

Blade Power Amplifier Module



Features

- THD: <0.003%
- SNR: 117dB @ 24V into 2Ω or 4Ω load
- Differential audio input
- Module dimensions: 24mm x 22mm
- SMT Mounting

Applications

- AV home audio, iPod docks, linear speakers, active speakers
- Automotive, marine
- Standalone power amps

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Table of Contents

1 Introduction	3
1.1 Overview	3
1.2 Module Benefits	3
1.3 Indice Semiconductor Pty Ltd Support Contacts	3
1.4 Device Pin Out	4
1.5 Basic System Diagram	5
1.6 Recommended implementation	5
2 Operating Conditions	6
2.1 Absolute Maximum Ratings	6
2.2 Recommended Operational Conditions	6
2.3 Input Pin Operation	6
2.4 Thermal Information	8
2.5 Performance data	8
3 Module Functionality	9
3.1 Power supply bypassing	9
3.2 Over temperature shutdown	9
3.3 Input signal conditioning	9
3.4 Output stage filtering	10
3.5 EMI filtering	10
3.6 PCB layout guidelines	11
4 Mechanical drawings	13
4.1 Module drawing	13
4.2 PCB Footprint	13
5 Ordering Information	14
6 Revision Control	15

1 Introduction

1.1 Overview

Indice's Power Amplifier '*Blade*' provides class leading acoustic fidelity and control in a highly efficient, small package. Delivering uncompromising control of speakers with excellent attack, fade and phase response, the *Blade* has an impressive 115dB SNR and THD < 0.004. This is only possible with Indice's proprietary Continuous Sigma encoding with direct drive technology.

1.2 Module Benefits

The Indice *Blade* enables audio equipment manufacturers to reduce power consumption, size, weight, and cost of their audio products. With SMT mounting, the modules can be used either in isolation or with an additional passive heat sink. With heat sinking, up to 364WRMS into 1Ω per module is possible for high power applications.

- **Ultra Small Package:** Combined with ultra high efficiency reduces the size and space required for thermal heat sink and controls.
- **Ultra low THD:** Each *Blade* module is capable of up to 96WRMS @1% THD into a 4Ω load (without heat sinking)
- **High efficiency:** >96% efficient allows truly high density design with minimal heat sinking
- **Thermal cutout:** In the even the module gets too hot; it is intelligent to shutdown to prevent damage to the module and surrounding system.
- **Continuous sigma encoding:** Enables excellent attack, fade and phase alignment and with an asynchronous carrier, the EMI profile is dramatically reduced.
- **Single or differential input:** Provides the system integrator with flexibility to use either single ended or differential input modes
- **EMI Compliant:** Designed for CISPR 25 and FCC providing the reference design recommendations are followed

1.3 Indice Semiconductor Pty Ltd Support Contacts

The following key contacts should be used for any additional correspondence and queries in response to this document.

Email	support@indicesemi.com
Phone	+61 3 9831 7400 (9am – 5pm, Mon – Fri, UTC+10:00)

1.4 Device Pin Out

Below in Figure 1 and Table 1 are details on the pin out and pin functions for the Blade audio module.

