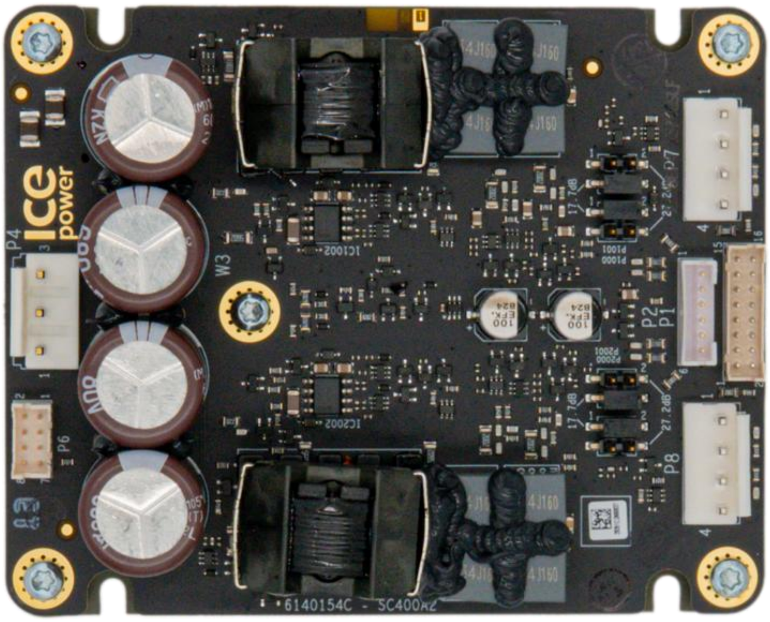

ICEpowerSC400A2

Two Channel 400W ICEpower Amplifier
Version 1.2

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1. Contents

2. General Description

ICEpowerSC400A2 is designed for extremely transparent audio quality in a compact size. The SC400A2 incorporates the latest state of the art ICEpower patent pending Super Conductor technology, enabling superior sound quality with a low noise floor, of typical 13 µV for an A-weighted Signal To Noise ratio of 130 dB, with medium voltage gain. It is an efficient two/one-channel audio power amplifier intended for driving two 4Ω loudspeakers or one 8Ω speaker in BTL mode.

The ICEpowerSC400A2 provides comprehensive protection and monitoring functions with an easy-to-use control interface. The over current protection is a patent pending adaptive circuit which adjusts the thresholds on the fly to maintain maximum robustness. Additionally, dedicated monitor outputs for loudspeaker connector output voltage enables real time protection system of the loudspeaker.

ICEpowerSC400A2 is designed for high output power, making it ideal for applications requiring sustained output power and high output voltage not only for home hi-fi, but also for demanding studio monitors and high performance amplifiers for PRO audio speakers as well. The integrated aluminum base plate enables easy extended heat transfer to external heatsink so that improved long term output power can be achieved.

The ICEpowerSC400A2 is designed to comply with EMC and safety enabling fast design-in and minimum time to market.

Features
Can be configured as a two channel SE amplifier or a single channel BTL amplifier
Designed for flexible mounting and, if needed, easy mechanical interface to external heatsink for even higher continuous power capability
Designed to use 750S1U(69V) as a power supply enabling system designs of up to four channels with one power supply
Thermal and over- and under- voltage rail protection
Enhanced over current protection
Suitable for 1U products
Fully differential audio inputs
Two gain settings, 17.7dB and 27.2dB
Silent fast amplifier Disable control input
Clip detect signals for both channels
Voltage monitor outputs for both channels
DC error output signal to shut down power supply

2.1 Key Specifications

- 2 channel 400 W @ 1 % THD+N, 20 Hz – 20 kHz, SE 4 Ω
  1 channel 800 W @ 1 % THD+N, 20 Hz – 20 kHz, BTL 8 Ω
- 125 dB(A) dynamic range SE @ 27.2dB gain
- 130 dB(A) dynamic range SE @ 17.7dB gain
- 128 dB(A) dynamic range BTL @ 27.2dB gain
- 133 dB(A) dynamic range BTL @ 17.7dB gain
- THD+N = 0.0003 % @ 10 W, 20 Hz – 20 kHz, SE, 4 Ω
- THD+N = 0.0003 % @ 50 W, 20 Hz – 20 kHz, SE, 4 Ω
- Load independent frequency response
- Very low THD+N in the entire audio band

- Very low IM distortion
- 22uVrms A-weighted idle noise SE @ 27.2dB gain
- 13uVrms A-weighted idle noise SE @ 17.7dB gain
- 32uVrms A-weighted idle noise BTL @ 27.2dB gain
- 17uVrms A-weighted idle noise BTL @ 17.7dB gain
- Dimensions (L × W × H): 100 × 80 × 33 mm, (3.93 x 3.14 x 1.38 inch)

2.2 Module Overview & Comparative Table

Unless otherwise noted, all comparison table values represent typical characteristics.

Amplifier Section	**Power (PSU / amp) & PSU Section**
2x400 W (SE), 1 % THD+N, 20 Hz – 20 kHz / 4 Ω	Continuous combined output power 1x 150W, 2x100 W 4 Ω, T_a = 25 °C
1x800 W (BTL) 20 Hz – 20 kHz, 1 % THD+N / 8 Ω 2x215 W (SE) 20 Hz – 20 kHz, 1 % THD+N / 8 Ω	Time of max rated output power: 75 s (1x400 W), 60 s (2x400 W) 4 Ω, T_a = 25 °C
Max output voltage: 56.6 V_p (SE / 4 Ω), 113 V_p (BTL / 8 Ω) Max output current: 19 A_p for > 1.5 ohm load 12 A_p for < 1.5 ohm load	Max operating ambient temperature 50 °C
Min load impedance 3Ω (SE), 6Ω (BTL)	Maximum total module efficiency 96 %
THD+N 0.0003 % (SE) @ 1 kHz, 10 W / 4 Ω	
THD+N 0.0003 % (SE) @ 6.67 kHz, 10 W / 4 Ω	
THD+N 0.00025 % (SE), 0.00035 % (BTL) @ 1 kHz, 10 W / 8 Ω	
Two gain settings 17.7dB and 27.2dB (SE)	**GND**, P6 Pin 1 & 8
Input sensitivity: 5.22 VRMS, 7.38 Vp @ 17.7dB and 1.75 VRMS, 2.46 Vp @ 27.2dB (input voltage req. to reach rated power / clip level)	
Voltage gain: 17.7 dB or 7.66 x and 27.2 dB or x 22.90 (SE), 23.7dB or x 15.31 and 33.2 dB or x 45.70 (BTL)	
Output idle noise: A-weighted 13 µV@17.7dB, 22 µV@27.2dB unweighted 15 µV@17.7dB, 28 µV@27.2dB (SE) A-weighted 17 µV @23.7dB, 32 µV@33.2dB unweighted 22 µV @23.7dB, 40µV@33.2dB (BTL)	
Bandwidth (-3 dB): upper 120 kHz (SE / 4 Ω), 120 kHz (BTL / 8 Ω) and lower <5 Hz (SE & BTL)	**Vdrive**, P6 Pin 7, V_S + 9.5 V_{DC} to V_S + 17 V_{DC}
Dynamic range A-weighted: 130 dB @17.7dB and 125 dB @27.2dB (SE), 133 dB @23.7dB and 128 dB @33.2dB (BTL)	**VDD**, P6 Pin 3, +11 V_{DC} to +17 V_{DC}
ICEpower patent pending Super Conductor technology	**VSS**, P6 Pin 5, -11 V_{DC} to -17 V_{DC}
Can be configured in 2-channel SE or 1-channel BTL	
	Module dimensions: L 100 mm / W 80 mm / H 33 mm
	Compatibility: 750S1U (±69V rails)
	EMC pre-approved
Order information	
ICEpowerSC400A2, part number 8000154	

3. Release Notes

Data Sheet Version	Date	Revised by	Description
1.0	2026-02-01	RSM/PBM	Preliminary revision
1.1	2026-06-03	RSM/PBM	First release
1.2	2026-09-01	RSM/PBM	Graphs for high gain setting, module overview and comparative table, Jumper arrangement for gain settings table added

4. Getting Started

ICEpowerSC400A2 is a fully self-contained amplifier module and requires no interaction or control to operate.

For first time use, please connect an audio source to the analog input and loudspeakers to the loudspeaker output connectors before applying power to the power rail supply connectors, auxiliary supplies and Vdrive. ICEpowerSC400A2 will start after all supply voltages are applied.

The ICEpowerSC400A2 is a two-channel single ended output Class D audio amplifier utilizing ICEpower patented technology. Each channel comprises a highly accurate differential receiver for high suppression of hum and noise in a multi-channel application. The two-channel amplifier module can easily be bridged creating a single channel of higher output power by connecting the two balanced inputs in parallel, one with swapped polarity, and the load between + of one channel and + of the other channel.

5. Block Diagram

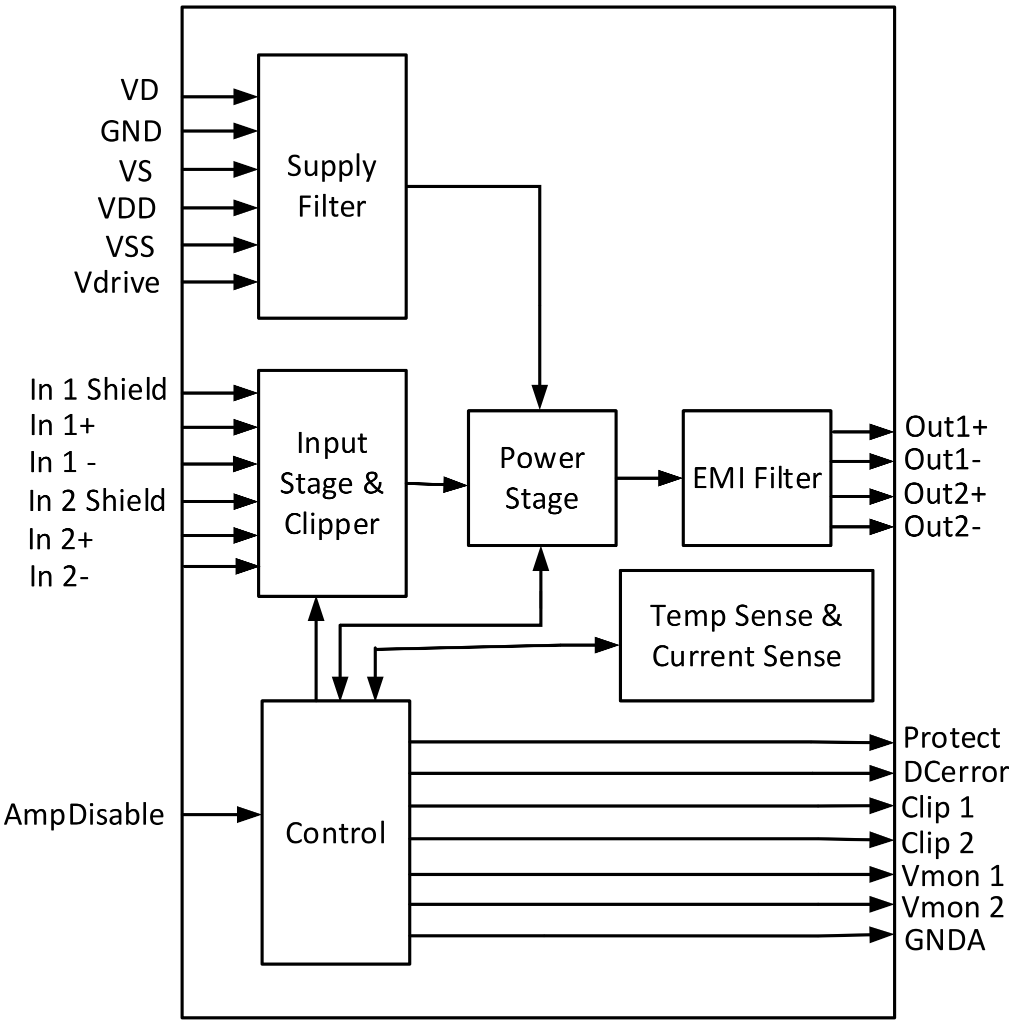


Figure 1: ICEpowerSC400A2 block diagram

6. Connectors

The ICEpowerSC400A2 module comes with industry standard connectors selected for long-term reliability.

