

High Efficiency High Power Audio SMPS

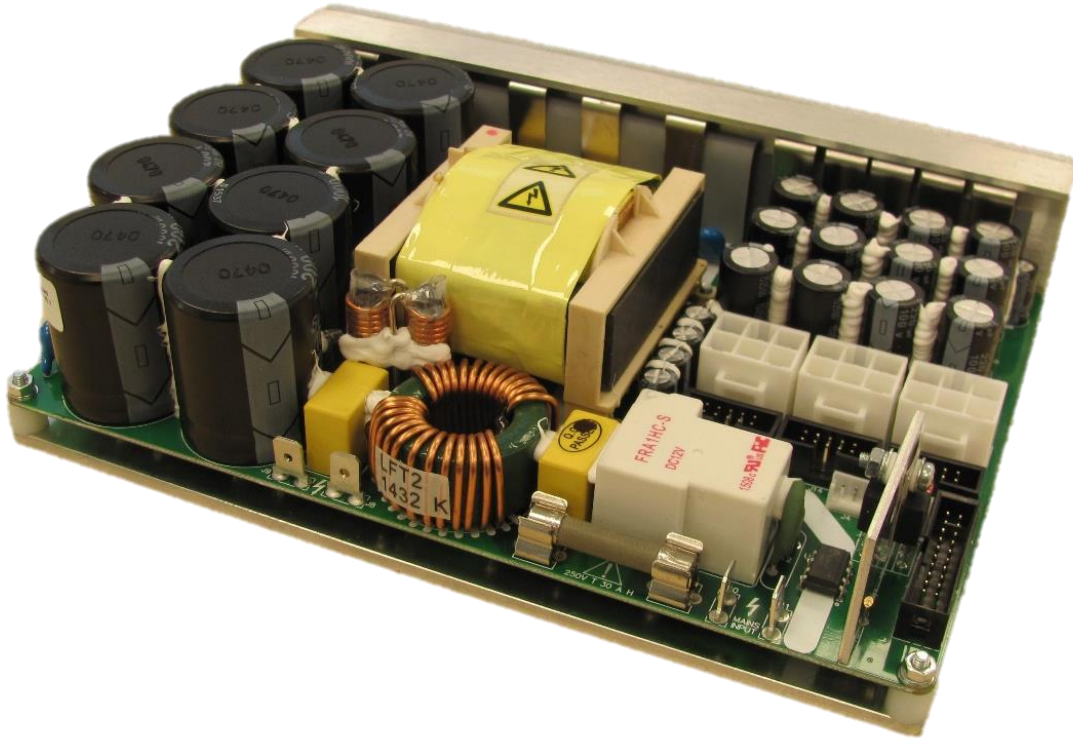


Image is for illustrative purposes only. Please refer to product description.

Highlights

- High efficiency
- Selectable input voltage range
- Low EMI
- 2 variants available
- Fixed output voltage

Features

- Advanced over current protection
- Remote controlled operation
- Low weight: 1475gr.
- Compact design: 200 x 145 x 55mm

Applications

- Supply for single or multiple amplifiers of the UcD and NCore ranges
- Active loudspeakers

Introduction

The SMPS3K is a high efficiency Safety Class 1 switch mode power supply specifically designed for use with our range of Ncore and UcD amplifier modules. Key features are high efficiency over the entire load range, extremely small form factor, low weight and very low radiated and conducted EMI. The SMPS3K also features an advanced over current protection which in case of temporary overload limits the output current, only when the overload condition remains for a longer time the supply will enter hiccup mode until the overload condition disappears. This feature combined with large primary electrolytic buffer capacitors, leads to the capability of delivering high dynamic headroom power to the connected amplifier. The SMPS3K also includes a symmetrical auxiliary output and a control circuit directly interfacing with our range of UcD/NCore amplifier modules. The supply is triggered for normal operation or latched off in case of critical fault via built-in actuators. The SMPS3K is optimized from the first phase of design to final implementation to realize the lowest possible EMI signature required of the most demanding audio applications.

Please make sure you always download the latest datasheet from our website.

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1 Safety precautions



This module operates at mains voltage and carries hazardous voltages at accessible parts. These parts may never be exposed to inadvertent touch. Observe extreme care during installation and never touch any part of the unit while it is connected to the mains.

Disconnect the unit from the mains and allow all capacitors to discharge for 10 minutes before handling it.



Attention: Observe precautions for handling electrostatic sensitive devices. This module uses semiconductors that can be damaged by electrostatic discharge (ESD).

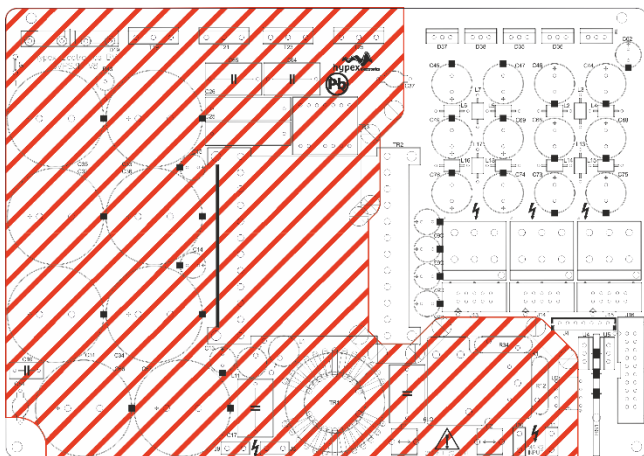
Damage due to inappropriate handling is not covered by warranty.

This product has no user-serviceable parts.



This symbol indicates the presence of hazardous voltages at accessible conductive terminals on the board. Parts that are not highlighted in red may also carry voltages in excess of 200 Vdc!

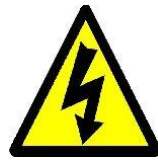
Warning: To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.



This is a Safety Class 1 device. When mounting the module in an enclosure, a minimum safety distance of 3mm from the SMPS to all possible conducting parts must be ensured to keep compliance with Safety Class 1. All parts enclosed by the red line carry hazardous voltages. This includes parts on the top and the bottom of the board.

Standard the SMPS3K is supplied as a module mounted on an L-Shaped aluminium frame. This creates the mandatory 3mm clearance from the bottom side of the PCBA to the chassis without the need for additional insulating material. If the enclosure is limited in height, the L bracket can be omitted. An insulating sheet with a minimum thickness of 0.4mm, protruding a minimum of 3mm from the SMPS3K's footprint must be installed below the SMPS if shorter spacers are used to mount the SMPS to keep compliance with safety class 1.