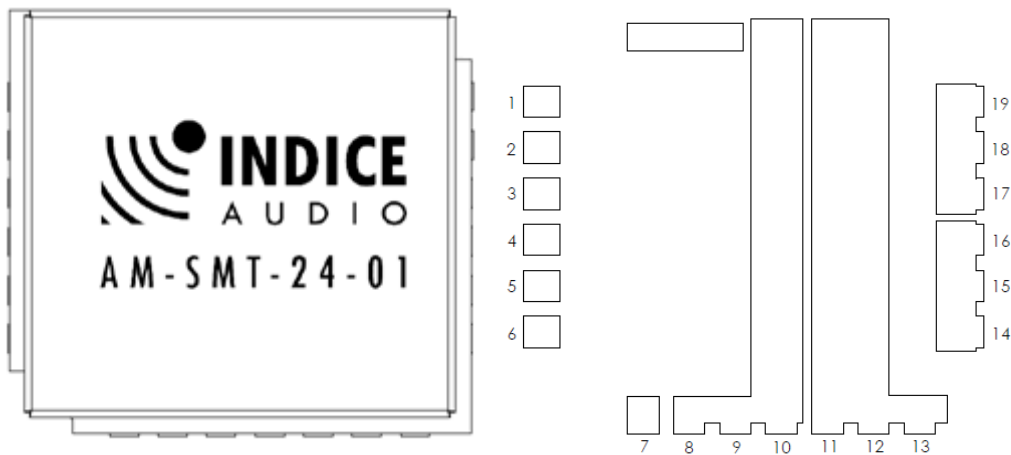


Figure 1: Top view of AM-SMT-24-01 Module with pins labelled

Name	Pin Number	I/O	A/D	Description
SIG+	1	I	A	Positive Input signal
GND	2	-	-	Signal ground
SIG-	3	I	A	Negative input signal (Tie to GND for single ended)
GND	4	-	-	Signal ground
5V_A	5	I	A	5V analog supply
~OT	6	O	D	Over temperature shutdown notification: High = Module OK Low = Module has entered over temperature shutdown
5V_D	7	I	D	5V digital supply
VCC	8, 9, 10	I	A	Power input rail for amplifier module
GND	11, 12, 13	-	-	Power ground connection
OUTD1	14, 15, 16	-	-	Output 1 of the amplifier module
OUTD2	17, 18, 19	O	-	Output 2 of the amplifier module

Table 1: Pin functions of AM-SMT-24-01 – Input or O – Output. A/D column indicates either A – Analogue or D – Digital.

1.5 Basic System Diagram

Figure 2 is a basic system diagram depicting the AM-SMT-24-01 audio module.

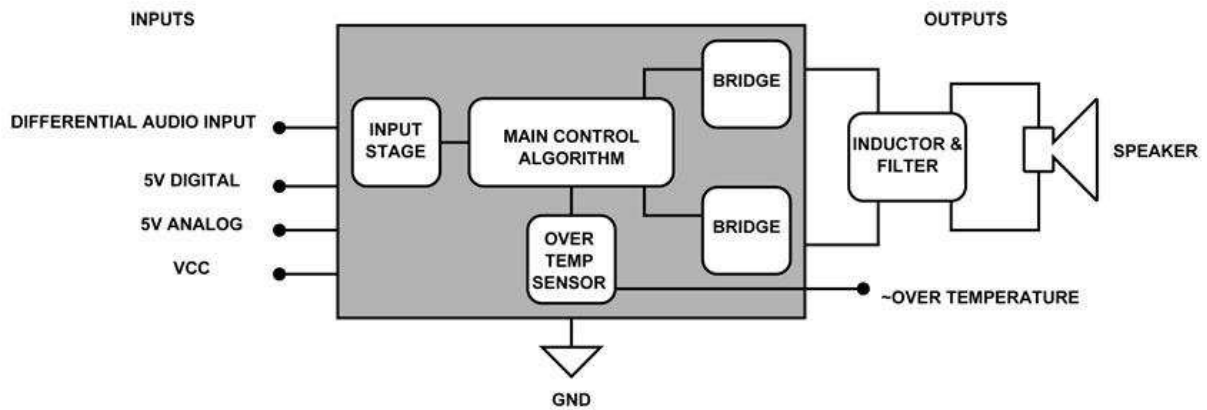


Figure 2: Basic system diagram

1.6 Recommended implementation

Refer to Indice's demo board schematic and PCB for the recommended system implementation for the AM-SMT-24-01 module.

2 Operating Conditions

2.1 Absolute Maximum Ratings

Subjecting the AM-SMT-24-01 to any conditions beyond those listed in this section may cause permanent damage to the device. These are maximum condition ratings only. Exposure to the absolute maximum rated conditions for long periods can adversely affect device reliability. Proper operation of the device under any conditions, other than those indicated in the “Recommended Operational Conditions” section, is not implied. Absolute maximum ratings of the AM-SMT-24-01 are included in Table 2.