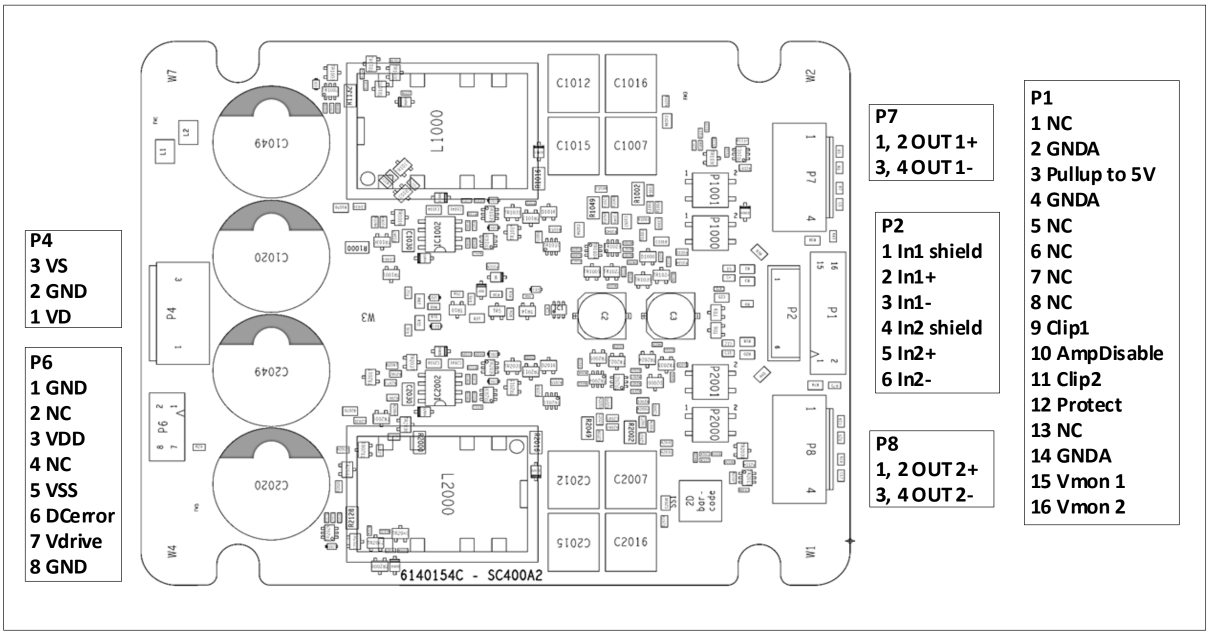


Figure 2: ICEpowerSC400A2 connector overview

6.1 P4: Power Rail Supply Connector

Type: JST, B03P-NV (LF)(SN)				
PIN	**Function**	**Description**	**Type**	**Reference**
1	VD	Positive amplifier DC rail supply	Power input	GND
2	GND	Ground	Power GND	
3	VS	Negative amplifier DC rail supply	Power input	GND

Table 1: Power rail connector

6.2 P6: Auxiliary Supply Connector

Type: JST, B8B-PHDSS (LF)(SN)				
PIN	**Function**	**Description**	**Type**	**Reference**
1	GND	Ground	GND	
2	NC			
3	VDD	Positive supply for low voltage circuitry	Input	GND
4	NC			
5	VSS	Negative supply for low voltage circuitry	Input	GND
6	DCerror	DC error signaling for shutting down the power supply	Status output, open drain, active low	GND
7	Vdrive	Vdrive voltage for the power stage	Input	VS
8	GND	Ground	GND	

Table 2: Auxiliary Supply connector

The module should only be supplied by VDD/VSS

6.3 P1: Basic+ Control Connector

Type: JST, B16B-PHDSS (LF)(SN)				
PIN	**Function**	**Description**	**Type**	**Reference**
1	NC		NC	
2	GNDA	Ground ref	Reference voltage	GND
3	Pullup to 5V	47k pull up resistance	Output	GND
4	GNDA	Ground ref	Reference voltage	GND
5	NC		NC	
6	NC		NC	
7	NC		NC	
8	NC		NC	
9	Clip1	Voltage clip indicator, channel 1	Status output, open drain, active low	GND
10	AmpDisable	Disable amplifier (mute)	Control input, active high	GND
11	Clip2	Voltage clip indicator, channel 2	Status output, open drain, active low	GND
12	Protect	Protect signal	Status output, open drain, active low	GND
13	NC		NC	
14	GNDA	Ground ref	Reference voltage	GND
15	Vmon1	Voltage monitor, channel 1	Analog Output	GND
16	Vmon2	Voltage monitor, channel 2	Analog Output	GND

Table 3: Basic Control Connector

6.4 P2: Audio Input Connector

Type: JST, B6B-PH-K-S (LF)(SN)				
PIN	**Function**	**Description**	**Type**	**Reference**
1	In1 Shield	Analog audio input shield	Input	Resistor to GND
2	In1+	Non-Inverting analog audio input signal	Input	GND
3	In1-	Inverting analog audio input signal	Input	GND
4	In2 Shield	Analog audio input shield	Input	Resistor to GND
5	In2+	Non-Inverting analog audio input signal	Input	GND
6	In2-	Inverting analog audio input signal	Input	GND

Table 4: Audio Input connector

6.5 P7: Channel 1 Loudspeaker Output Connector

Type: JST, B4P-VH (LF)(SN)			
PIN	**Function**	**Description**	**Type**
1	Out1+	Amplifier output, channel 1	Audio power Output
2	Out1+	Amplifier output, channel 1	Audio power Output
3	Out1-	Amplifier GND output, channel 1[1)]	Audio power Output
4	Out1-	Amplifier GND output, channel 1[1)]	Audio power Output

Table 5: Channel 1 Loudspeaker Output connector

[1)]Do not connect this to normal GND.

6.6 P8: Channel 2 Loudspeaker Output Connector

Type: JST, B4P-VH (LF)(SN)			
PIN	**Function**	**Description**	**Type**
1	Out2+	Amplifier output, channel 2	Audio power Output
2	Out2+	Amplifier output, channel 2	Audio power Output
3	Out2-	Amplifier GND output, channel 2[1)]	Audio power Output
4	Out2-	Amplifier GND output, channel 2[1)]	Audio power Output

Table 6: Channel 2 Loudspeaker Output connector

[1)]Do not connect this to normal GND.

6.7 Jumper arrangement for different gain settings

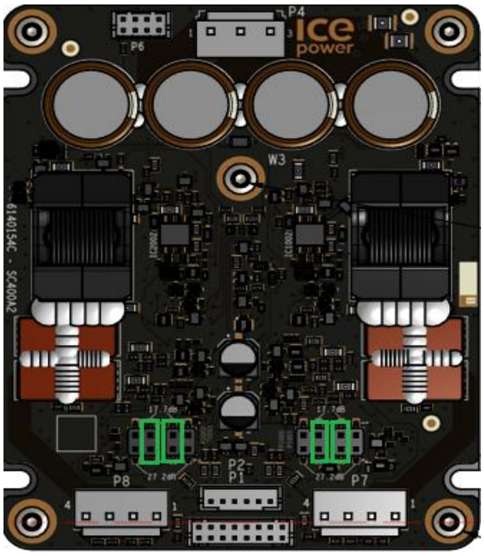
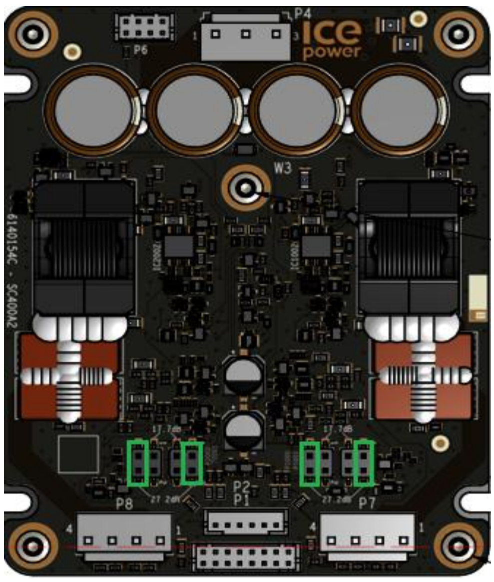
Sr. No.	Gain	Jumper setting	Description
1.	17.7dB		Place jumper (green rectangles) between pin 1 and pin 2 of P1000. Place jumper between pin 3 and pin 4 of P1001. Place jumper between pin 1 and pin 2 of P2000. Place jumper between pin 3 and pin 4 of P2001
2.	27.2dB		Place jumper (green rectangles) between pin 3 and pin 4 of P1000. Place jumper between pin 1 and pin 2 of P1001. Place jumper between pin 3 and pin 4 of P2000. Place jumper between pin 1 and pin 2 of P2001.

Table 7: Jumper arrangement for gain settings

7. Absolute Maximum Rating

Absolute maximum ratings indicate limits beyond which damage may occur.

7.1 Power Rail Supply Section

Pin	Parameter	MIN	MAX	Unit
P4: 2,1	Positive amplifier DC rail supply	+45	+71	Vdc
P4: 2,3	Negative amplifier DC rail supply	-45	-71	Vdc

Table 8: Absolute maximum ratings, power supply section

7.2 Auxiliary Supply Section

Pin	Parameter	MIN	MAX	Unit
P6: 1,3	Positive analog supply (VDD)	+11	17	Vdc
P6: 1,5	Negative analog supply (VSS)	-11	-17	Vdc
P6: 7 to P4: 3	Vdrive supply (referenced to VS)	VS+9.5	+17	Vdc

Table 9: Absolute maximum ratings, auxiliary supplies

7.3 Control pin section P1

Pin	Parameter	MIN	MAX	Unit
10 AmpDisable	Voltage range on control pin	-0.3	+20	Vdc

Table 10: Absolute maximum ratings, control pin section

7.4 Amplifier Signal Input Section

Pin	Parameter	Value	Unit
P2: 4, 5 | 4, 6 P2: 1, 2 | 1, 3	Maximum voltage range on audio input pins	± 10	V_p

Table 11: Absolute maximum ratings, input section

7.5 Output Section

Pin	Parameter	Value	Unit
P7: (1+2), (3+4) P8: (1+2), (3+4)	Minimum amplifier load resistance SE	3	Ω
	Minimum amplifier load resistance BTL	6	Ω
	Maximum current draw from amplifier output	19	A
	Maximum amplifier pure capacitive load	220	nF
P1: 3,9,11,12,15,16	Maximum current draw from basic control connector	20	mA

Table 12: Absolute maximum ratings, output section

8. Electrical Specifications

Unless otherwise specified:

- f = 1 kHz, Ta = 25 °C, R_L = 4 Ω, VD/VS=±69V, VDD/VSS =±12V, Vdrive = +12V referenced to VS, Measured at medium gain 17.7dB.
- Audio Precision AUX0025 passive class-D filter and AES17 20 kHz 7th order measurement filter.
- ICEpowerSC400A2 mounted on heatsink base plate horizontally on plain surface.

8.1 General

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{sw}	Switching frequency	Idle, 4 Ω	480	510	570	kHz
f_{sw}	Switching frequency range	Idle to full scale, 4 Ω	135		570	kHz
	Vmon1, Vmon2 output voltage range	Idle to 1% THD+N Output power (56.6Vp@400W,4Ω)	0		±5	V_P
	Voltage monitor gain, speaker output to Vmon outputs	±69 VD/VS		±0.07		-
	Voltage monitor frequency response	f = 20 Hz - 20 kHz		±0.1		dB
	Voltage monitor phase response[1)]	f = 20 Hz - 20 kHz		±0.15		Deg
	Monitor output impedance			1.4		KΩ
	Monitor output impedance, ground sense wire			30		Ω

Table 13: Electrical specifications

[1)]This phase response is in relation to the output signal.

8.2 Power specification

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_D	Nominal operating DC supply voltage		+45	+69	+71	V
V_S	Nominal operating DC supply voltage		-45	-69	-71	V
VDD	Nominal operating pos. analog supply		+11	+12	+14	V
VSS	Nominal operating neg. analog supply		-11	-12	-14	V
Vdrive	Nominal operating drive analog supply	Referenced to Vs	V_S+9.5	V_S+12	V_S+17	V
t_{Pmax}	Duration of power burst at full power, one channel driven	Po = 400 W		75		S
t_{Pmax}	Duration of power burst at full power, both channels driven	Po = 2x400 W		60		S
$P_{o\text{-}con}$	Continuous output power without thermal shutdown, one channel driven, Ta = 25 °C, no additional heatsink or fan	THD+N < 1 %		150		W
$P_{o\text{-}con}$	Continuous combined output power without thermal shutdown, both channels driven[1)] Ta = 25 °C, no additional heatsink or fan	THD+N < 1 %		200 (2x100)		W
$P_{o\text{-}con}$	Continuous output power without thermal shutdown, one channel driven Ta = 50 °C, mounted on heatsink base plate, no fan	THD+N < 1 %		70		W
$P_{o\text{-}con}$	Continuous combined output power without thermal shutdown, both channels driven[1)] Ta = 50 °C, mounted on heatsink base plate, no fan	THD+N < 1 %		100 (2x50)		W
Iq	Idle current consumption	VD VS VDD VSS Vdrive		36 45 70 48 70		mA
Pq	Total idle power consumption			7.84		W

Idisabled	Disabled current consumption	VD VS VDD VSS Vdrive		9 13 70 48 12		mA
Pdisabled	Disabled power consumption			3.1		W
η	Module power efficiency both channels driven. The efficiency when driving 8 Ω is identical.	Po = 2x400W, 4Ω Po = 2x200W, 4Ω Po = 2x100W, 4Ω Po = 2x50W, 4Ω		96.3 93.7 92.1 88.0		%

Table 14: Power specifications

[1)]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.