1 Précautions de sécurité



Ce module est sous tension secteur et certaines de ses pièces accessibles sont sous une tension dangereuse. Ces pièces doivent dans tous les cas être protégées contre contacts accidentels. Lors de l'installation, une prudence extrême s'impose. Ne jamais

toucher les pièces du module quand celui-ci est relié au secteur. Isoler l'appareil du secteur et attendre 10 minutes pour laisser à tous les condensateurs le temps de se décharger avant de le manipuler.



Attention : Respecter les consignes de sécurité pour la manipulation d'appareils sensibles aux courants électrostatiques. Ce module est pourvu de semi-conducteurs qui peuvent être endommagés par les décharges électrostatiques (DES).

Les dommages causés par un usage non approprié sont exclus de la garantie.

Ce produit ne contient aucune pièce devant être entretenue par l'utilisateur.



Ce symbole indique la présence de tensions dangereuses aux broches de raccordement accessibles sur la carte. Les pièces non marquées en rouge peuvent être elles aussi sous une tension supérieure à 200 VCC.

Avertissement: Pour réduire les risques de choc électrique, ne pas exposer cet appareil à la pluie ou l'humidité.

1. Read these instructions.
2. Keep these instructions.
3. Heed all warnings.
4. Follow all instructions.
5. Do not use this apparatus near water.
6. Protect the power cord from being walked on or pinched, particularly at plugs, convenience receptacles, and the point where they exit from the application.
7. Only use attachments/accessories specified or approved by the manufacturer.
8. Unplug this apparatus during lightning storms or when unused for long periods of time.
9. Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally or has been dropped.
10. Don't run any cables across the top or the bottom of the module. Apply fixtures to cables to ensure that this is not compromised.
11. Observe a minimum clearance of 6mm with all possible conducting parts (housing etc.).
12. Natural convection should not be impeded by covering the module (apart from the end applications housing).
13. This product is to be used with Hypex amplifier modules only.
14. Before using this product, ensure all cables are correctly connected and the power cables are not damaged. If you detect any damage, do not use the product.
15. Changes or modifications not expressly approved by Hypex Electronics will void compliance and therefore the user's authority to operate the equipment.
16. Service or modifications by any person or persons other than by Hypex Electronics authorized personnel voids the warranty.

2 The SMPS3K Series

The SMPS3K series is a range of Switch Mode Power Supplies. In the next table there is an overview of the different models, their output voltages and application.

Model	Main rails output	For use with amplifiers (examples)
SMPS3KA400	2x 63Vdc	UcD250LP, UcD400 Series, NC400 DIY, NC500 oem
SMPS3KA700	2x 85Vdc	UcD700 Series, NC500 oem, NC1200, UcD2K

The maximum number of modules which can be connected to the SMPS3k is limited by the output power of the SMPS. Please refer to the amplifier's datasheet for more information.

2.1 Half-bridge amplifiers (UcD400/UcD700)

The SMPS3K is intended to power our range of high power amplifier modules. As a result, this SMPS product does not feature the 2-quadrant operation as most of our other SMPS products do. Therefore, they are unable to handle large reverse currents generated by half-bridge amplifiers operated at low frequencies. For this reason, it is not advisable to use this SMPS to power half bridge amplifiers like our UcD700 and UcD400 modules when used in the frequency range below 100Hz. A workaround for this could be using the UcD700/UcD400 in bridge mode, or reversing phase for half of the modules.

3 Electrical Specifications

3.1 Power Specifications

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
High Line Input Voltage	-	V _B	180	230	264	Vac	1)
Low Line Input Voltage	With Low Line jumper placed	V _{B,FP}	90	115	132	Vac	1)
Line Input Frequency	-	f	47		63	Hz	1)
Fuse rating	250Vac, slow blow			30		A	2)

Note 1: Operation beyond these limits may result in irreversible damage.

Note 2: If fuse is blown, please consult a skilled technician to inspect your module. If applicable, replace the fuse with same type and rating.

3.2 General Performance Data

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Output Voltage Main	A400, symmetric	V _{OUT}	2x49	2x63	2x72	Vdc	1), 2)
	A700, symmetric	V _{OUT}	2x66	2x85	2x97	Vdc	1), 2)
Output Power Main		P _{OUT}		3000		W	
Output Voltage Vaux	A400, symmetric	V _{AUX}	2x 15.5	2x20	2x23	Vdc	1)
	A700, symmetric	V _{AUX}	2x18	2x23	2x26	Vdc	1)
Output Current Vaux	All versions, per rail	I _{AUX}	-	-	500	mA	4)
Output Voltage V _{DR}	A400	V _{OUT,Vdr}	-	15.6	-	Vdc	
	A700	V _{OUT,Vdr}	-	15	-	Vdc	
Output Current V _{DR}	All versions	I _{OUT,Vdr}	-	-	500	mA	
Output Voltage Regulated	All versions	V _{AUX,REG}		2x12		Vdc	3)
Output Current Regulated	All versions, per rail	I _{AUX,REG}	-	-	100	mA	
In-rush current	20Ω In-rush NTC, worst-case	I _{Inrush}			19	A	
Efficiency	Full power	η	93			%	
Power consumption	Depending on load	P _{max}			3800	W	
Idle Losses	230 Vac, 50 Hz	P ₀	-	15	-	W	
Standby Power	Power consumption in standby	P _{standby}		450		mW	
Switching frequency		F _{SW}	80	100	120	kHz	

Note 1: Output voltage is proportional to the mains line voltage (Min@180Vac, Typical@230Vac, Max@264Vac).

Note 2: These outputs are fully long-term shortcut protected: outputs to ground, output to output.

Note 3: Regulated output voltage is required for the connected amplifiers, external use is not recommended in multi-amplifier applications.

Note 4: This output is protected against overcurrent.

3.3 Timing Specifications

These timings are measured at room temperatures, approximately 21°C, 230Vac.

