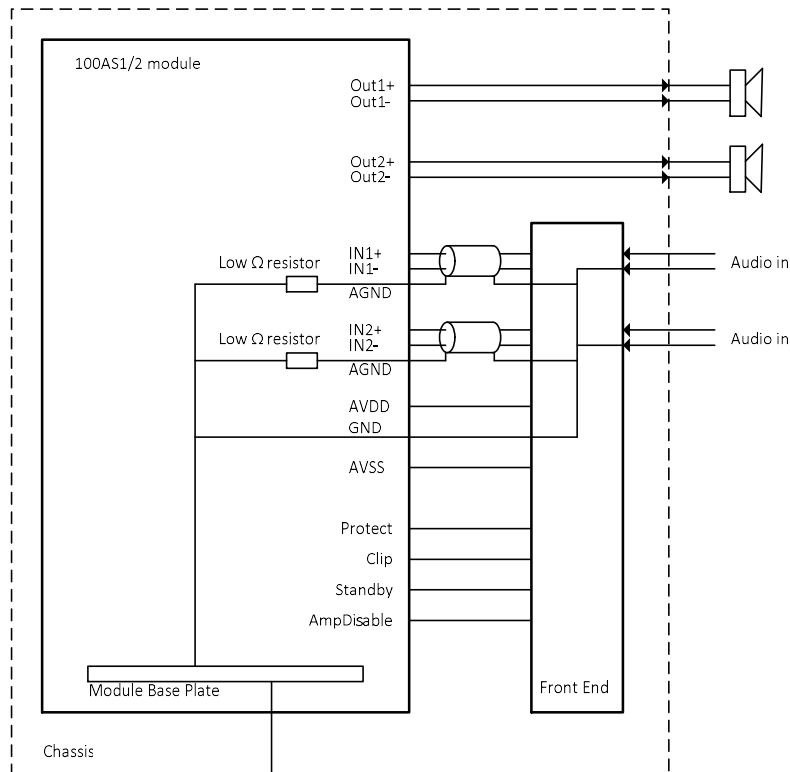


Figure 27: Grounding scheme

### 13.2 EMC management

As described in Section 2, the 100AS1/2 module is EMC pre-approved as is. However, because of the high power switching electronics included in the module, some EMC precautions are required to ensure an EMC approvable end-product design.

- Connect the module baseplate to the chassis. Mounting of the module isolated from the chassis may cause extended HF radiation.
- Do not use cable/wires between module and other PCBs that are longer than necessary.
- Avoid wire loops on the speaker output wires. Use wires closely paired side by side or if required use twisted or shielded cables (Figure 28)

- Avoid wire loops on the mains wires from the mains inlet to the module mains connector.
- Do not route cables near by the magnetic components on the module i.e. inductors and transformers.
- Do not bundle mains wires together with other cables (Figure 29).
- Do not bundle speaker wires together with other cables (Figure 29).

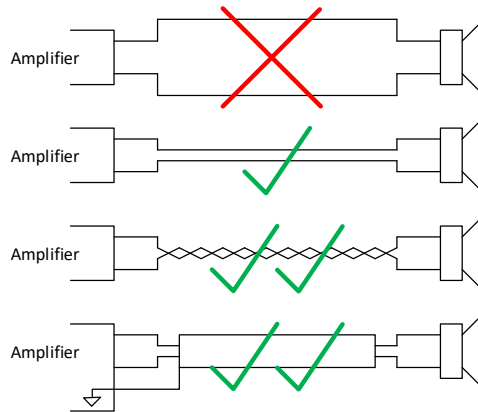


Figure 28: Speaker wire routing

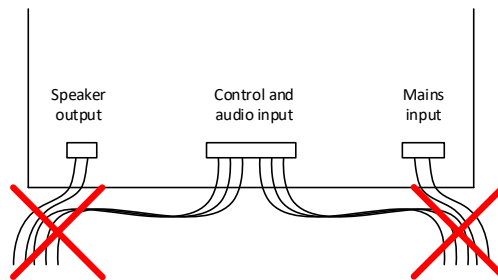


Figure 29: Wire bundling

As specified in Section 2, the ICEpower modules are EMC pre-approved as is. However, depending on the specific application, additional EMC initiatives and filtering can be required to have the entire end-product EMC approved. The reason for this could be, among others, insufficient cable routing within the application or DSP/microprocessor based front-end systems.

To improve on such issues, it is often advisable to revisit the used grounding scheme and cable routing, and eventually add EMC filters on some or all of the connector on the end-product.

### 13.3 Thermal design

The 100AS1/2 module is designed with an integrated cooling system in the aluminum base plate. The module can therefore operate without any further cooling however at reduced power levels. Even though use of the module without further cooling is possible, it is recommended to add more cooling.