8.3 Audio

Symbol	Parameter	Conditions	Typ	Unit
P_o	Output power SE @ 1 % THD+N f = 1 kHz, 1ch driven f = 1 kHz, 2ch driven	R_L = 4 Ω	420 420	W
P_o	Output power SE @ 1 % THD+N 20 Hz < f < 20 kHz, 1ch driven 20 Hz < f < 20 kHz, 2ch driven	R_L = 4 Ω	400 400	W
P_o	Output power SE @ 1 % THD+N 20 Hz < f < 20 kHz, 1ch driven 20 Hz < f < 20 kHz, 2ch driven	R_L = 8 Ω	210 210	W
P_{o_BTL}	Output power BTL @ 1 % THD+N f = 1 kHz	R_L = 8 Ω	820	W
P_{o_BTL}	Output power BTL @ 1 % THD+N 20 Hz < f < 20 kHz	R_L = 8 Ω	800	W
THD+N	THD+N in 4 Ω SE	f = 100Hz, P_O =10 W, Medium gain	0.0003	%
		f = 100Hz, P_O =10 W, High gain	0.0005	
THD+N	THD+N in 8 Ω BTL	f = 100Hz, P_O =10 W, Medium gain	0.0003	%
		f = 100Hz, P_O =10 W, High gain	0.0005	
Phase	20 Hz < f < 20 kHz	R_L = 4 Ω	+0.0 -20.0	Deg
Phase	20 Hz < f < 20 kHz	R_L = 8 Ω	+0.0 -20.0	Deg

N	Output referenced idle noise (SE) 20 Hz < f < 20 kHz	A-weighted Medium Gain 17.7dB	13	μV
		A-weighted High Gain 27.2dB	22	
N	Output referenced idle noise (SE) 20 Hz < f < 20 kHz	Unweighted Medium Gain 17.7dB	15	μV
		Unweighted High Gain 27.2dB	28	
N	Output referenced idle noise (BTL) 20 Hz < f < 20 kHz	A-weighted Medium Gain 17.7dB	17	μV
		A-weighted High Gain 27.2dB	32	
N	Output referenced idle noise (BTL) 20 Hz < f < 20 kHz	Unweighted Medium Gain 17.7dB	22	μV
		Unweighted High Gain 27.2dB	40	
A_v	Nominal Voltage Gain (SE)	f = 1 kHz, P_o = 1 W, Medium gain	17.7	dB
		f = 1 kHz, P_o = 1 W, High gain	27.2	
A_v	Nominal Voltage Gain (BTL)1)	f = 1 kHz, P_o = 1 W, Medium gain	23.7	dB
		f = 1 kHz, P_o = 1 W, High gain	33.2	
f	Frequency response (SE) 20 Hz < f < 20 kHz	R_L= 4 Ω – infinity Ω f_{ref} = 1 kHz P_o = 1 W	+0.0 −0.1	dB
f	Frequency response (BTL) 20 Hz < f < 20 kHz	R_L= 8 Ω – infinity Ω f_{ref} = 1 kHz P_o = 1 W	+0.0 −0.1	dB
f_{U_SE}	Upper bandwidth limit (-3 dB) (SE)	R_L = 4 Ω, P_o = 1 W, Medium gain	120	kHz
		R_L = 4 Ω, P_o = 1 W, High gain	120	
f_{U_BTL}	Upper bandwidth limit (-3 dB) (BTL)	R_L = 8 Ω, P_o = 1 W, Medium gain	120	kHz
		R_L = 8 Ω, P_o = 1 W, High gain	120	
f_L	Lower bandwidth (-3dB) Depends on system capacitance	R_L = all loads no measurement filters	<5Hz	Hz
$Z_{in\text{-}signal}$	Input impedance	See section 13		
Z_o	Abs. output impedance	f = 1 kHz	1	mΩ
$Vo_{\text{-}max\_SE}$	Maximum output voltage SE	R_L = 4 Ω	56.6	Vp
$Vo_{\text{-}max\_BTL}$	Maximum output voltage BTL	R_L = 8 Ω	113	Vp
$Io_{\text{-}max}$	Maximum output current Depends on the output voltage	>1.5 ohm load	19	Ap
		< 1.5 ohm load	12	
DNR	Dynamic range SE	A-weighted 400 W @ 4 Ω , Medium gain	130	dB
		A-weighted 400 W @ 4 Ω , High gain	125	
DNR	Dynamic range SE	Unweighted 400 W @ 4 Ω , Medium gain	128	dB
		Unweighted 400 W @ 4 Ω , High gain	123	
DNR	Dynamic range BTL	A-weighted 800 W @ 8 Ω, Medium gain	133	dB
		A-weighted 800 W @ 8 Ω, High gain	128	

DNR	Dynamic range BTL	Unweighted 800 W @ 8 Ω , Medium gain	131	dB
		Unweighted 800 W @ 8 Ω , High gain	126	
$SINAD_{SE}$	Signal to noise and distortion	A-weighted 5 W @ 4 Ω Medium gain	111	dB
		A-weighted 5 W @ 4 Ω High gain	106	
		Unweighted 5 W @ 4 Ω Medium gain	109	
		Unweighted 5 W @ 4 Ω High gain	104	
$SINAD_{BTL}$	Signal to noise and distortion	A-weighted 10 W @ 8 Ω Medium gain	114	dB
		A-weighted 10 W @ 8 Ω High gain	109	
		Unweighted 10 W @ 8 Ω Medium gain	112	
		Unweighted 10 W @ 8 Ω High gain	107	

Table 15: General audio specifications

[1)]With configuration shown in Figure36

8.3.1 Asymmetrical Loading

It is also possible to load one channel with for example 4 Ω or 3.5 Ω and the other channel with 8 Ω. This can be used to provide power to a low/midrange driver while still having enough power to drive a high frequency driver.

8.4 Control, Status and supervision

Symbol	Parameter	Comment	Min	Typ	Max	Unit
$V_{control}$	Control input voltage range		0		20	V
$V_{control\_low}$	Control input low signal				0.8	V
$V_{control\_high}$	Control input high signal		3			V
$Z_{control}$	Control input impedance	Internal pull down		39		kΩ
V_{status}	Status output voltage range	Open drain, external pull up	0		20	V
V_{status_low}	Status output low	I_{out} = 1mA		0.5		V
I_{status}	Status output sink current		0		20	mA
Z_{status}	Status output series impedance			240		
$Vstart_{VD-VS}$	Rising voltage threshold for start of module	Measures between VD and VS		76		V
$Vstop_{VD-VS}$	Falling voltage threshold for stop of module	Measures between VD and VS		70		V
$Vstart_{VDD-VSS}$	Rising voltage threshold for start of module	Measures between VDD and VSS		19.0		V
$Vstop_{VDD-VSS}$	Falling voltage threshold for stop of module	Measures between VDD and VSS		18.2		V
$Vstart_{Vdrive}$	Rising voltage threshold for start of module	Measures between VDrive and VS		9.5		V
$Vstop_{Vdrive}$	Falling voltage threshold for stop of module	Measures between VDrive and VS		8.5		V
$V_{dc-protect}$	Positive DC-protect activation threshold	Positive DC voltage on output referenced to GND		9.0		V
$V_{dc-protect}$	Negative DC-protect activation threshold	Negative DC voltage on output referenced to GND		-9.0		V
$V_{overvoltage}$	Vd shutdown voltage referenced to GND			74.2		V
$V_{restart}$	Vd restart voltage referenced to GND			73.8		V
$V_{overvoltage}$	Vs shutdown voltage referenced to GND			73.8		V
$V_{restart}$	Vs restart voltage referenced to GND			73.4		V

Table 16: Control, Status and protection specifications

8.5 Timing

For detailed description of the below listed timing values, please consult Section 12 in this datasheet.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$t_{Supply-Audio-set}$	Time from all supplies[1)] are good to amplifier output is enabled	Po = 0W		170		ms
$t_{Supply-Audio-hold}$	Supply input – audio output hold time	Po = 0W		12		ms
$t_{Amp-Disable-set}$	Time from AmpDisable is pulled High (active) to amplifier output is disabled	Po = 0W		40		us
$t_{Amp-Enable-release}$	Time from AmpDisable is pulled low (not active) to amplifier output is enabled	Po = 0W		170		ms
$t_{Amp-Protect-recovery}$	Amplifier Protect Recovery			3		s

Table 17: Timing specifications

[1)] VD/VS, VDD/VSS then Vdrive

9. Mechanical Specification

9.1 Dimensions

Symbol	Parameter	Condition	Min	Typ	Max	Unit
L	Module length			100		mm
W	Module width			80		mm
H	Module height			33		mm
Mass	Weight			177		g
H	Mounting hole depth Heatsink base plate	M3 threads on heatsink base plate		6.0	8	mm
T	Mounting torque	M3 threads on heatsink base plate		0.6		Nm

Table 18: Mechanical dimensions

9.2 3D-View

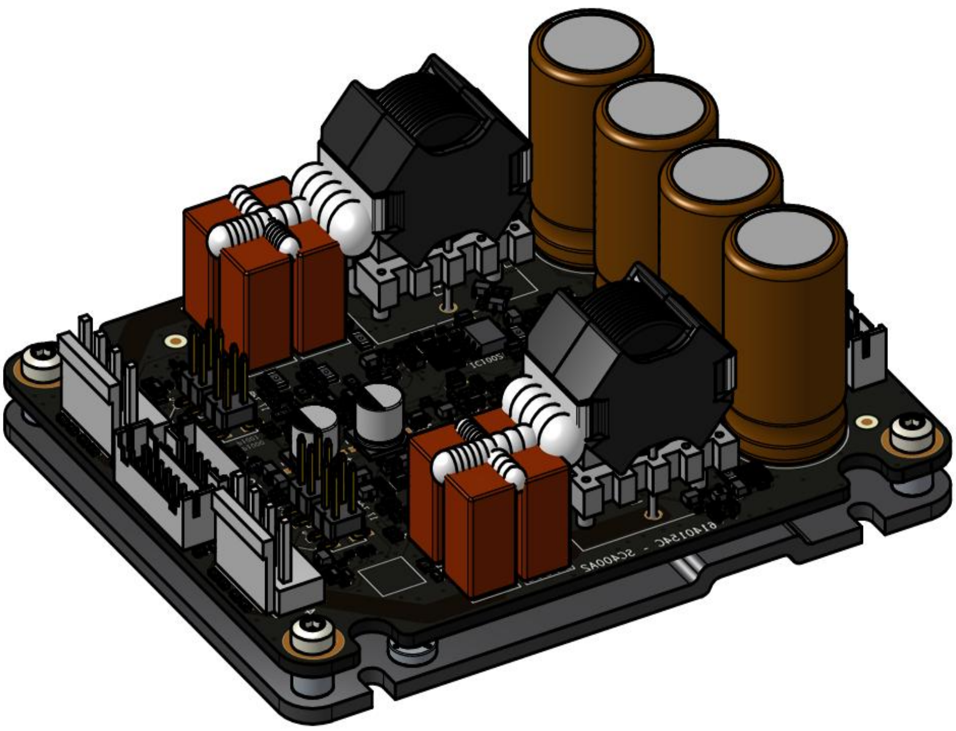


Figure 3: ICEpowerSC400A2 3D-View

9.3 Mounting holes

The ICEpowerSC400A2 module is designed with a heat sink base plate which has threaded holes for mounting in a chassis.

When choosing screws for mounting, the length must be chosen to not reach the bottom side of the PCB as well as the specified mounting torque, both specified in Section 9.1

Drill Pattern (all dimensions are in mm):

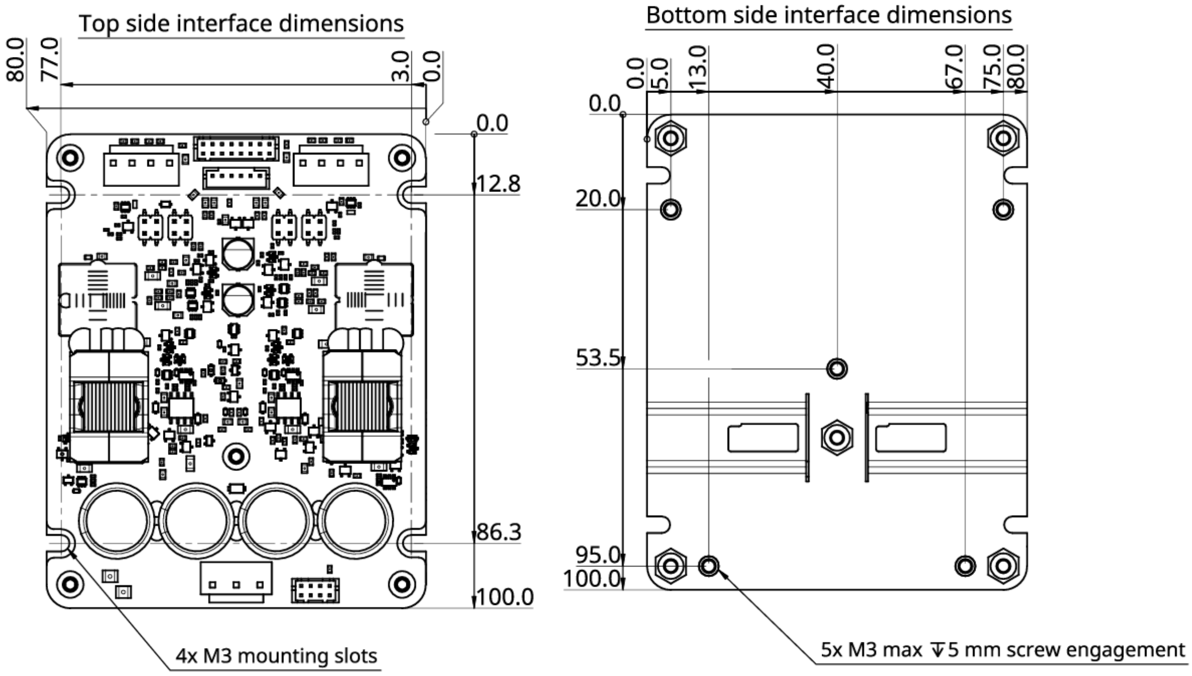


Figure 4: ICEpowerSC400A2 Top view bottom side mounting holes and Bottom view showing 5 bottom mounting holes.

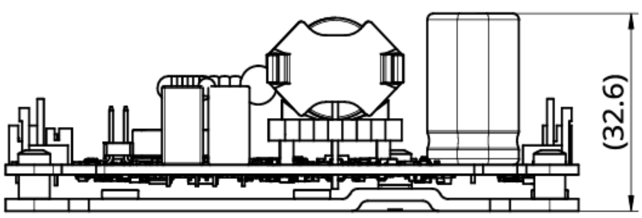


Figure 5: ICEpowerSC400A2 Side view.