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Switching start up delay	Time to when all power supplies are within operational limits			TBD		ms	
Output delay	Time delay to signal			TBD		ms	
Shutdown delay	Supply failure or Standby pin			TBD		ms	

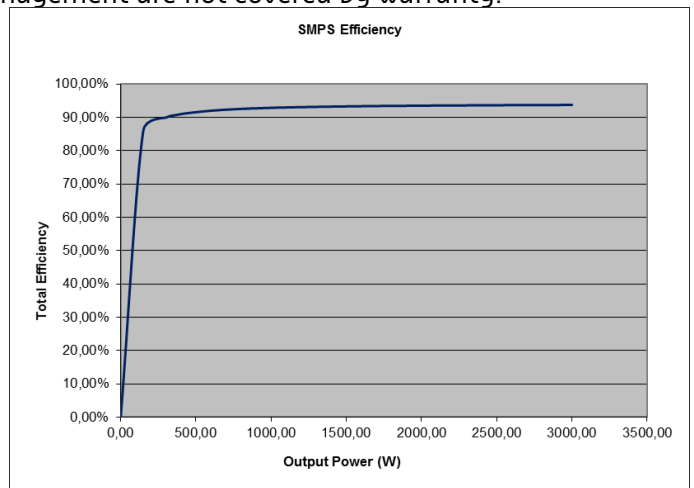
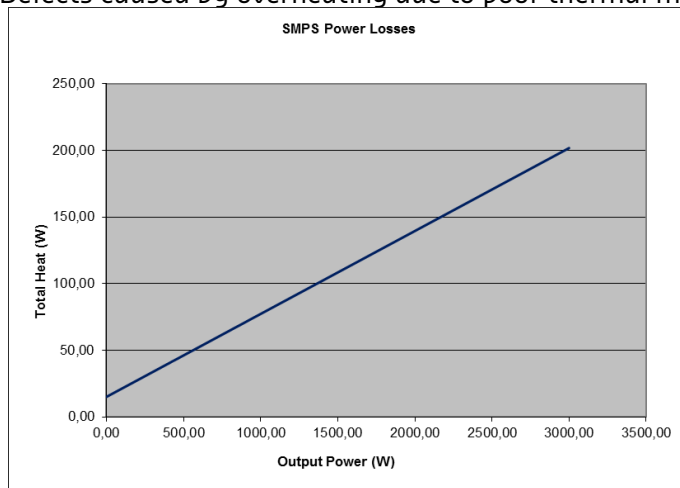
4 Environmental Specifications

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Ambient Temperature	Storage		-25	-	70	°C	
	Operation	T _{amb}	0	-	50	°C	
Heat-sink Temperature		T _{h,max}			95	°C	1)
Humidity	Max 85 percent relative humidity, non-condensing.						

Note 1: This module features a thermal shutdown mechanism to protect against over temperature. This mechanism is meant to be a final protection. Please apply adequate cooling measures to prevent over temperature.



4.1 Heat dissipation

Switch mode power supplies' known high efficiency often leads to a gross underestimation of the cooling required. Please apply adequate cooling to the module to ensure the module operates within specification. The following graphs provide an indication of the heat (in Watts) generated at different output levels. For more information regarding cooling, please refer to our application note "Thermal Design", available on our website. Defects caused by overheating due to poor thermal management are not covered by warranty.



5 Product Markings

This module has two marking stickers applied.

Model sticker example	Identification sticker example
<p>Hypex Electronics BV</p> <p>SMPS3k 100-120V~ / 200-240V~ 50-60Hz 3800W MAX</p> 	 <p>Hypex Electronics B.V. Kattegat 8, NL-9723JP</p> <p>WK/RV: wwyy H02U001010-0100A12345-0123 PCBA SMPS3KA700</p>

6 IO Specifications

6.1 SMPS Stand-by

Applying an external DC voltage to this input will put the SMPS in standby. Both main and auxiliary output voltages will drop gradually. Removing the standby voltage will result in a normal soft-start of the SMPS1200. Putting the SMPS in standby also automatically releases the Amp Enable line, guarantying pop-free shut down of the connected UcD/NCore Amplifier. This is an opto-coupler input with a 270 ohm series resistor.

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
SMPS in standby	Logic High level		3,3	-	5	Vdc	¹⁾
SMPS enabled	Logic Low level		-	-	0,8	Vdc	

Note 1: The current (A) drawn can be calculated as follows: $(V_{pin} - 1.2) / 270$

6.2 Amp Standby

Applying an external DC voltage to the Amp Standby pin will put the amplifier in standby. The connected amplifier must be connected to Amp Enable to use this option.

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Amplifier in standby	Logic High level		3,3	-	V _{AUX}	Vdc	¹⁾
Amplifier enabled	Logic Low level		-	-	0,8	Vdc	

Note 1: The current (A) drawn can be calculated as follows: $(V_{pin} - 0.7) / 47000$

6.3 DC-Error

In the event of a critical failure occurring in the connected amplifier, the SMPS3K needs to be switched off rapidly. The SMPS3K provides a DC Error Input designated for each connected UcD OEM/NCore series amplifiers. The DC Error Input is latched and will not auto-recover. To reset the DC Error the module must be disconnected from mains for at least 1 minute to allow the primary capacitors to drain.

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
No error condition	Use open collector		-	-	-	Vdc	¹⁾
DC Error	Pull pin to Gnd		-	Gnd	-	Vdc	^{1), 2)}

Note 1: DC-Error must be pulled to ground to activate. Most Hypex amplifier modules use open collector output (DC-Error pin) to achieve this, please refer to the datasheet of the amplifier module.

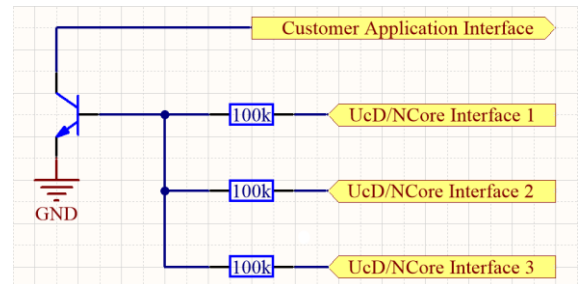
Note 2: The current (A) can be calculated as follows: $(V_{aux} - 1.2) / 1000$

6.4 Amplifier Ready Bus

The Amplifier Ready Bus consists of 3 inputs and 1 output pin.

The inputs are part of the UcD/NCore Interface and will work with our compatible UcD/NCore amplifier modules.

The output is routed to the Customer Application Interface. If one of the connected amplifiers enters error-state, due to a permanently shorted output or an overvoltage situation, this output is pulled low by means of an open collector output.



Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Amplifier not Ready	Logic High level Input		3,3	-	12	Vdc	1)
Amplifier Ready	Logic Low level Input		-	-	0,8	Vdc	

Note 1: The current (A) drawn can be calculated as follows: $(V_{pin} - 0.7) / 100000$

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Collector voltage	Open collector output		-	-	50	V	
Collector current	Open collector output		-	-	100	mA	

6.5 Amp Enable

When the enable-line of a UcD/NCore series amplifier is connected to this pin, the amplifier will be enabled and disabled automatically when the SMPS3K is switched on and off. By doing so, it prevents unwanted audio artefacts during powerup and powerdown.

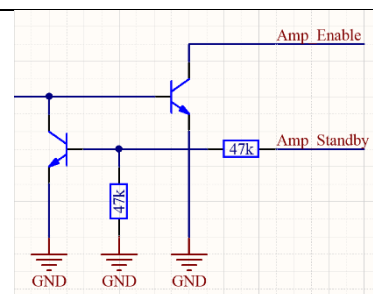
Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Collector voltage	Open collector output		-	-	50	V	
Collector current	Open collector output		-	-	100	mA	

6.6 Power Good

The Power Good will be activated if the main SMPS is functioning correctly. If the main SMPS is disabled, the Power Good pin is immediately released.

Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Collector voltage	Open collector output		-	-	50	V	
Collector current	Open collector output		-	-	100	mA	

Using Amp Standby in combination with Amp Enable, one can make a pop-free control of the SMPS and amplifier setup. This circuit illustrates a part of the internal circuit of the SMPS.



6.7 Bootstrap Driver Voltage (V_{DR})

The SMPS3K provides a regulated Bootstrap Driver Voltage (V_{DR}) which is used to power the driver circuit of an UcD or NCore series amplifier. Most Hypex amplifier modules need the V_{DR} voltage referenced to the negative supply rail (HV-). To achieve this, the V_{DR-} should be connected to the main negative supply rail (HV-) at the amplifier side. The V_{DR+} must be connected to the UcD/NCore series V_{DR} supply input.

Output Ground Characteristics

The Output Ground reference, Main Output Ground and Auxiliary Output Ground are connected together on the board.

Rail Voltage Sensing

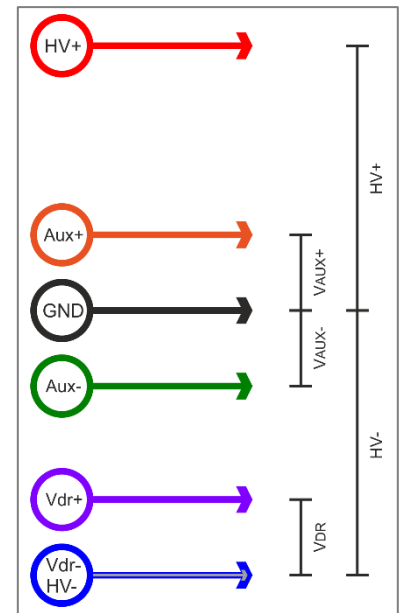
Both the positive and negative supply rail and the VDR rail are connected to the Customer Application Interface via 100k 0805 resistors. This enables the user to interface these rails with a microcontroller and measure its values.

Amp Clip

The Amp Clip pins in the Customer Application Interface are a direct pass-through from the respective UcD/NCore Interface. Therefore, the IO characteristics of these pins are equal to these on the connected amplifier.

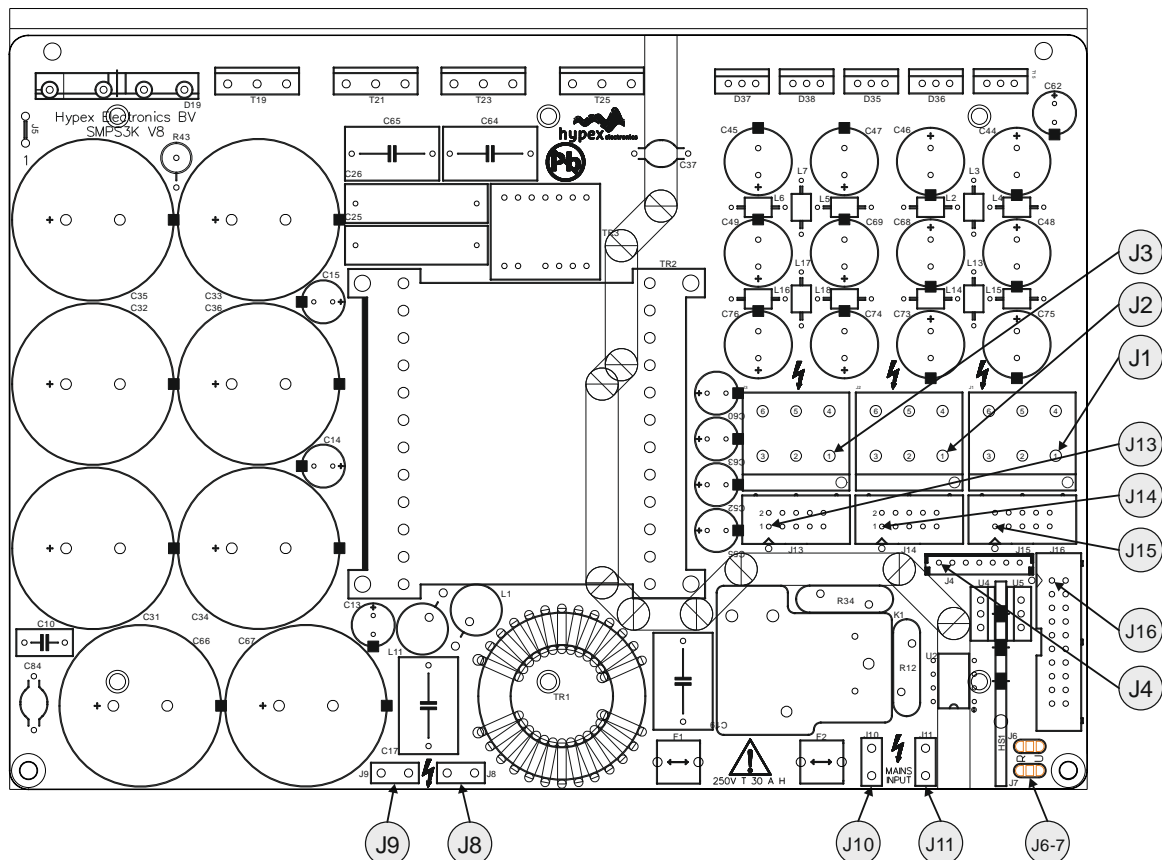
Audio Pass-through

The SMPS3K supports the direct pass-through of balanced audio signals from the Customer Application Interface to the respective UcD/NCore Interface. By doing so the customer application can be connected to the power stage using a single interface cable.