In most applications, the module will be additionally cooled through the metal chassis or heatsink on which it is mounted. As specified in Section 8, a 2 mm x 200 mm x 300 mm aluminum plate representing a metal chassis has been used as cooling for the power specification in this datasheet.

Besides cooling through the baseplate, it is important to ensure proper airflow around the module. In most cases, this can be achieved through passive convection, but in some cases e.g. 1U rack enclosures, forced airflow can be required depending on end-product mechanical design constraints or end-product use environment.

## 14 Mechanical mounting

As described in Section 13.3, the 100AS1/2 modules are designed for mounting in a metal chassis or on a heatsink for added cooling through the aluminum base plate. To give flexibility in the mechanical solutions in different applications, two mountings methods are possible. These are:

- Mounting from the bottom side through six pieces of M3 treaded holes.
- Mounting from the top side through six recesses along the two long sides of the module.

The six circular holes on Figure 3 indicates standoffs with internal M3 threading, used to mount the module PCB to the module base plate. These standoffs have free thread from the bottom side, which can be used for mounting the module. When choosing screws for the mounting, the depth of the threaded holes must be observed as well as the specified mounting torque both specified in Section 9.1.

Alternatively, the module can be mounted from the top side by use of six recesses in the module PCB and base plate along the two long edges. 3 mm or 1/8 inch non-countersunk screws can be used for this.

When designing the chassis or heatsink solutions for the 100AS1/2 module, the metal part surface flatness must be controlled to avoid bending or flexing of the module. Additionally, uneven contact surface will result in non-optimal thermal interface.

Finally, thermal conductive compound can be used in the mechanical interface between module and chassis/heatsink if required. Please follow the instructions provide by the thermal compound manufacture as incorrect use can result in non-optimal performance.

## 15 Safety and EMC standards

ICEpower100AS1/2 has been verified to conform to the following standards.

### 15.1 Safety

IEC 62368:2014 (Second Edition)

IEC 60065:2014 (Eight Edition) Incl. Compliance with the National requirements of AR, AU, CA, CN, DE, DK, GB, IE, JP, KR, MY, NO, SE, SG, and US.

EN 60065: 2002/A1:2006; EN 60065:2002/A11:2008; EN 60065:2002/A2:2010; EN 60065:2002/A12:2011

CAN/CSA 60065-03 + Am1 + Am2

UL Std No. 60065-03 (2012)

### 15.2 EMC

EN 55032: 2012  
(CISPR 32: 2012)

Electromagnetic compatibility of multimedia equipment – Emission requirements

EN 61000-3-2: 2014  
(IEC 61000-3-2: 2014)

Harmonic current emission

EN 61000-3-3: 2013  
(IEC 61000-3-3: 2013)

Voltage changes, voltage fluctuations and flicker

EN55020: 2007 + A11: 2011  
(CISPR 20: 2006)

Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement

EN 61000-4-2: 2009  
(IEC 61000-4-2:2008)

Electrostatic discharge immunity test

EN 61000-4-3: 2006 + A1: 2008 + A2: 2010  
(IEC 61000-4-3: 2006 + A1: 2007 + A2: 2010)

Radiated, radio frequency, electromagnetic field immunity test

EN 61000-4-4: 2004 + A1: 2010  
(IEC 61000-4-4: 2004 + C1: 2006 + C2: 2007 + A1: 2010)

Electrical fast transient / burst immunity test

CFR 47 Part 15 Subpart B (FCC): 2015 Class B

Telecommunication – Radio Frequency Devices – Unintentional Radiation

CFR 47 part 15, subpart B, section 15.107

AC Line conducted emission

CFR 47 part 15, subpart B, section 15.109(a)

Radiated emission, general requirements



## 16 ESD warning

ICEpower products are manufactured according to the following ESD precautions:

- ANSI/ESD-S20.20-2007: Protection of Electrical and Electronic Parts, Assemblies and Equipment.

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

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

## 17 Ordering, Packaging and Storage

All ICEpower modules are packaged in ESD safe bags and cardboard boxes.

### 17.1 Ordering information

Order Codes	Description	Part Number
ICEpower100AS1	One channels 100 W ICEpower amplifier with integrated universal mains power supply	8008241
ICEpower100AS2	Two channels 100 W ICEpower amplifier with integrated universal mains power supply	8008242

### 17.2 Shipping dimensions and weight

Package	Quantity	Dimensions (w × d × h) [mm]	Gross Weight [kg]
Carton	30	390 x 585 x 210	12.38

### 17.3 Storage conditions

**Storage Humidity and Temperature:**

Please find storage humidity and temperature information in Section 1.1, Environmental Specifications.

**Stacking**

Pallets may not be stacked on top of each other.

## 18 Contact

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

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## 19 Legal Notes

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- Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labelling, can be reasonably expected to result in a significant injury to the user.
- A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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