9.4 Environmental Specifications

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$T_{operating}$	Ambient temperature, operating	End-customer use cases	-10		50[1)]	°C
$T_{storage}$	Ambient temperature, storage	End-customer use cases	-40		70	°C
T_{shelf}	Ambient temperature, shelf	Storage before goods sold to end-customer	0		60	°C
RH	Relative humidity	Non-condensing Operating and storage			85	%
	Altitude, operating				2000	m

Table 19: Environment specifications

[1)] For safety test at 50 °C ambient with 1/8 power (2x400W/8=2x50W in 4 Ω), the module requires additional cooling in terms of, for example, the module being mounted on a large aluminum surface as the bottom of a chassis.

10. Typical Performance Characteristics SE

Unless otherwise specified:

- One channel driven, all channels enabled.
- f = 1 kHz, T_a = 25 °C, R_L = 4Ω, VD/VS=±69V, VDD/VSS =±12V, Vdrive = VS+12V
- Audio Precision AUX0025 passive class-D filter and AES17 20 kHz 7th order measurement filter.
- ICEpowerSC400A2 mounted on heatsink baseplate horizontally on plain surface.

10.1 Frequency Response

Conditions: Measurement bandwidth 250 kHz, Vo=2Vrms (1Wrms@4Ω)

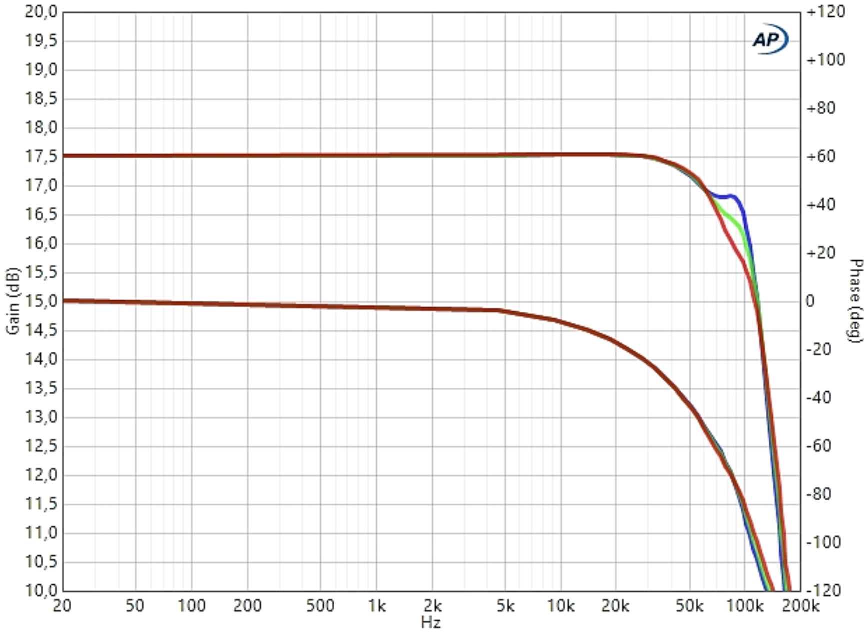


Figure 6: Gain vs frequency 4 Ω (blue), 8 Ω (green), and open circuit (red), @medium gain 17.7dB

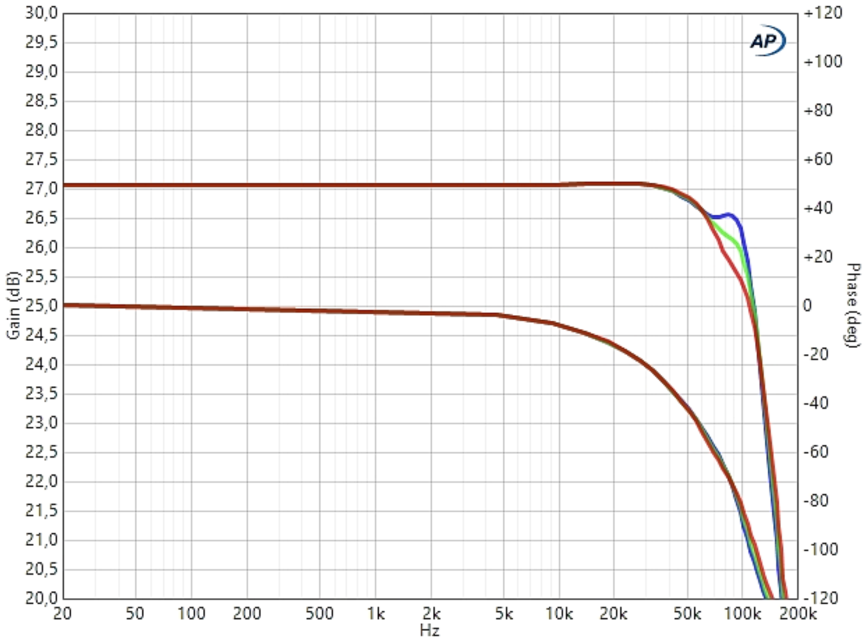


Figure 7: Gain vs frequency 4 Ω (blue), 8 Ω (green), and open circuit (red), @high gain 27.2dB

10.2 Total Harmonic Distortion + Noise

Conditions: The frequency 6.67 kHz corresponds to the worst-case scenario where both 2nd and 3rd harmonics are within the audio band.

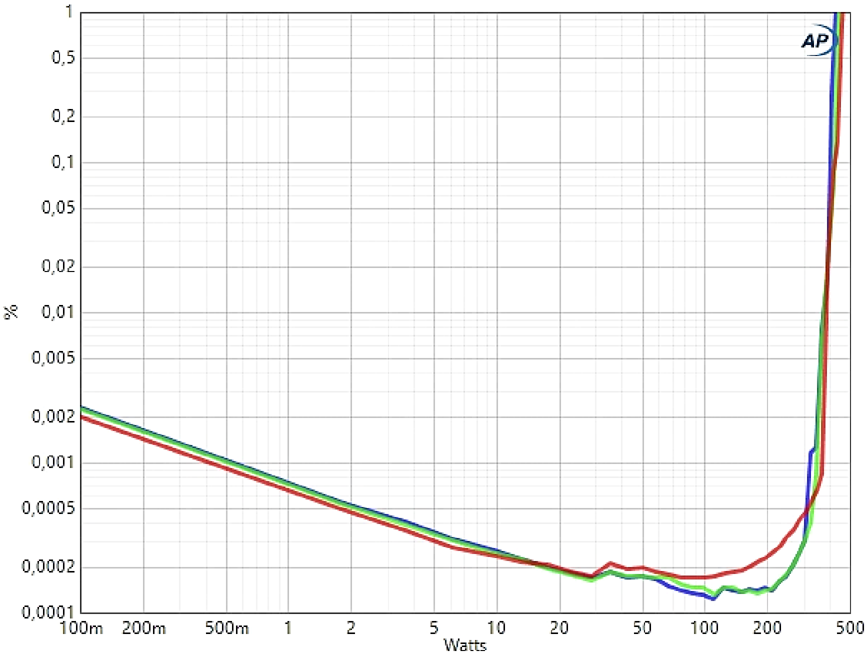


Figure 8: THD+N vs. Po SE @ 100Hz (blue), 1kHz (green), 6.67kHz (red), RL=4 Ω, @medium gain 17.7dB

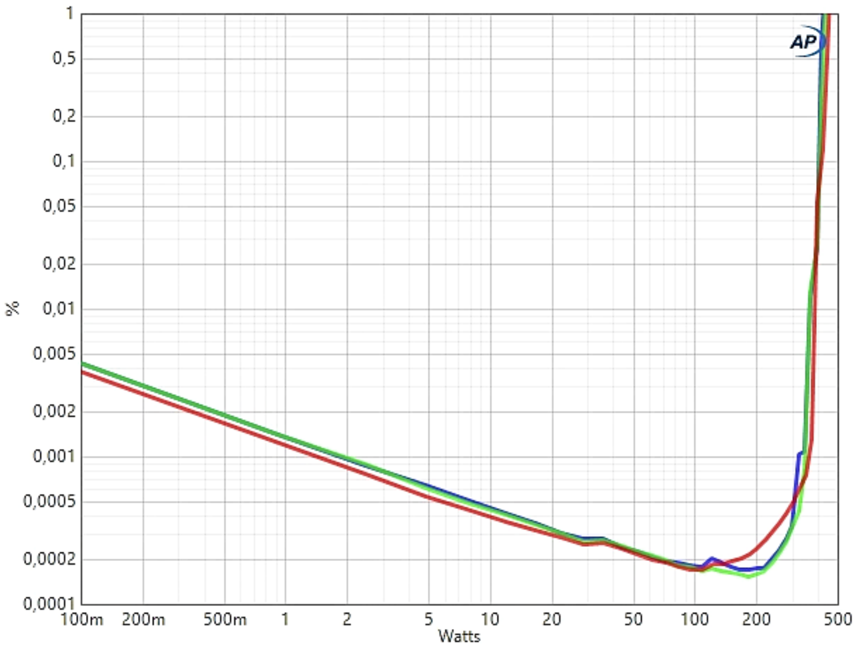


Figure 9: THD+N vs. Po SE @ 100Hz (blue), 1kHz (green), 6.67kHz (red), RL=4 Ω, @high gain 27.2dB

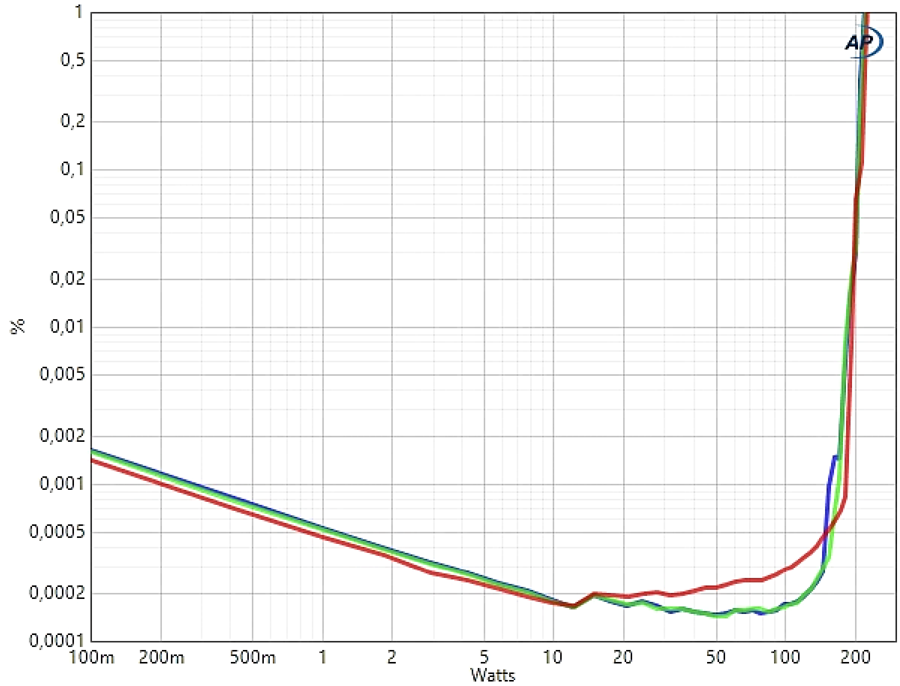


Figure 10: THD+N vs. Po W @ 100Hz (blue), 1kHz (green), 6.67kHz (red), RL=8Ω, @medium gain 17.7dB

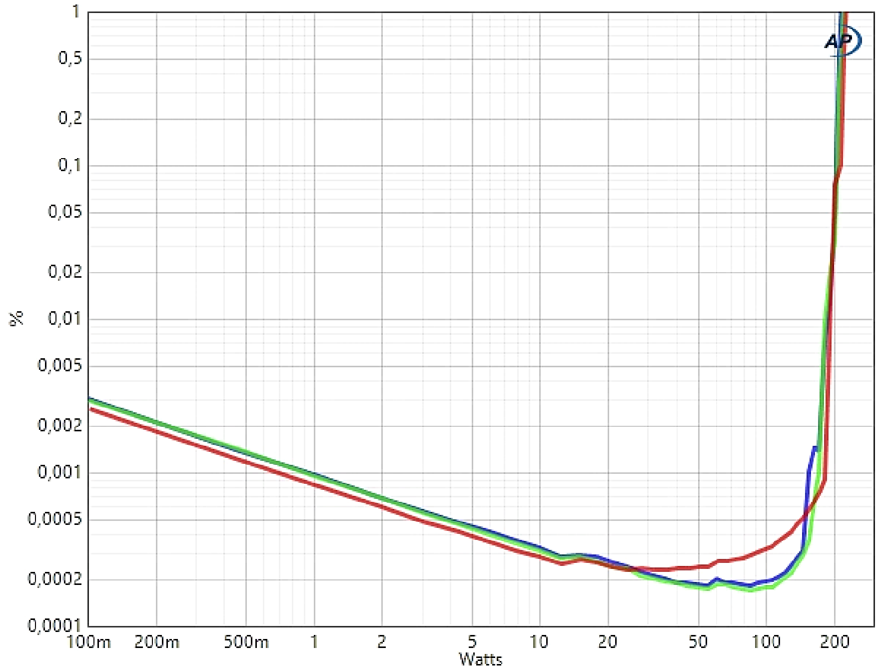


Figure 11: THD+N vs. Po W @ 100Hz (blue), 1kHz (green), 6.67kHz (red), RL=8Ω, @high gain 27.2dB