7 Connector Pinouts

This chapter describes the functional connectors of the power supply module. A connector not stated in this chapter is only used for production or quality control and must remain unconnected in the end user appliance. The arrow points towards pin1 of the connector.



7.1 Main output connector

The following table is applicable to J1, J2, and J3.

Pin	Direction	Function	Remarks
J1.1	Output	V_{DR+}	Positive bootstrap driver voltage
J1.2	Output	HV+	Positive supply rail
J1.3	-	GND	Ground
J1.4	Output	V_{DR-}	Negative bootstrap driver voltage
J1.5	Output	HV-	Negative supply rail
J1.6	-	GND	Ground

Connector type equivalent: B06P-VL.

Matching cable part: VLP-06V.

7.2 AC Connector Specification

Pin	Direction	Function	Remarks
J10.1	Input	Mains input	6,3x0,8 mm FASTON [®] tab
J11.1	Input	Mains input	6,3x0,8 mm FASTON [®] tab

7.3 Mains Voltage Selection

Pin	Direction	Function	Remarks
J8, J9	Jumper	Input Voltage Select	Open = 230Vac; Closed = 115Vac.

Connector type equivalent: 6,3x0,8 mm FASTON® tab

7.4 UcD/NCore Interface

The following table is applicable to J13, J14, and J15.

Pin	Direction	Function	Remarks
J13.1	Output	V _{AUX,REG}	Positive rail
J13.2	Output	V _{AUX,REG}	Negative rail
J13.3	-	GND	Ground
J13.4	Input	Amp Ready	Amplifier Ready Bus Input ¹⁾
J13.5	Input	Amp Clip	Pass-through to J16 ¹⁾
J13.6	Output	Amp Enable	Amplifier enable
J13.7	Output	Audio Output (Hot)	Pass-through from J16 ¹⁾
J13.8	Output	Audio Output (Cold)	Pass-through from J16 ¹⁾
J13.9	-	GND	Ground
J13.10	Input	DC Error	

Connector type equivalent: T821110A1S100CEU

Contact material: Brass, gold flash over nickel

Note 1: See Chapter 6, IO Specifications for more information

7.5 Aux Voltage and PS Control

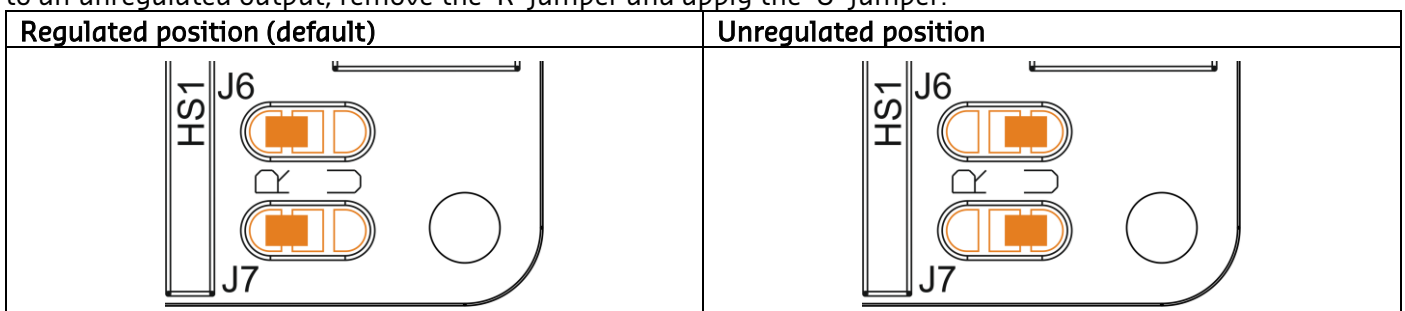
Pin	Direction	Function	Remarks
J4.1	Input	SMPS Standby	
J4.2	Input	Amp Standby	
J4.3	Output	V _{AUX}	Positive Auxiliary Output (regulated or unregulated)
J4.4	-	NC	Do not connect
J4.5	-	GND	Ground
J4.6	-	NC	Do not connect
J4.7	Output	V _{AUX}	Negative Auxiliary Output (regulated or unregulated)

Connector type: B7B-EH-A(LF)(SN).

Matching cable part: EHR-7.

7.6 Aux voltage selection

By default, the auxiliary outputs are routed to be regulated. This is done via jumper J6 and J7. However, some amplifiers need an unregulated auxiliary voltage, like the NC1200. To bypass the Positive Auxiliary Output regulation circuit, jumpers needs to be modified. 'R' and 'U' represent Regulated and Unregulated. To switch to an unregulated output, remove the 'R' jumper and apply the 'U' jumper.



7.7 Customer Application Interface

Pin	Direction	Function	Remarks
J16.1	Input	Audio Input (Cold)	Pass-through to J15
J16.2	Input	Audio Input (Hot)	Pass-through to J15
J16.3	Input	Audio Input (Cold)	Pass-through to J14
J16.4	Input	Audio Input (Hot)	Pass-through to J14
J16.5	Input	Audio Input (Cold)	Pass-through to J13
J16.6	Input	Audio Input (Hot)	Pass-through to J13
J16.7	-	GND	Ground
J16.8	Output	Amp Clip	Pass-through from J15
J16.9	Output	Amp Clip	Pass-through from J14
J16.10	Output	Amp Clip	Pass-through from J13
J16.11	Output	Amplifiers Ready	Amplifier Ready Bus Output
J16.12	Input	Amplifier Standby	Amplifier Stand-by Input
J16.13	Input	SMPS Standby	Power Supply Stand-by
J16.14	Output	Power Good	Power Supply Stable indicator (open collector)
J16.15	Output	Vaux+	Positive Auxiliary Output (regulated or unregulated)
J16.16	Output	Vaux-	Negative Auxiliary Output (regulated or unregulated)
J16.17	-	GND	Ground
J16.18	Output	Voltage sensing HV-	Inline 0805 100K resistor
J16.19	Output	Voltage sensing HV+	Inline 0805 100K resistor
J16.20	Output	Voltage sensing VDR	Inline 0805 100K resistor

8 Typical Performance Data

The SMPS3K is designed for music reproduction and is therefore not able to deliver its maximum output power long-term. The RMS value of any common music signal generally doesn't exceed 1/8th of the maximum peak power. The SMPS3K is therefore perfectly capable of driving the connected amplifier in clipping continuously with a music signal without the need of forced cooling.