Parameter	Value
GND to VCC	-0.3 V to 28V
GND to 5V_D / 5V_A	-0.3 V to 5.5V
GND to Sig+ / SIG-	-0.3 V to 5.5V
Maximum power to the load	365W
Storage temperature range. T _{STORAGE} ⁽¹⁾ .	-40 °C to 100 °C

(1) Higher temperatures can be applied during board soldering according to current JEDEC J-STD-020 standards specification. Peak reflow temperatures should not exceed those classified on the device packaging.

Table 2: Absolute maximum ratings of the AM-SMT-24-01 module.

2.2 Recommended Operational Conditions

Recommended operational conditions for AM-SMT-24-01 are given in Table 3.

Parameter	Value
GND pin voltage.	0 V
V _{CC} pin voltage (Referenced to GND pin voltage)	12V – 27V
5V_D / 5V_A (Referenced to GND pin voltage)	4.5V – 5.5V
Operating ambient free air temperature. T _A	-40 °C to 85 °C
Idle Losses	0.81W @ VCC = 12V 2.37W @ VCC = 24V

Table 3: Recommended operational conditions of AM-SMT-24-01.

2.3 Input Pin Operation

The measured operational characteristics of the Blade audio module input pins are presented below, in Note: *Sig must be less than 5V_A to ensure the signal does not clip

Table 4. All of these values are measured over recommended supply voltages and operating ambient free air temperatures (unless otherwise stated.)

Parameter	Test Conditions	MIN	TYP	MAX	Unit
5V_A / 5VD	V _{CC} = 24 V.	4.5		5.5	V
Sig + / Sig -	5V_A = 5.5V*	-0.3		5.5	V
5V_D Current draw	V _{CC} = 24 V.		0.3		mA
5V_A Current draw	V _{CC} = 24 V.		47		mA

Note: *Sig must be less than 5V_A to ensure the signal does not clip

Table 4: Input pin operation of AM-SMT-24-01.

2.4 Thermal Information

The measured operational characteristics of the AM-SMT-24-01 mounted to a 2oz, 4 layer FR4 PCB at 25 deg ambient.

Parameter	Test Conditions	MIN	TYP	MAX	Unit
Thermal resistance, power stage to heat pads	$V_{CC} = 24\text{ V}$, $P_{out} = 300\text{ W}$			TBA	$^{\circ}\text{C/W}$
Thermal cut out	$V_{CC} = 24\text{ V}$, $P_{out} = 300\text{ W}$			105	$^{\circ}\text{C}$

Table 5: Thermal performance of the AM-SMT-24-01.

2.5 Performance data

Item	Symbol	Typ	Unit	Notes
Rated Output Power (VCC = 12V)	P_R	17	WRMS	@1%thd into 4 Ω
		35		@1%thd into 2 Ω
		70		@1%thd into 1 Ω
Rated Output Power (VCC = 27V)	P_R	96	WRMS	@1%thd into 4 Ω
		189		@1%thd into 2 Ω
		351		@1%thd into 1 Ω
Differential input voltage range	V_{in}	5	V p-p	
Distortion	THD, IMD	0.003	%	$V_{CC} = 27\text{ V}$, Load = 4 Ω
Output noise	U_N	23	μV	$V_{CC} = 12\text{ V}$, Load = 4 Ω
		40		$V_{CC} = 27\text{ V}$, Load = 4 Ω
Signal-to-noise ratio (A-weighted)	SNR	114	dBA	$V_{CC} = 27\text{ V}$, Load = 2 Ω / 4 Ω
		111		$V_{CC} = 12\text{ V}$, Load = 2 Ω / 4 Ω
Power Bandwidth	PBW	25	kHz	
Frequency Response		15 – 25k	Hz	+0/-3dB. All loads.
Voltage Gain	A_V	5.5	V/V	
Output Offset Voltage	V_{00}	2.5	mV	$V_{CC} = 12\text{ V}$
		3.7		$V_{CC} = 27\text{ V}$
Supply Ripple Rejection	PSRR	-77	dB	$V_{ripple} = 1\text{ VRMS @ } 100\text{ Hz}$
Efficiency	η	>96	%	@10%THD into 2 Ω
IC Idle losses		200	mW	$V_{CC} = 27\text{ V}$
System Idle Losses (including magnetic)	P_0	0.81	WRMS	$V_{CC} = 12\text{ V}$
		2.37		$V_{CC} = 27\text{ V}$