10.3 Idle Noise

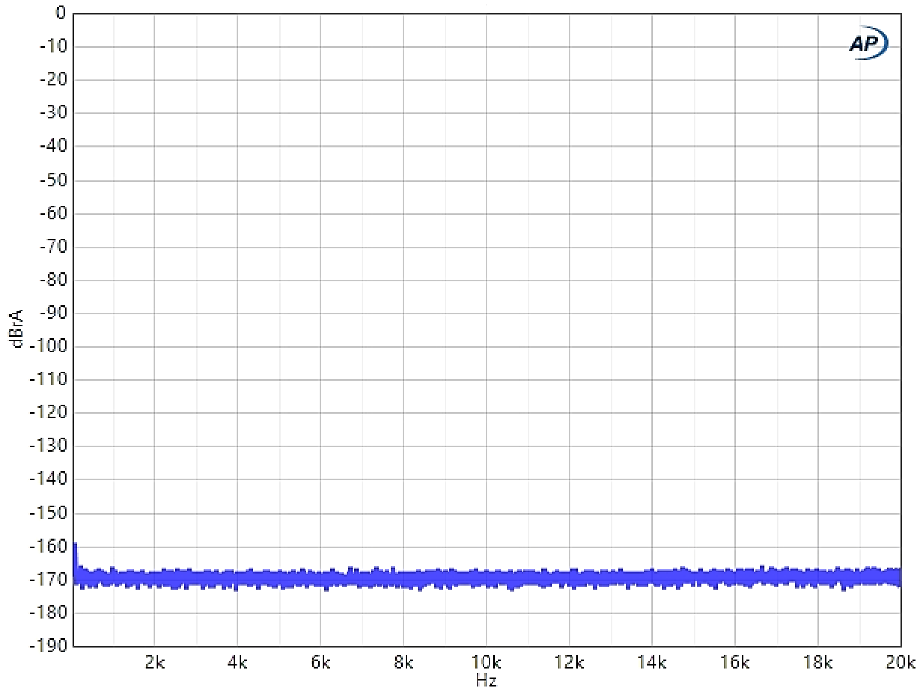


Figure 12: Idle noise (64K FFT), RL = 4 Ω (Relative to 400 W), @medium gain 17.7dB

10.4 Intermodulation Distortion

Conditions: The selected CCIF signal is equal amplitude 18 kHz and 19 kHz. Dual tone intermodulation spectrum, 0 – 20 kHz @ 0 dB = 400 W / 4 Ω

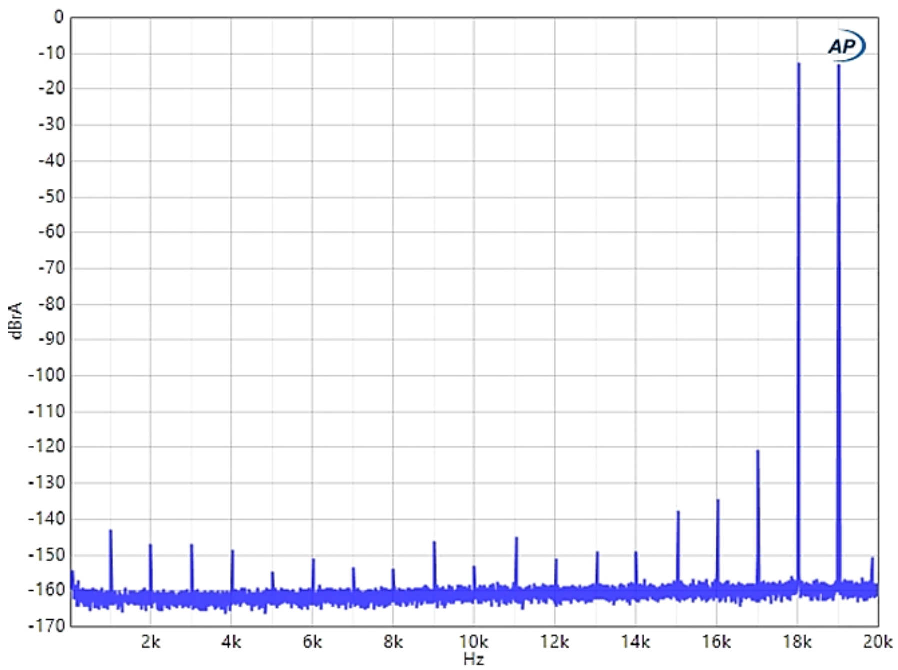


Figure 13: CCIF vs. Po, RL=4Ω, f1=18kHz, f2=19kHz, @medium gain 17.7dB

10.5 Crosstalk

Conditions: Po=50 W, RL= 4 Ω Audio Precision AUX-0025 passive class-D filter and Audio Precision AES17 20 kHz 7th order measurement filter are used for measurements. Both channels active/enabled during all measurements, only input signal is switched.

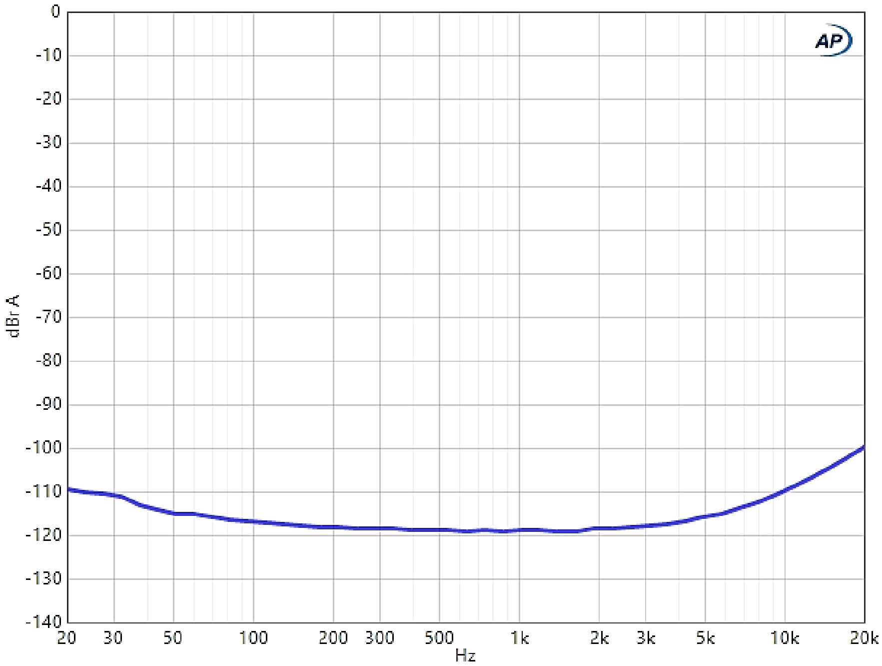


Figure 14: Crosstalk Ch1 vs Ch2 @ 50W into 4Ω, @medium gain 17.7dB

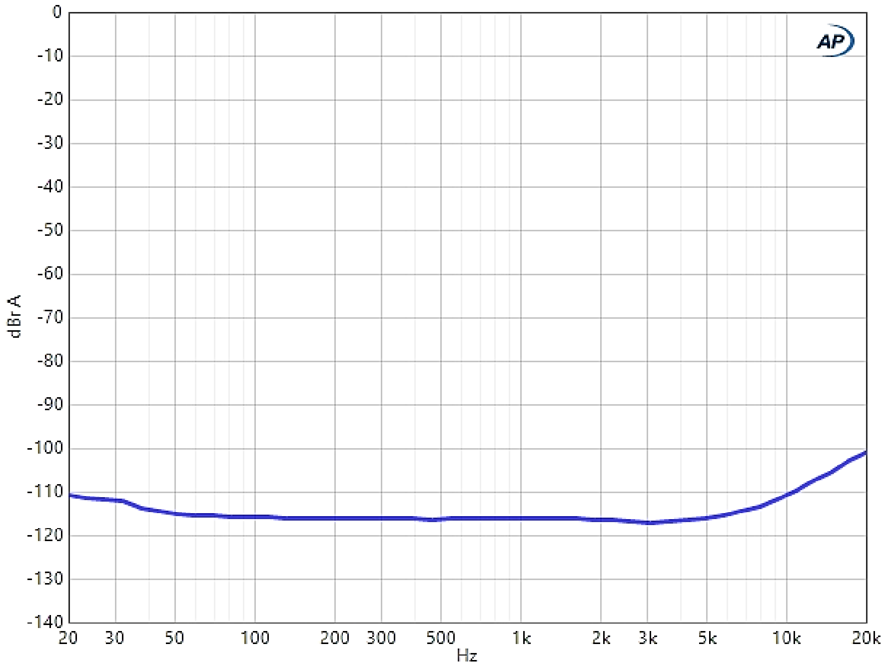


Figure 15: Crosstalk Ch2 vs Ch1 @ 50W into 4Ω, @medium gain 17.7dB

10.6 Output Impedance

The output impedance is measured by feeding 1ARMS 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 at the terminals on the PCB.

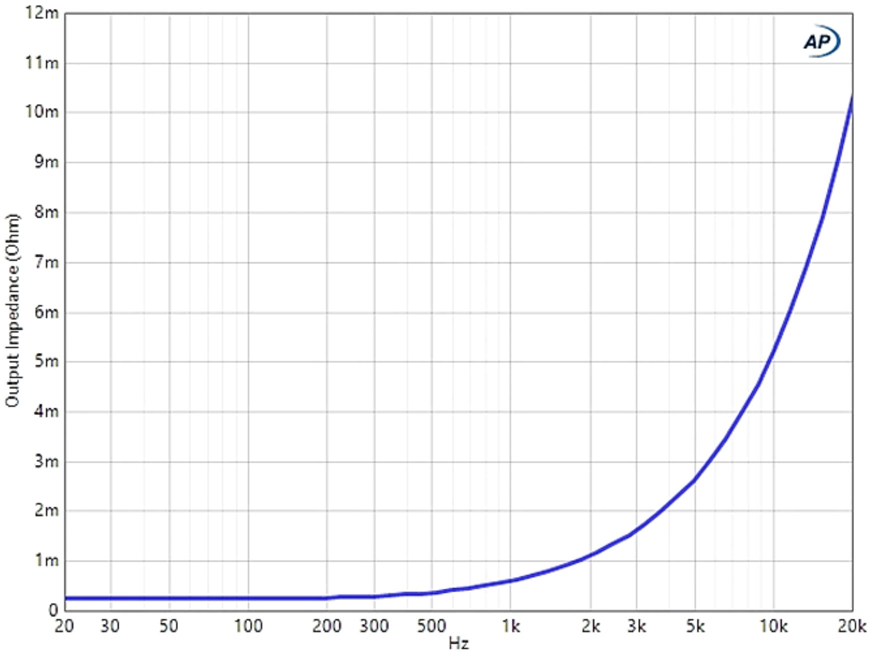


Figure 16: Output Impedance Amplitude 1mV=1mΩ, @medium gain 17.7dB

10.7 Damping Factor

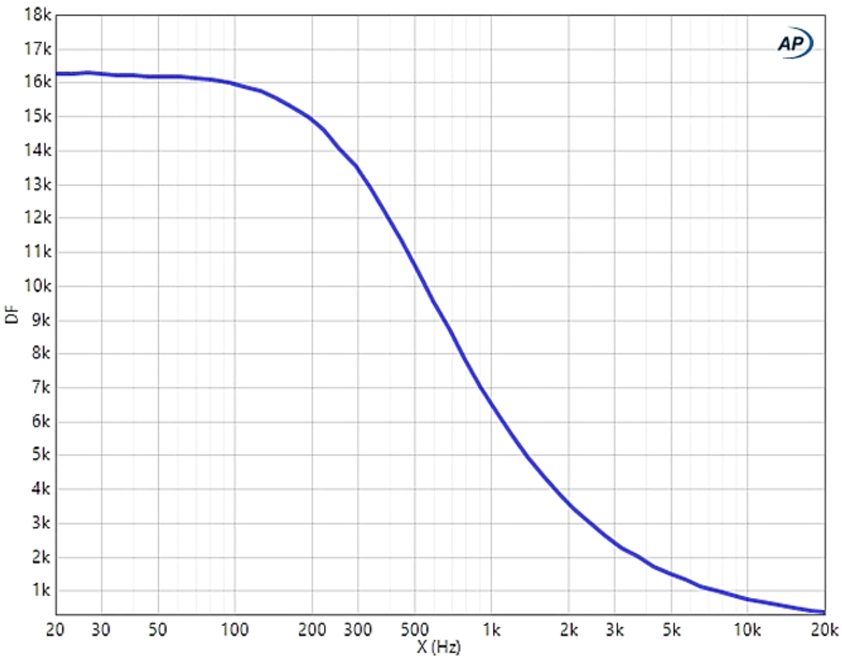


Figure 17: Damping factor in 4 Ω, @medium gain 17.7dB

10.8 Output Power vs. Rail Voltage supplies

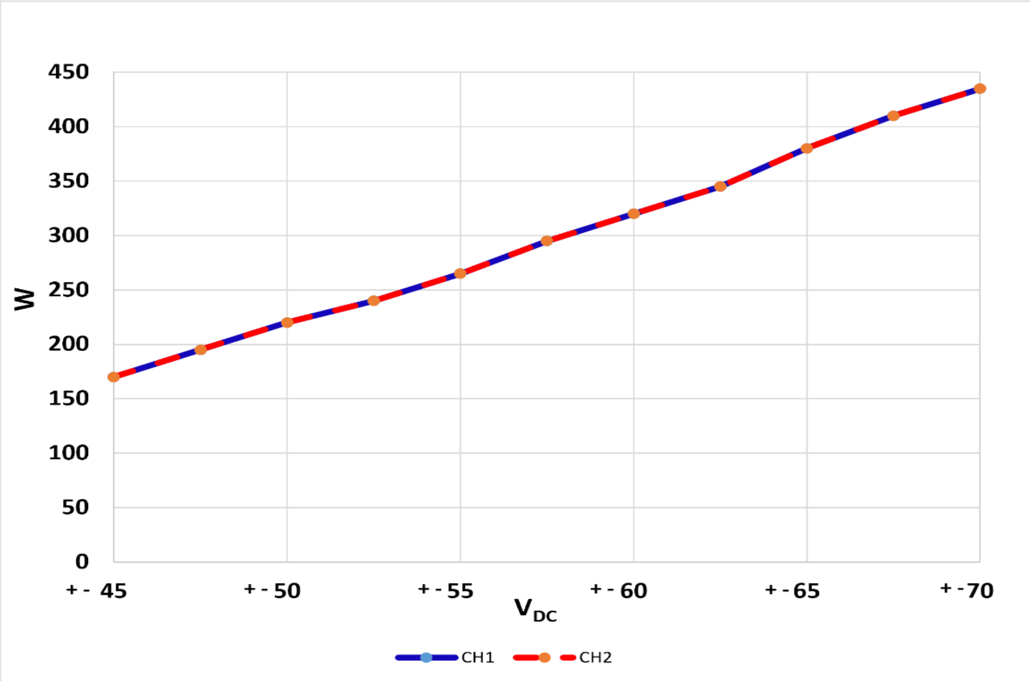


Figure 18: Output power @ 4Ω and 1 % THD+N vs. rail Voltage, 2 ch driven, CH1 (blue) CH2 (red-dashed), 1kHz, @medium gain 17.7dB

10.9 Power Efficiency

Module efficiency when driving both channels with 4Ω load. All supplies are included. This is identical to driving an 8Ω load in BTL.