Unless otherwise specified. $T_a = 25^\circ\text{C}$. Connected amplifier: 2 x UcD2K, $f = 1\text{ kHz}$.

SMPS3K is horizontally mounted in free air without additional external cooling. The SMPS3K was preheated at 1/8P_R (2 x 190W@ 1 kHz into 4 Ohm amplifier load).

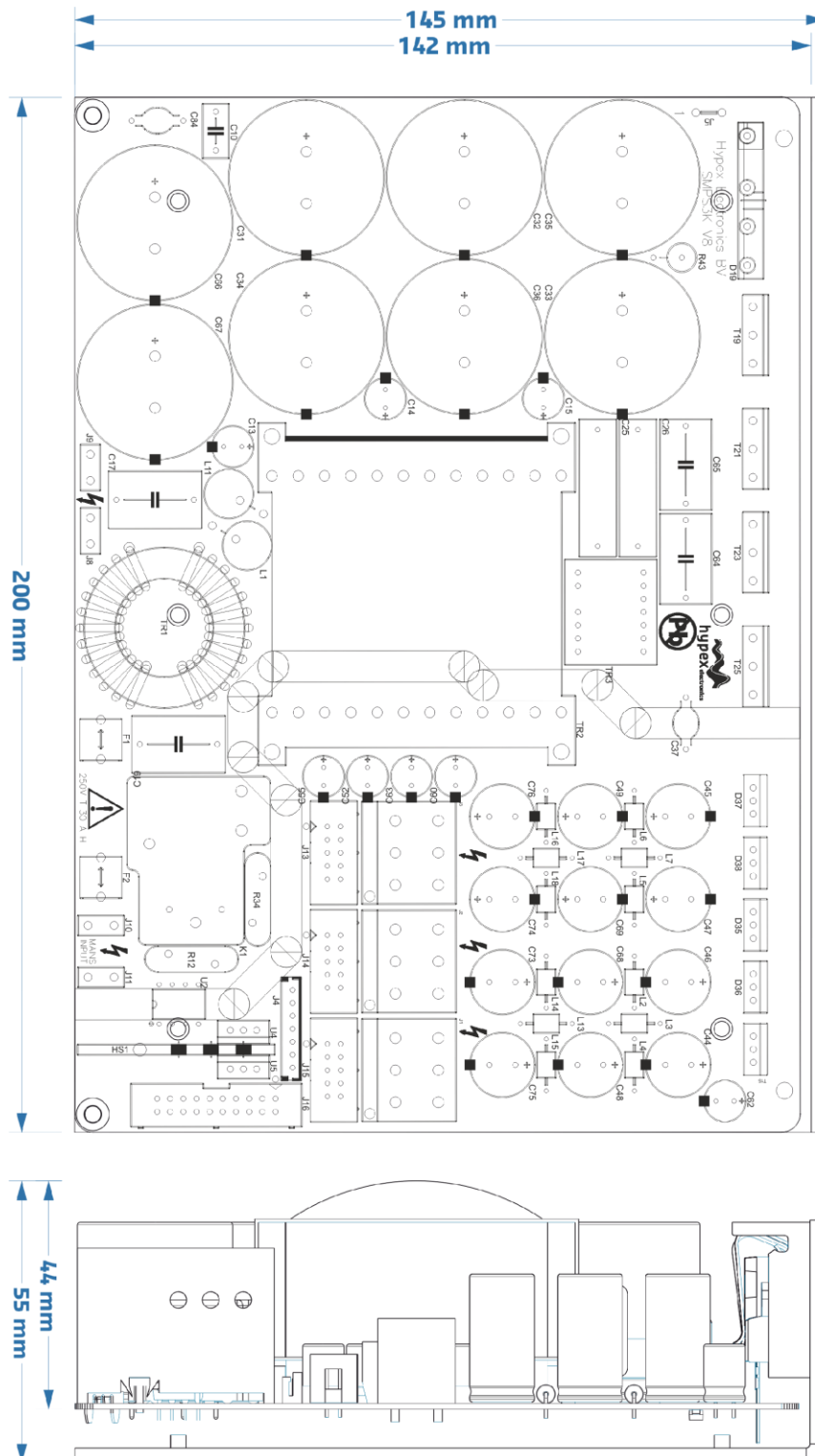
Parameter	Conditions	Symbol	Min	Typ	Max	Unit	Note
Amplifier output power for 10 sec. until $T_{\text{Sink}} = 95^\circ\text{C}$	Load = 4Ω 230Vac/50Hz	P _o	-	1200		W	
Continuous output power. T_{Sink} stabilized at 95°C	Load = 4Ω 230Vac/50Hz	P _o	-	1000		W	

9 Dimensions and Drill pattern

Maximum allowed protruding depth inside each spacer is 4mm. Spacer threads are M3.