Table 6: Typical performance data

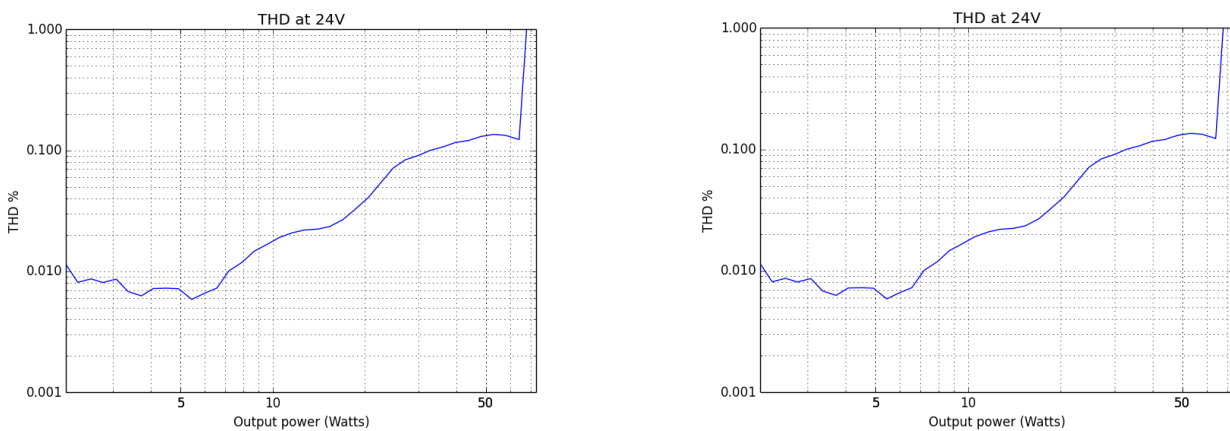


Figure 3: Typical Performance Graphs

3 Module Functionality

3.1 Power supply bypassing

The AM-SMT-24-01 is capable of switching up to 20 Amps into the load and as such consideration needs to be made for adequate bypassing capacitors on the power supplies. Indice recommends the minimum bypassing on the following power supplies. **The customer must measure the power supply ripple, particularly on VCC to ensure that the maximum voltage rating of the device is not exceeded at any time.**

It is strongly recommended that the 5V digital and analog power supplies are separated by a 22uH inductor that forms a LC filter with the recommended capacitors.

Voltage rail	Test Conditions	Min capacitance
VCC	$V_{CC} = 12- 27 \text{ V}$, Pout = up to 364W	1 x 470uF E-Cap, 35V, Low ESL/ESR 4 x 10uF X7R, 1206 2 x 10nF X7R, 0603 1 x 100nF X7R, 1206
5V_D	$V_{CC} = 12- 27 \text{ V}$, Pout = up to 364W	2 x 22uF 0603, X7R, >6V3 1 x 100nF 0603, X7R, >6V3 1 x 10nF 0603, X7R, >6V3
5V_A	$V_{CC} = 12- 27 \text{ V}$, Pout = up to 364W	2 x 22uF 0603, X7R, >6V3 1 x 100nF 0603, X7R, >6V3 1 x 10nF 0603, X7R, >6V3

Table 7 – Minimum power supply bypassing

Note all capacitors described in Table 7 are Ceramic unless otherwise stated from quality suppliers

3.2 Over temperature shutdown

The module comes standard with over temperature protection circuitry that prevents damage to the internal electronics in the event that heat sinking is not sufficient for the power being driven into the load. When the over temperature shutdown activates, OT~ is driven LOW and the module output (audio) is muted. In order to restore normal operation the 5V_D power rail need to be gated low for a minimum of 25ms to clear this state.