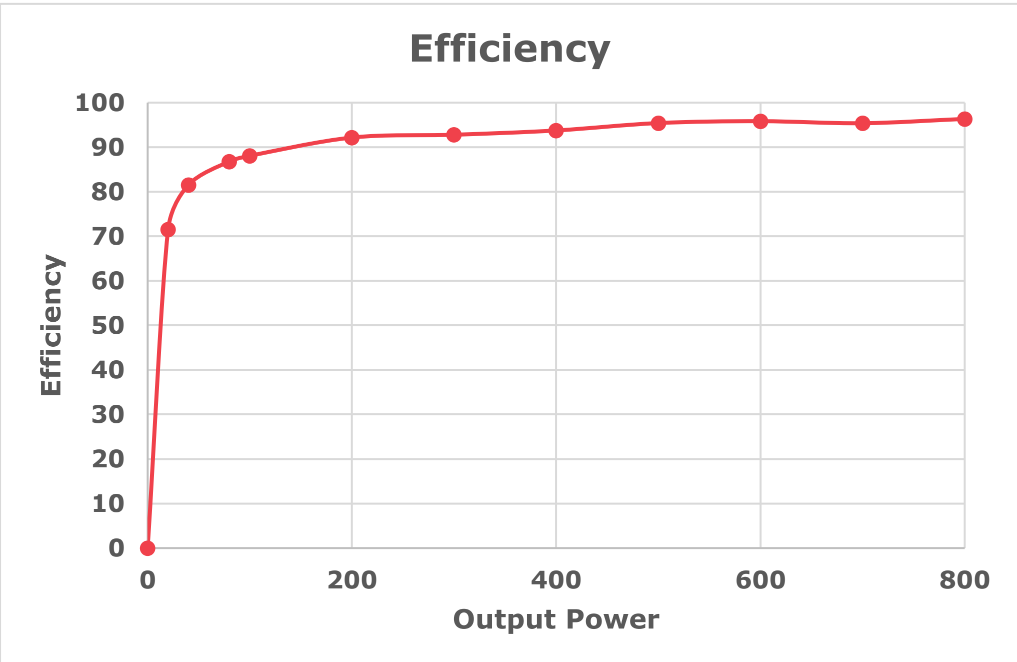


Figure 19: Efficiency, 2ch driven, 4Ω load

11. Typical Performance Characteristics BTL

Unless otherwise specified:

- f = 1 kHz, T_a = 25 °C, R_L = 8Ω, VD/VS=±69V, VDD/VSS =±12V, Vdrive = VS+12
- Audio Precision AUX0025 passive class-D filter and AES17 20 kHz 7th order measurement filter.
- ICEpowerSC400A2 mounted on heatsink base plate horizontally on plain surface.

11.1 Frequency Response

Conditions: Measurement bandwidth 250 kHz, Vo=3.68Vrms (1.7Wrms@8Ω)

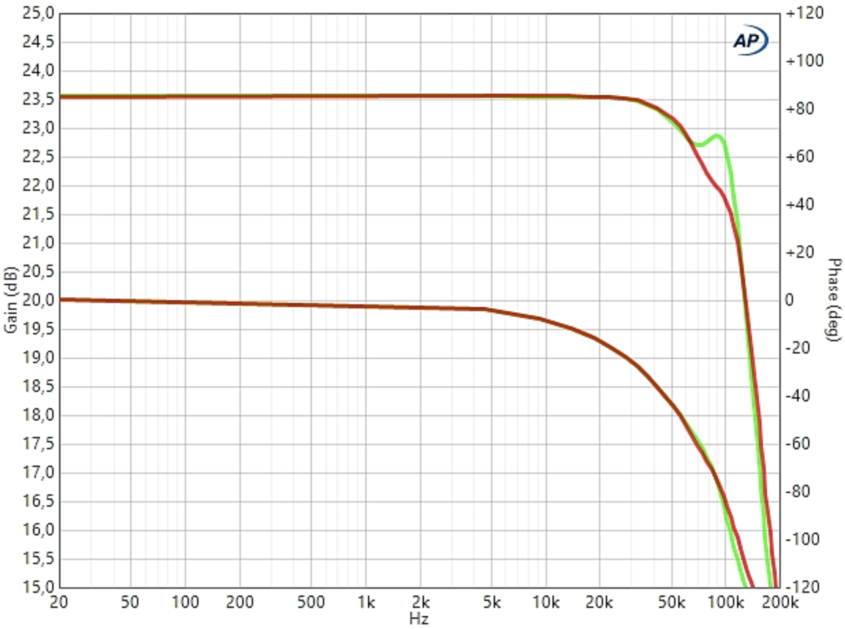


Figure 20: Gain vs frequency 8 Ω (green), open circuit (red), @medium gain 17.7dB

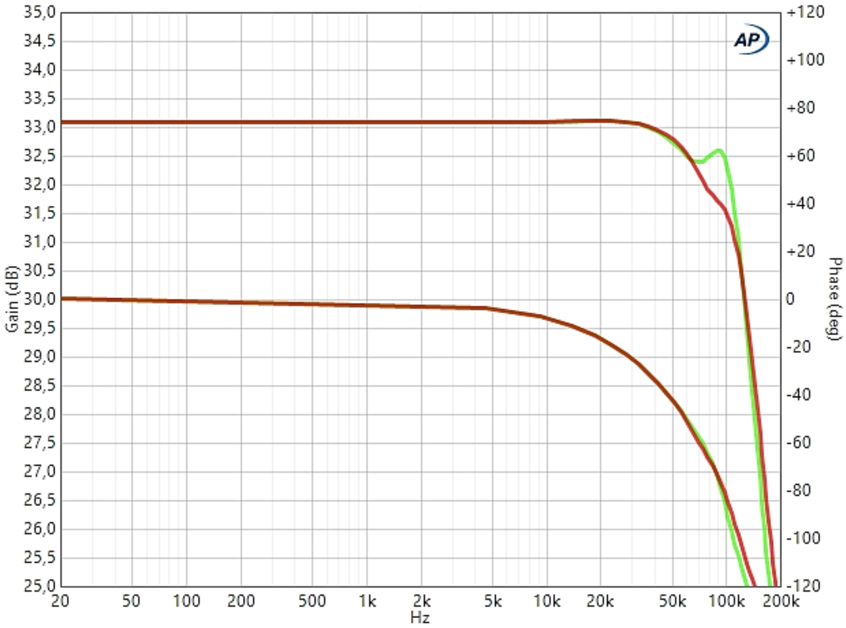


Figure 21: Gain vs frequency 8 Ω (green), open circuit (red), @high gain 27.2dB

11.2 Total Harmonic Distortion + Noise

Conditions: The frequency 6.67kHz corresponds to the worst-case scenario where both 2nd and 3rd harmonics are within the audio band. 100Hz (blue), 1kHz (green) and 6.67kHz (red).

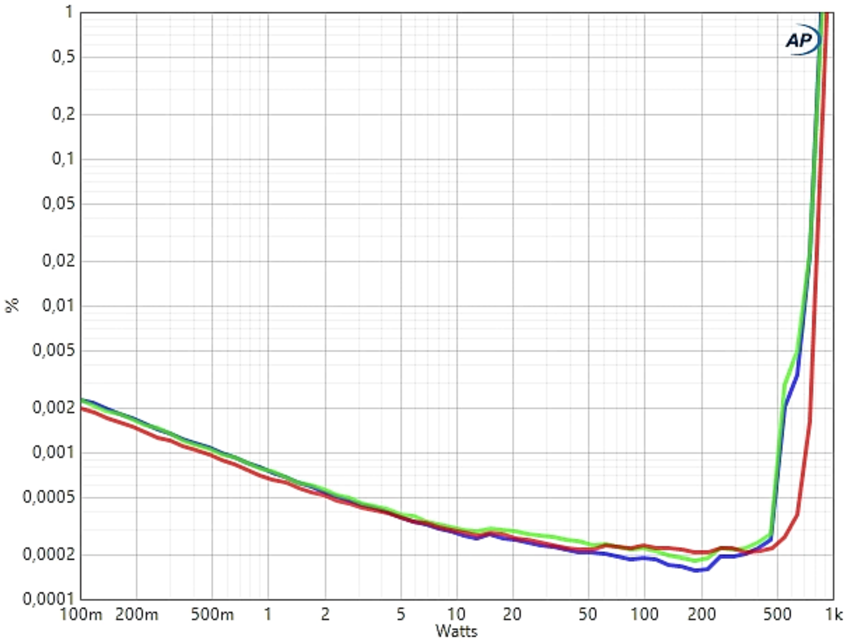


Figure 22: THD+N vs Po BTL @ 100Hz, 1kHz, 6.67kHz, RL=8 Ω, @medium gain 17.7dB

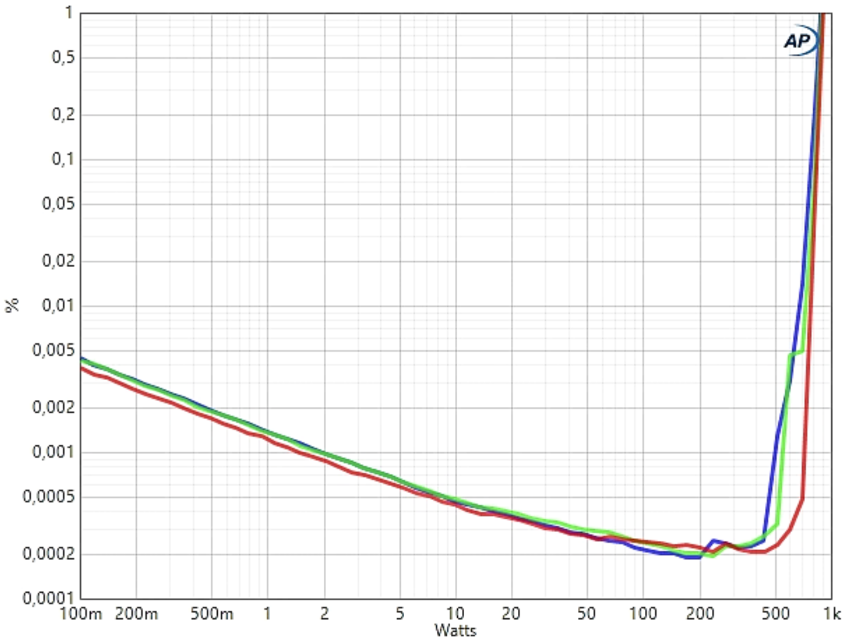


Figure 23: THD+N vs Po BTL @ 100Hz, 1kHz, 6.67kHz, RL=8 Ω, @medium gain 27.2dB

11.3 Idle Noise

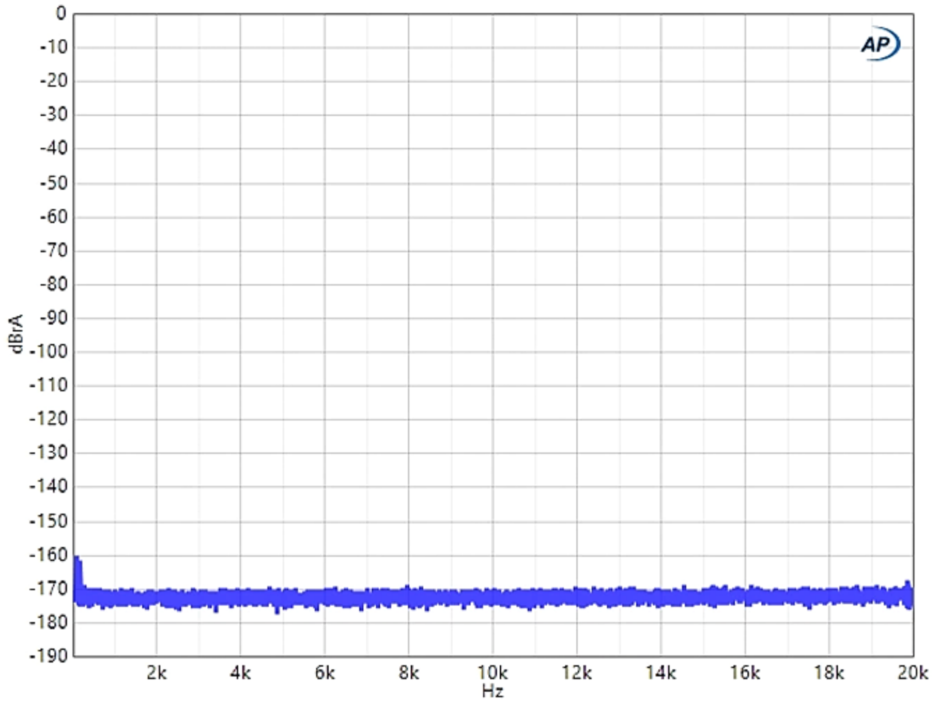


Figure 24: Idle noise (64K FFT). RL = 8 Ω (Relative to 800 W into 8 Ω), @medium gain 17.7dB