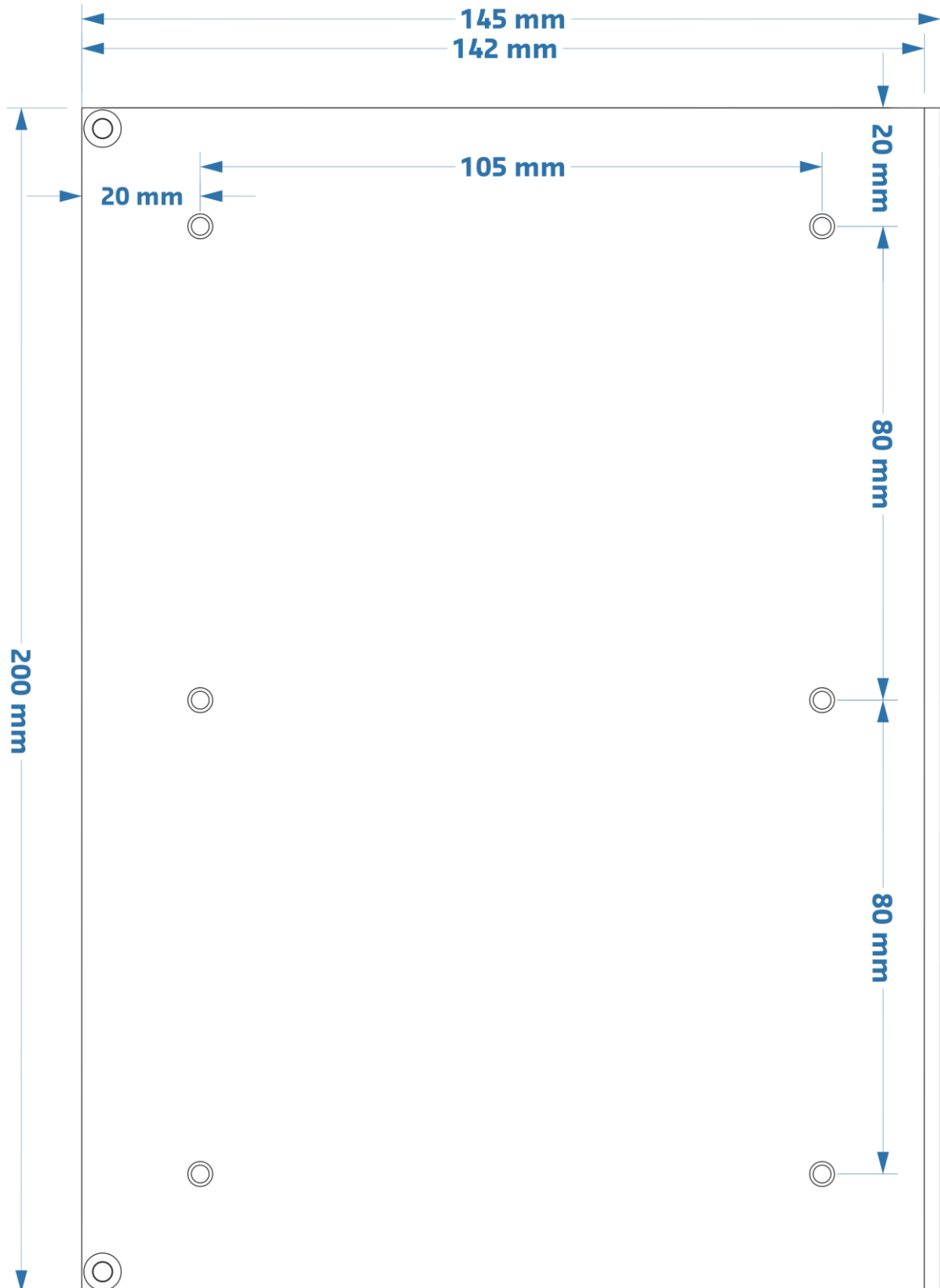
9.1 Bottom view, L-profile dimensions

Note that the image below is not a 100% scale. Assembly version V7 and higher. For older dimensions, refer to older datasheet.



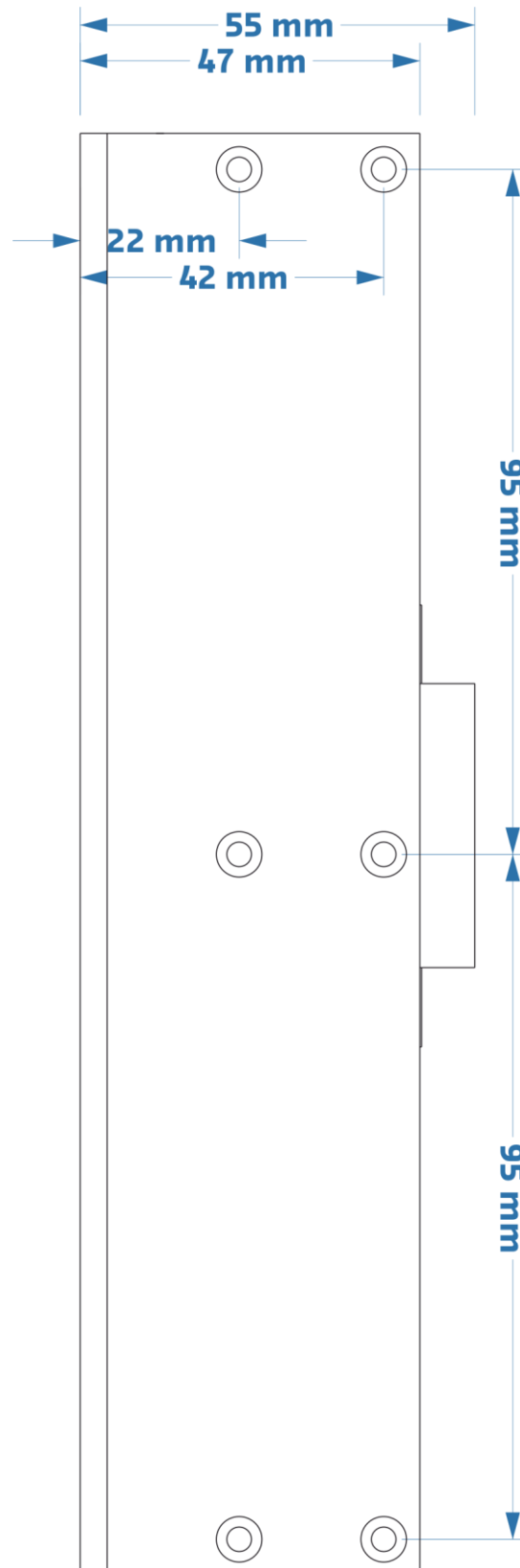
9.2 Bottom view, L-profile

If printed correctly (scale 100%, A4), the scale of the image below should be 1:1. You may use it as a model to drill holes in your casing. Please verify before drilling!