3.3 Input signal conditioning

The circuit in Figure 4 is recommended to convert a single ended signal into differential which enables full use of the amplifiers dynamic input range. This circuit is not mandatory and the amplifier can be operated single ended with a marginal reduction in its performance specs.

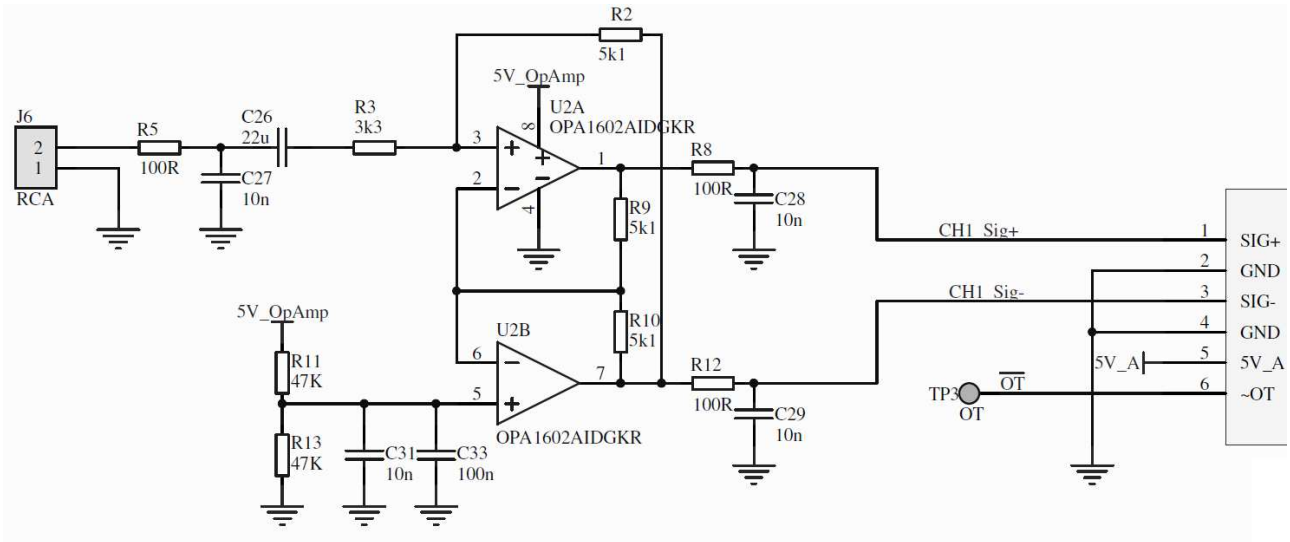


Figure 4 – Converting single ended input to differential

3.4 Output stage filtering

The circuit depicted in Figure 5 must be implemented to ensure correct operation when driving a speaker.

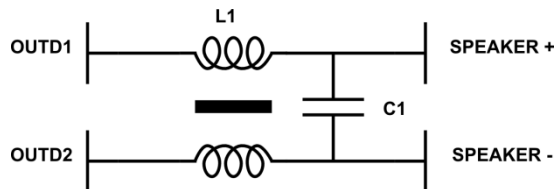


Figure 5 – Required output stage filter

The recommended values of L1 and C1 are as follows:

L1 – Refer to magnetic specification AM-SMT-IND-1.PDF for recommended value and construction

3.5 EMI filtering

We recommend circuit depicted in Figure 6 to filter out high frequency components so the amplifier is EMI compliant. The circuit recommended includes a connection to the amplifier CHASSIS which is critical in the function of this filter:

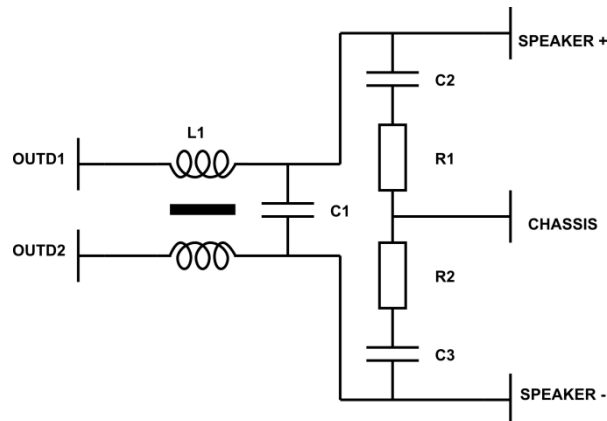


Figure 6 – Output stage filter and EMI filter

Recommended component values:

- CHASSIS = Chassis connection to the case of the amplifier. Where the case is plastic, a power plane on the PCB could be used as a virtual chassis ground plane.
- C2 / C3 = 100pF Ceramic Capaitor, X7R, >35V, 1206
- R1 / R2 = 47R 0805 Thin/Metal Film

3.6 PCB layout guidelines

The following guidelines are recommendations for system design and layout with the AM-SMT-24-01 module for Figure 7 on the top layer of the PCB:

1. Solid polygon pours are recommended to connect OUTD1/OUTD2 to the output filter and connector to reduce inductance and ohmic losses.
2. Solid via studding of the PCB from top layer to bottom to remove heat from the GND pad of the AM-SMT-24-01 module
3. Solid GND pour under all available sections of the module where other copper tracks are not required to reduce any possible EMI and maximise heat sinking area.
4. Pins 2 and 4 act as guard traces between the input signals and power supplies so a solid GND is recommended as well as via stitching to internal GND layers
5. Bypassing required as close as possible to the module VCC input pins to reduce loop currents and provide a sufficiently low inductance path for high speed transient currents. The input connector should also constitute thick copper to handle up to 20A.

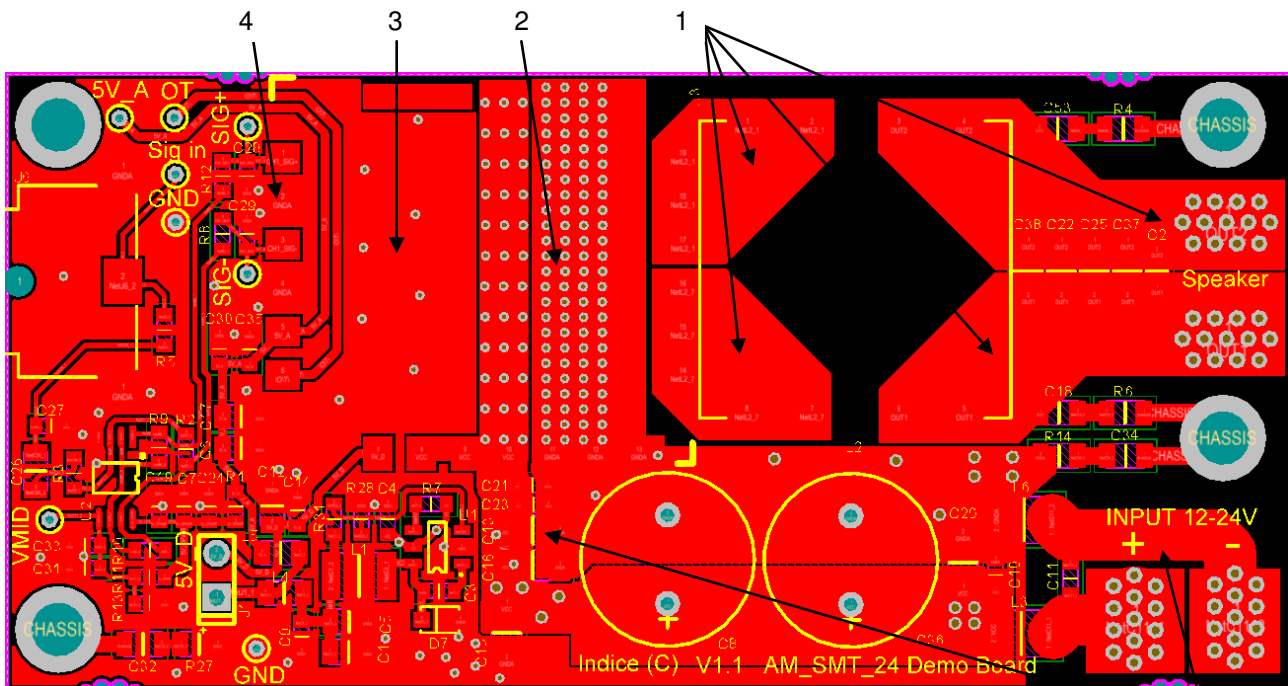


Figure 7 – Top layer suggestions for the AM-SMT-24-01 PCB layout

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The following guidelines are recommendations for system design and layout with the AM-SMT-24-01 module for Figure 8 on the bottom layer of the PCB:

1. In order to run the module at up 364W, the base PCB will need to be connected to the housing to dissipate heat at elevated ambient conditions (automotive for example). Under these conditions you can dedicate an area approximately the size of the module to connect the PCB with a gap pad or thermal compound to the heat sink
2. The EMI filter is constructed such that it functions well when connected to the chassis of the amplifier if it is a conductive metal. In the event the housing is plastic, a virtual GND is required on the bottom layer of the PCB.

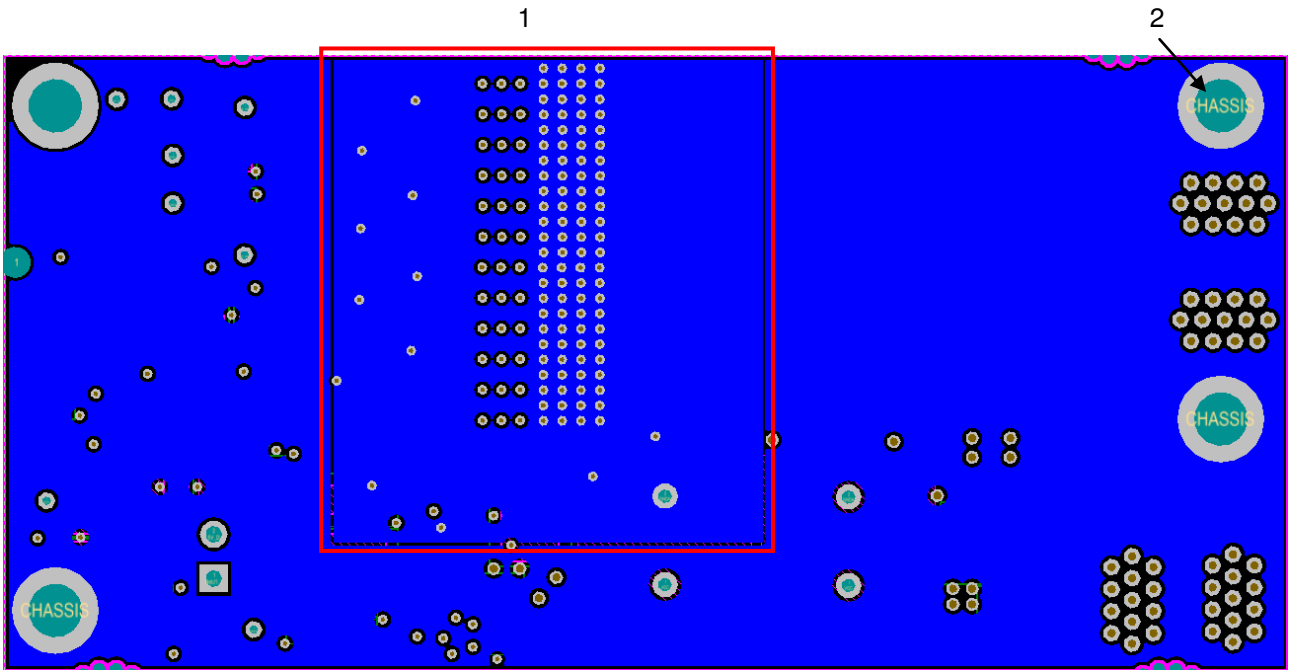


Figure 8 – Bottom layer suggestions for the AM-SMT-24-01 PCB layout

The evaluation board is constructed with a 1.6mm, 4 layer FR4 with 2oz copper and 70um plated through holes to ensure the board is able to reliably handle the currents for driving a speaker at high power.