11.4 Intermodulation Distortion

Conditions: The selected CCIF signal is equal amplitude 18kHz and 19kHz. Dual tone intermodulation spectrum, 0 – 20 kHz @ 0 dB = 800 W / 8 Ω

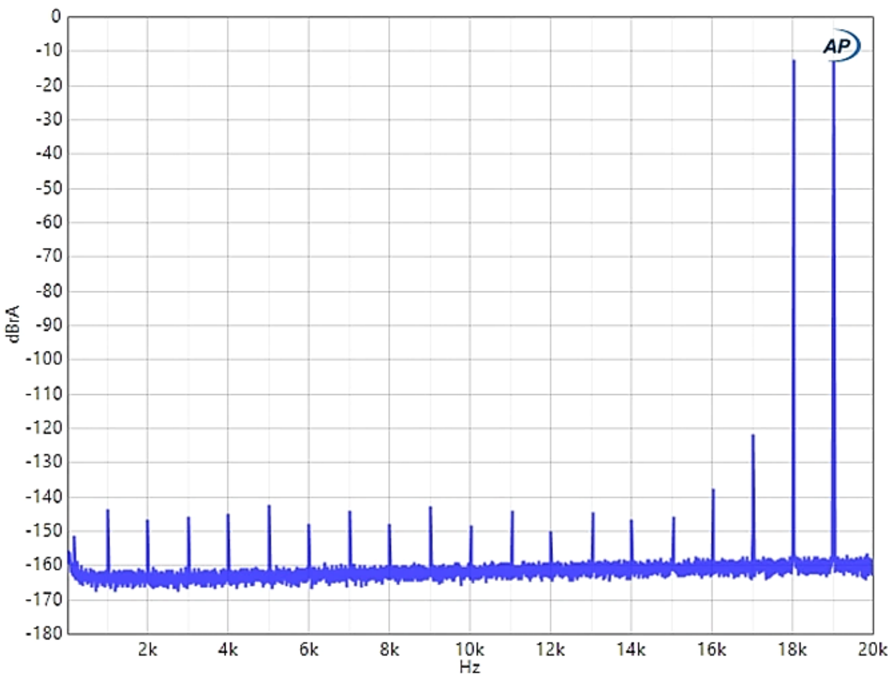


Figure 25: CCIF vs Po, R_L=8Ω, f_1=18kHz, f_2=19kHz, @medium gain 17.7dB

11.5 Output Impedance

The output impedance is measured by feeding 1ARMS 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 at the terminals on the PCB

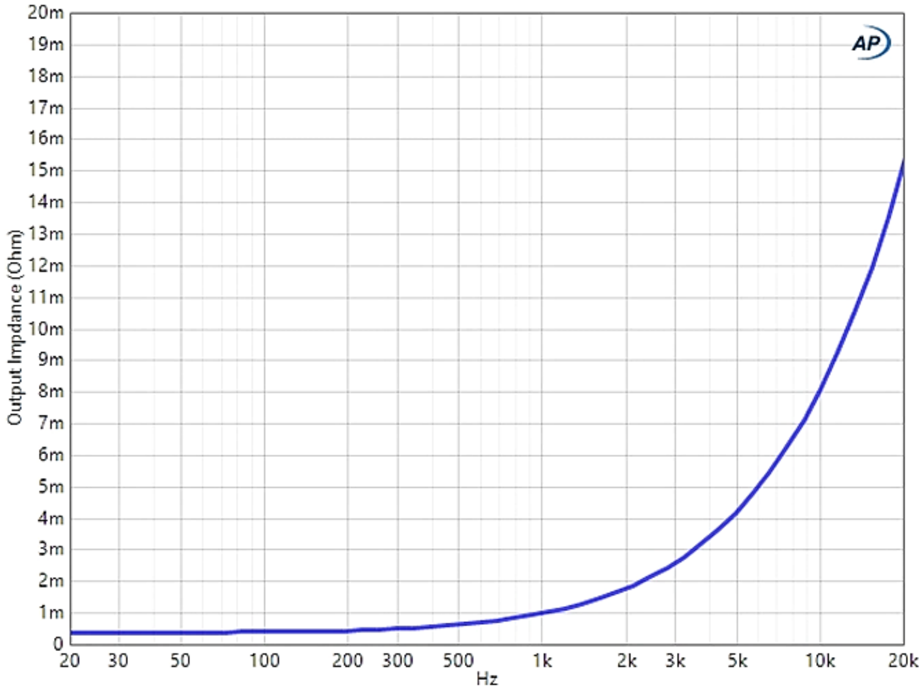


Figure 26: Output Impedance BTL, @medium gain 17.7dB

11.6 Damping Factor

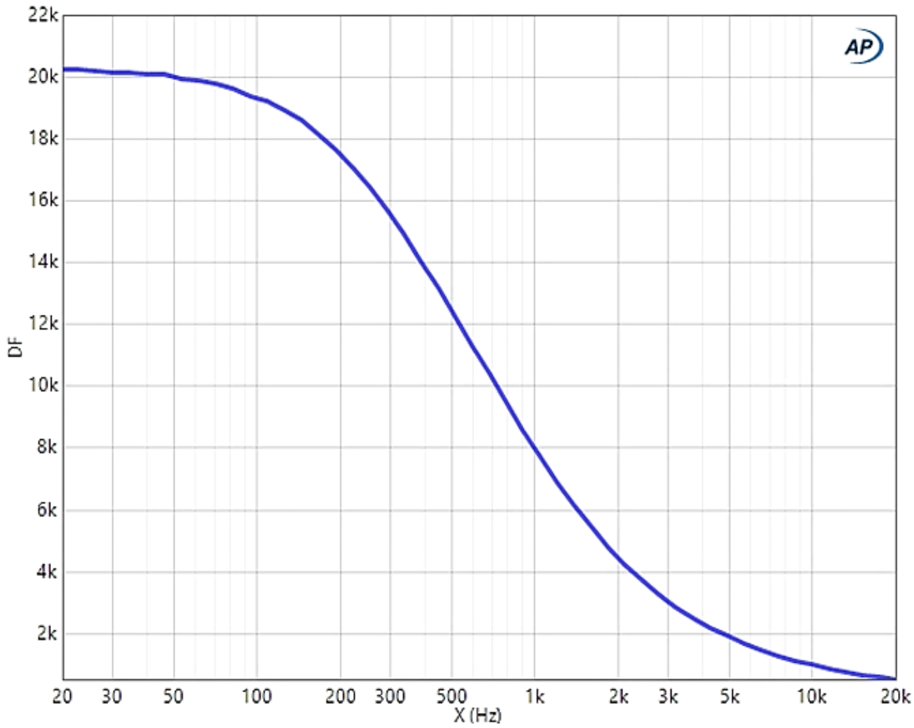


Figure 27: Damping factor in 8 Ω BTL, @medium gain 17.7dB

12. Functional Description

ICEpowerSC400A2 will start operating when power is applied to the module and therefore no special control is needed for simple applications. For more advanced applications, control, status and monitoring inputs and outputs are available through a connector following a selection of the ICEpower standard interface definition.

In the following subsections, a description is given for all ICEpowerSC400A2 features organized by the connector in which the corresponding input or output is located.

12.1 Audio Input

The ICEpowerSC400A2 is equipped with a simple four resistor differential receiver with 0.1% thin film resistors to maximize common mode rejection. This can be used in a system where cables are short and sending impedances are known, for example inside a chassis with a separate pre-amp board. In sending signals using long cables it is recommended to use input buffers with identical output resistors to get good common mode noise rejection. Any resistance in series with the input signal to the SC400A2 will also affect the gain of the module. See more details in section 13.

The audio inputs can be used in both a semi-balanced input configuration and in a fully balanced configuration. In semi-balanced configuration, it is recommended to connect the non-inverting input to a single ended signal source and use the inverting input as ground sense on the signal source ground reference but make sure to match the sending impedances. In both semi-balanced and in fully balanced configuration, the signal ground should 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 value 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 31 in Section 13.

The two audio signal inputs share the same connector on the SC400A2 module.

12.2 Pre clipper

A discrete, differential pre clipper compares the input signal to the VD/VS rail voltages and clips the input signal in order to limit the output voltage to 87% of the rail voltages.

12.3 Loudspeaker Outputs

The loudspeaker output of the SC400A2 is an unbalanced output capable of driving complex speaker loads. Bridging of the two channels is possible.

The loudspeaker output is 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.

12.4 Power Supply Input

All power lines should be connected before powering the ICEpowerSC400A2. First VD/VS and VDD/VSS then Vdrive. After all power supplies are applied to the SC400A2, the module will settle for 170ms and start operating accordingly. If the module controls are left unconnected, the module will start normal operation without further action.

The power up and power down timing is shown in Figure 28 and specific timing values are available in Section 8.5

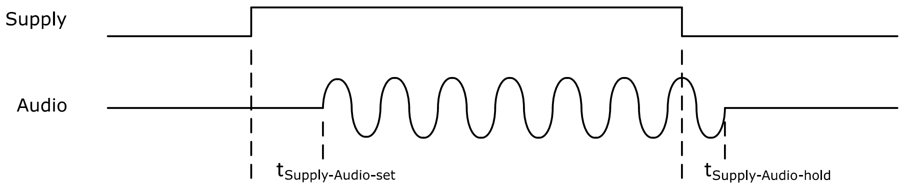


Figure 28: Power up timing after all supplies (VD, VS, and all aux supplies) are good to amplifier starts switching

12.5 Basic Control and Status

The Basic Control connector and Auxiliary Supply connector for e.g., a signal front-end PCB and the following features:

- AmpDisable
- Vmon1 and Vmon2
- Protect
- Clip1 and Clip2
- DCerror

The recommended connection to the control input and status outputs are shown on Figure 31 and Figure 32 in Section 13.

12.5.1 AmpDisable Input

The AmpDisable input shuts down the ICEpowerSC400A2 amplifier section when pulled high. An internal pull down ensures normal operation if the AmpDisable input is left unconnected.

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

Timing of the AmpDisable inputs shown in Figure 29 and specific timing values are available in Section 8.5.

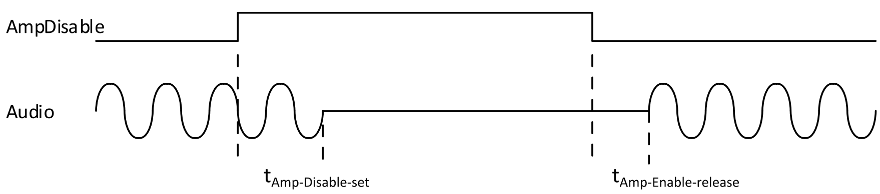


Figure 29: Standby and AmpDisable timing

Advanced pop and click reduction mechanisms are built into the SC400A2 leaving almost no audible artefacts when the AmpDisable input is used.

12.5.2 Vmon1 and Vmon2 output

Analog voltage divider high impedance output
Analog voltage divider connected to the output of the power stage. This serves as a high impedance output to monitor the output voltage.

12.5.3 Protect output

In case of potentially destructive overload situations, the SC400A2 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.
- Over-temperature errors in the module.
- DC error
- Vd-Vs supply overvoltage conditions

In the first two cases, the SC400A2 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.

The Protect output is an open-drain output pulled high by external pull-up resistors. Interface schematics can be found in Section 13.3

Timing of the protection events are shown in Figure 30 and specific timing values are available in Section 8.5.

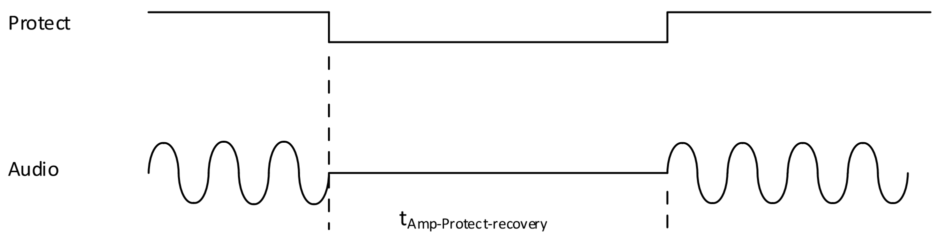


Figure 30: Amplifier Protect recovery

12.5.4 Clip1 and Clip2 output

The Clip output is a multi-purpose output indicating:

- Audio signal voltage clipping
- Audio signal current limiting

The Clip1 and Clip2 outputs are audio signal clipping indicators, one per channel. Clipping is indicated by a low on the Clip1 and Clip2 for channel 1 and 2 respectively. The clipping outputs stays low for the full duration of clipping in the audio signal.
The Clip output is an open drain output pulled high by external pull-up resistors. Interface schematics can be found in Section 13.3

12.5.5 DCerror output

The DC Error is an output indicating DC on the output. The module will shut down and send a shutdown signal to the power supply.

The DC Error output is an open drain output pulled high by external pull-up resistors. Interface schematics can be found in Section 13.3

13. Interface Schematics

In the following sub-sections, proposed interface schematics are shown. These schematics should be considered as assistance to the design process, and they represent the recommended interface to the SC400A2 module.

13.1 Audio Input

Generic interface for fully differential use of analog inputs.