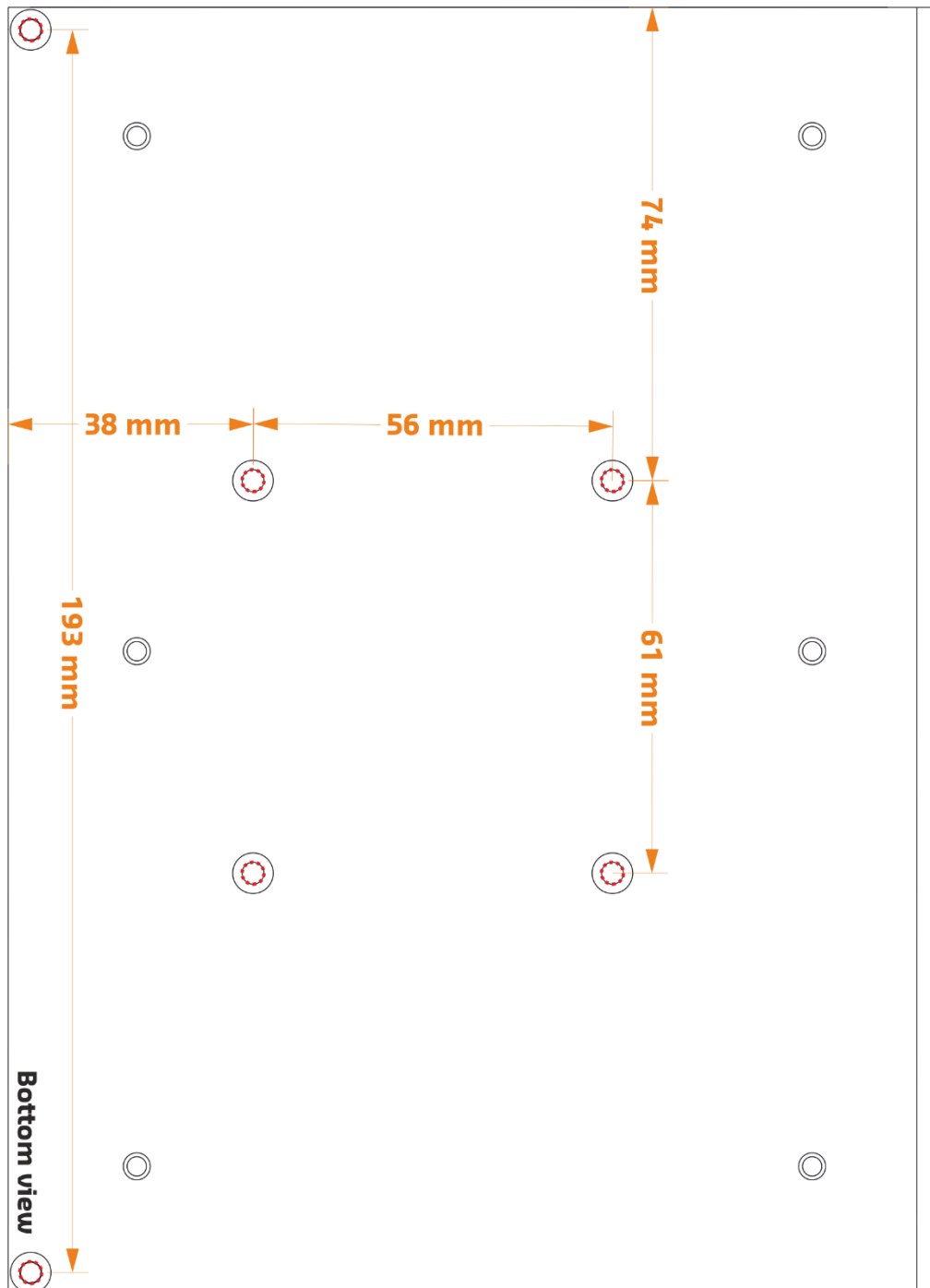
9.3 Back view, L-profile

If printed correctly (scale 100%, A4), the scale of the image below should be 1:1. You may use it as a model to drill holes in your casing. Please verify before drilling!



9.4 Bottom view, without L-profile

If the L-shaped profile is omitted, additional mounting holes are required. If printed correctly (scale 100%, A4), the scale of the image below should be 1:1. You may use it as a model to drill holes in your casing. Please verify before drilling!



10 Safety compliance

The SMPS3KA400 and SMPS3KA700 revision 1000 and higher are safety tested according to the following standards:

- IEC 60065:2014 + A11:2017
 - National deviations for CENELEC countries
 - National deviations for Japan
 - National deviations for China
- IEC 62368-1:2014 + A11:2017
 - National deviations for CENELEC countries
 - National deviations for USA
 - National deviations for Canada
 - National deviations for New Zealand
 - National deviations for Australia

Relevant standards

The SMPS3KA400 and SMPS3KA700 revision 1000 and higher fulfil the requirements of:

- IEC60065:2014 + A11:2017
- IEC62368-1:2014 + A11:2017
- UL62368-1:2014 Ed.2
- CSA C22.2#62368-1:2014 Ed.2

Test procedure

- CB scheme IEC60065
 - Test laboratory: Intertek SEMKO
 - Ref. Certif. No: SE-91801
- CB scheme IEC62368-1
 - Test laboratory: Intertek SEMKO
 - Ref Certif. No: SE-91800

ETL listing

The SMPS3KA400 and SMPS3KA700 are ETL listed components for the USA (UL62368-1:2014 Ed. 2) and Canada (CSA C22.2#62368-1:2014 Ed.2).

11 Revisions

Document revision	Module revision	Change log	Date
01	SMPS3k 01xx	Initial Draft. Applicable to SMPS3K V1.	08.06.2009
02	SMPS3k 03xx	Changes regarding output connectors. DC-error reset within 3sec. instead of 30mins. Improved EMI performance. VDR fully isolated to output connector.	05.10.2010
03	SMPS3k 03xx	VDR connection clarified in text.	11.02.2011
04	SMPS3k 04xx	Connector J4 added	19.08.2011
05	SMPS3k 05xx	Pinout updated	13.03.2012
06	SMPS3k 06xx	Format changed	14.01.2013
07			
08	SMPS3k07xx	SMPS3kA400 added	18.02.2014
09	SMPS3k 07xx	Auxiliary output figures corrected	02.02.2015
10	SMPS3k 07xx	Vdr output figures corrected Dimensions changed (height)	04.06.2015
11	SMPS3K 08xx	New datasheet format	16.11.2015
12	SMPS3k 09xx	AC Detect description modified, now Power Good. Vaux solder jumper added on top, description added. OCP Vaux remark added. Thermals shutdown remark added	Jan '18
12	SMPS3K 10xx	Update to revision 10xx Updated product marking Added safety approbations	13.09.2018

12 Disclaimer

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