4 Mechanical drawings

4.1 Module drawing

Below in Figure 9 are the dimensions of the AM-SMT-24-01 module.

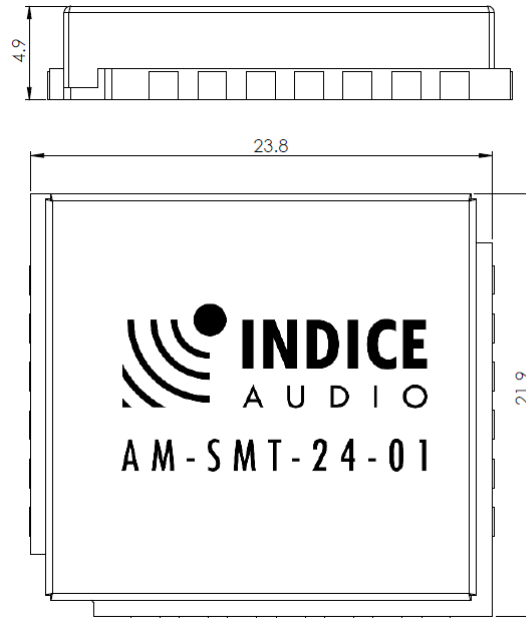


Figure 9: Package details. All noted dimensions in mm. Not to scale.

4.2 PCB Footprint

Suggested dimensions for PCB.

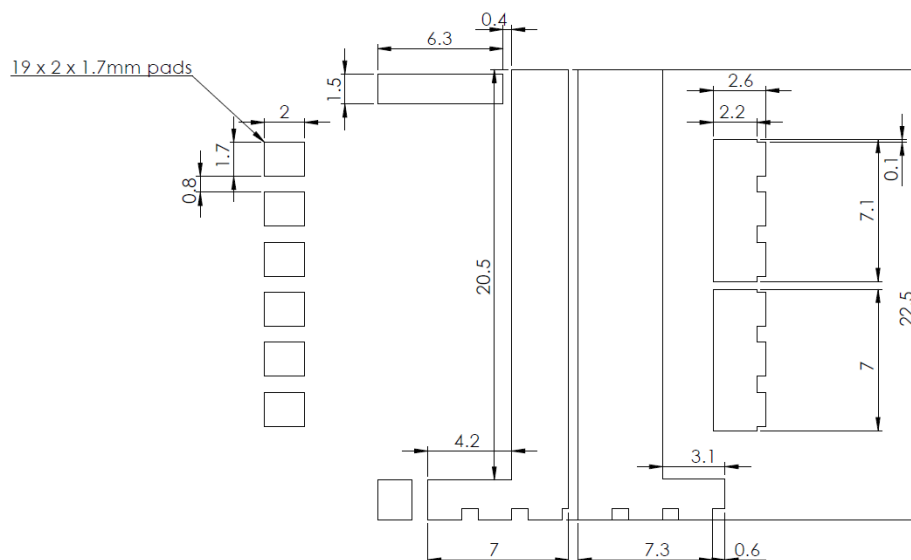


Figure 10: Suggested PCB footprint. All noted dimensions in mm. Not to scale.

5 Ordering Information

Ordering code	Interface	Description
AM-SMT-24-01	SMT	Power amplifier module (<i>Blade</i>)
EVM-1-SMT-01	EVB	Single channel evaluation board

6 Revision Control

Version	Date	Details
0.1	07/07/2014	Document creation
0.2	10/07/2014	Updated description in section 3.2
0.3	11/07/2014	Updated image in section 3.3 and edited text in section 3.4
0.4	04/08/2014	Updated performance specifications in various sections based on current test data
0.5	03/09/2014	Updated sections 2.1, 2.3, 3.1, 3.6
0.6	02/10/2014	Updated sections 1.2, 2.1, 2.5, 3.2