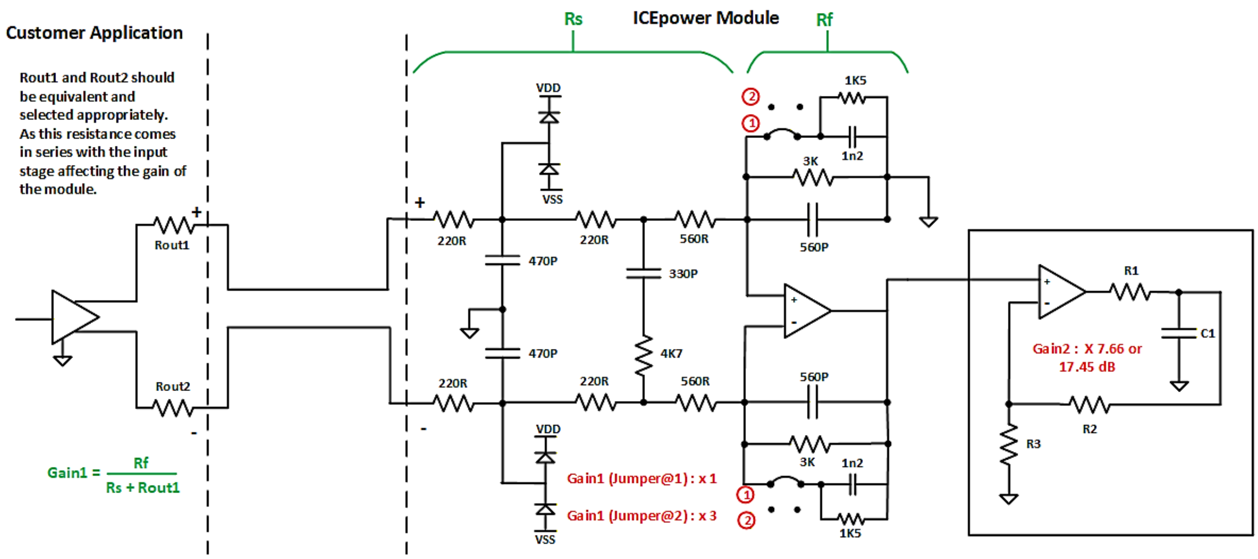


Figure 31: Fully balanced audio input interface schematics

Generic interface for semi-balanced use of the analog input.

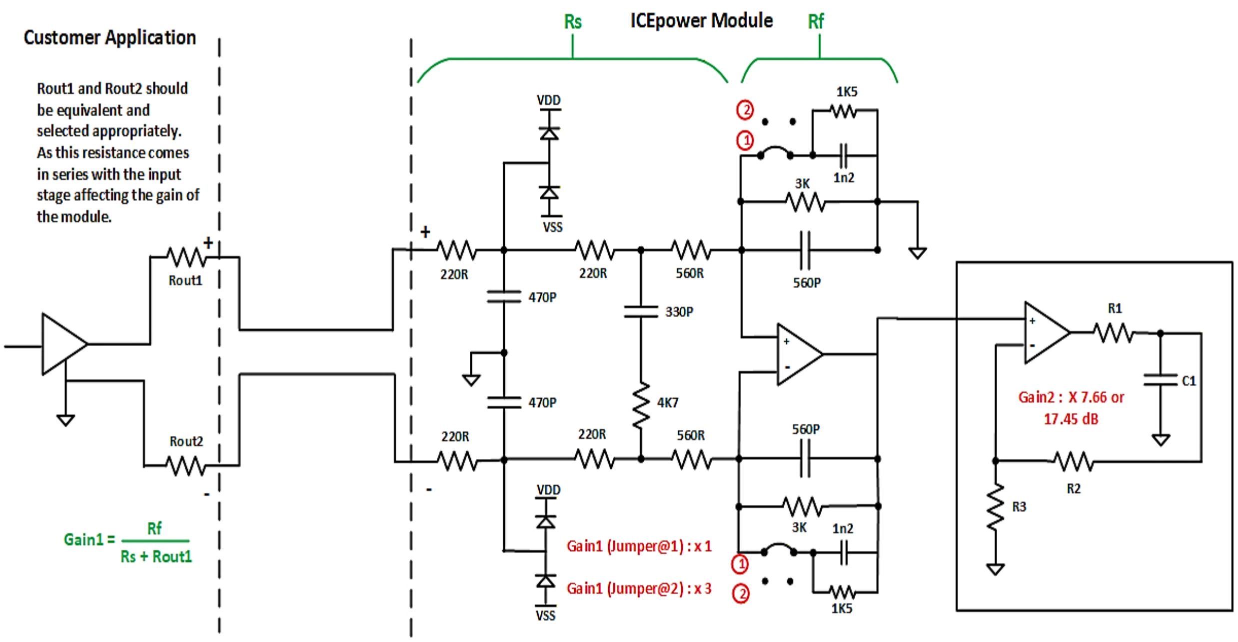


Figure 32: Semi-balanced audio input interface schematics

13.2 Control Input

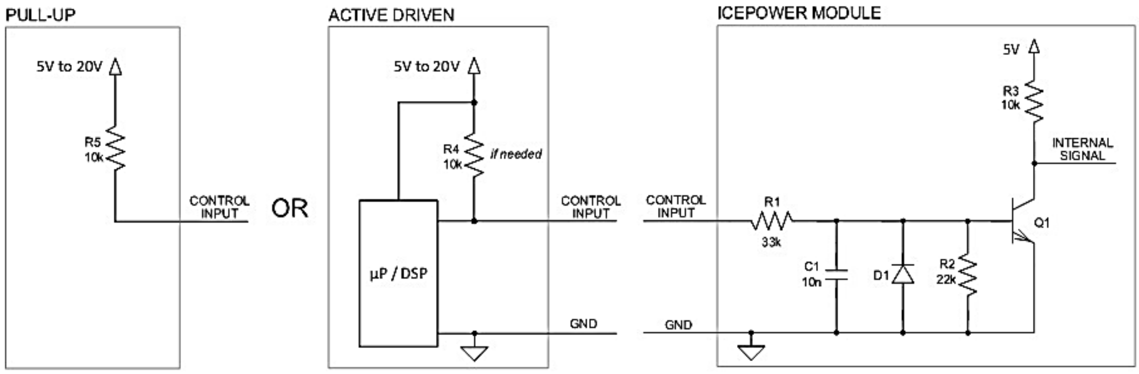


Figure 33: Recommended control input interface schematics

13.3 Status Output

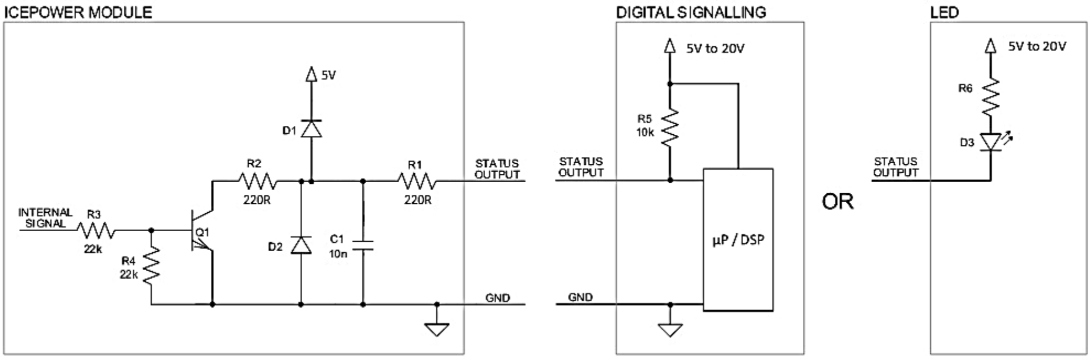


Figure 34: Recommended status output interface schematics

14. Integration Guidelines

The SC400A2 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.

14.1 Grounding Scheme

Depending on the complexity of the end-product several grounding schemes can be used. An example of the grounding scheme usable on the SC400A2 module is shown for a simple setup including a front-end PCB and PSU.

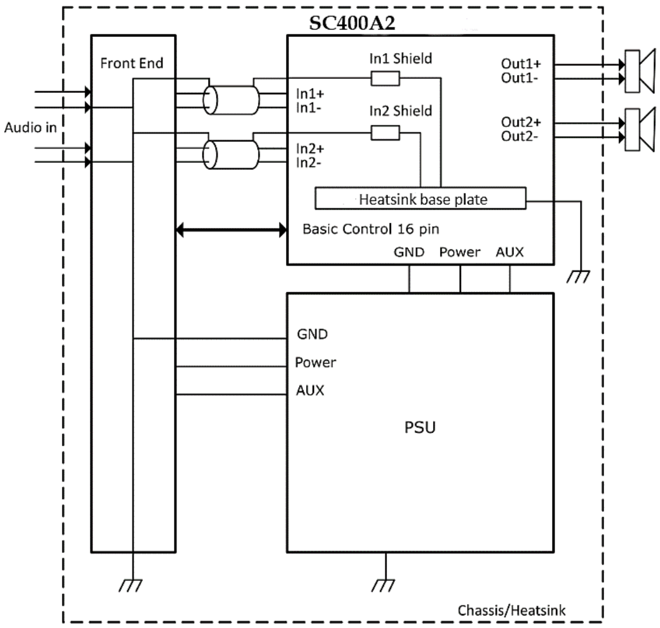


Figure 35: Typical grounding configuration

The low value series resistor included in the signal shield connection prevents ground loops between the SC400A2 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 connector to the chassis but to have them grounded on the front-end PCB.

14.2 BTL configuration

In BTL mode invert the two inputs shall be connected in parallel i.e. + to - and – to +. With this input for Ch2 is inverted.

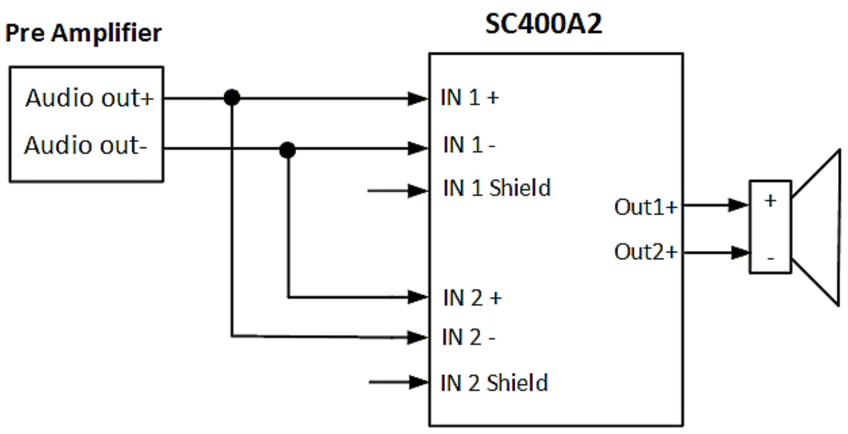


Figure 36: ICEpowerSC400A2 BTL block diagram

The BTL output is taken between the two outputs carrying signals, this means pin no.1, 2 on connector P7 and pin no. 1, 2 on connector P8.

14.3 EMC Management

As described in Section 1, the ICEpowerSC400A2 module is EMC pre-approved as is when mounted on a standard aluminum open back plate. 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 mounting holes to the chassis as described in section 9.3 . Mounting of the module isolated from the chassis may cause increased 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.

- Do not route cables near magnetic components on the module e.g., inductors and transformers.
- Do not bundle amplifier DC rail supply wires together with other cables.
- Do not bundle speaker wires together with other cables (Figure 8).

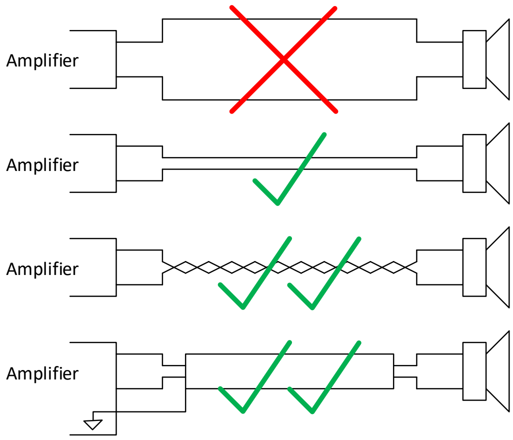


Figure 37: Speaker wire routing

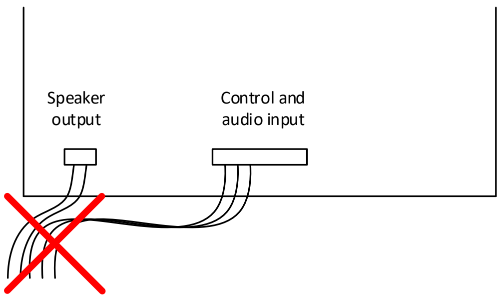


Figure 38: Wire bundling

Depending on the end-product application, additional EMC initiatives and filtering may be required to have the entire 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 EMC performance, it is often advisable to revisit the used grounding scheme and cable routing and add EMC filters on some or all the connectors on the end-product.

15. Safety and EMC Standards

ICEpowerSC400A2 is designed to comply with EMC directives and safety standards.

16. ESD Warning

ICEpower products are manufactured according to the following ESD precautions:

ANSI/ESD-S20.20-2014: 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 bubble wrap bags and cardboard boxes.

17.1 Ordering Information

Order Codes	Description	Part Number
ICEpowerSC400A2	Two channel 400 W ICEpower amplifier	8000154

17.2 Shipping Dimensions and Weight

Package	Quantity	Dimensions (w × d × h) [mm]	Gross Weight [kg]
Carton	56	80 x 100 x 33	9.91

17.3 Storage Conditions

Storage Humidity and Temperature:
Please find storage humidity and temperature information in Section 8.3, Environmental Specifications.

Stacking

A maximum of 4 cartons must be stacked on top of each other.
Pallets may not be stacked on top of each other.

18. 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.

19. Contact

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

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