AXPA47576

2x45W MOSFET
Dual Bridge 24V Audio Power Amplifier

ENCHIP 能芯

Preliminary Datasheet — Feb 2022

Description

The AXPA47576 is a dual bridge audio Class AB power amplifier with MOSFET output power stages. It has been specifically designed for 24V power supply system making it compatible with truck/bus applications. The feedback topology allows excellent distortion performance and the integrated buffer minimizes the need for external components. The fully complementary P-channel/N-channel output structure allows rail-to-rail output voltage swing minimizing saturation losses. The AXPA47576 integrates a DC offset detector, a clipping detector, and a diagnostic output.

Features

- 24V battery operation
- High output power capability
  - 2 x 45W/4Ω Max @ 28V, Sq Wave
  - 2 x 25W/4Ω @ 28V, 1kHz; 10% THD
- Minimized external components`
  - No decoupling capacitors
  - No bootstrap capacitor
  - No external compensation
  - Internally fixed gain
- Standby function
- Mute function
- Diagnostic pin for:
  - Clip detector (THD 2%)
  - Short circuit detection
  - Thermal protection
- Output DC offset detection
- Protections:
  - 60V load dump
  - Overrating chip temperature
  - Output short circuit protection (to GND, VCC and across the load)
  - ESD

Table 1 Device Summary

Order code	Package	Packing
AXPA47576	HZIP15	Tube

HZIP15

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

Contents

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

List of Figures

List of Tables

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

1 Block Diagram and Application Circuit

Figure 1 Block diagram

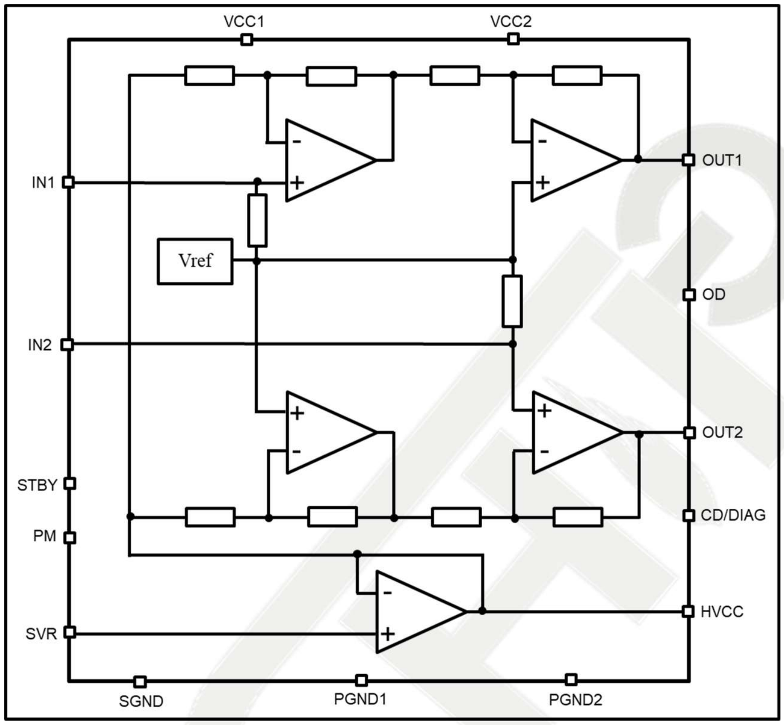
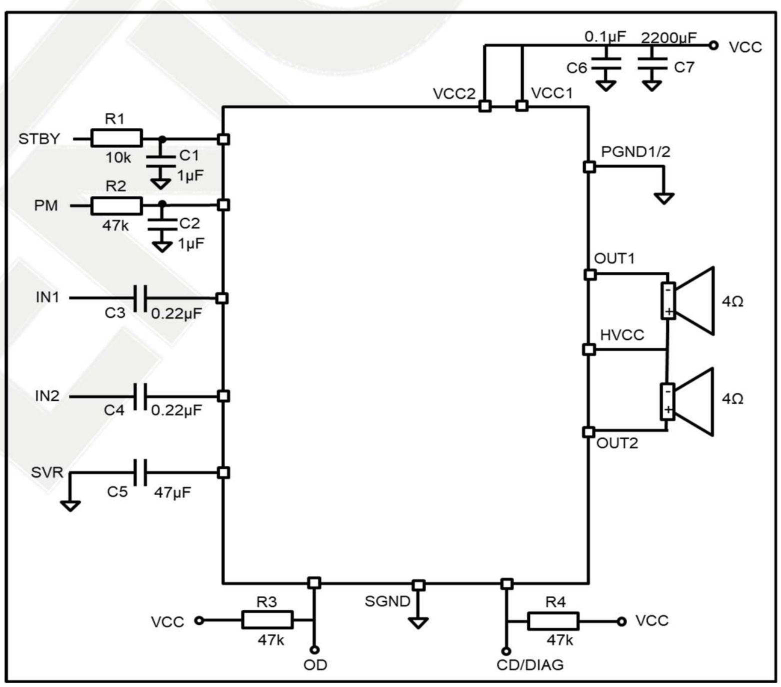


Figure 2 Application circuit

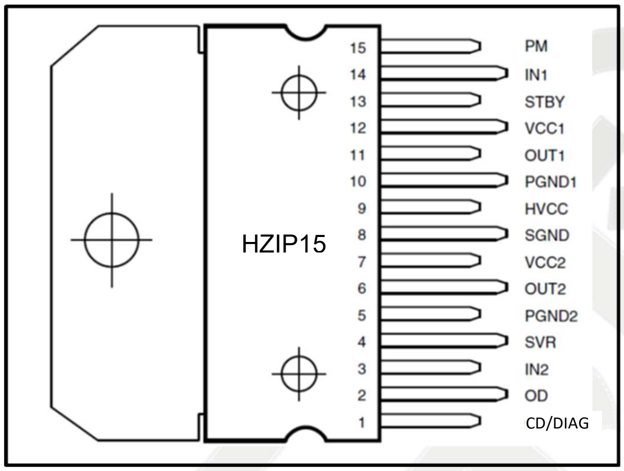


Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

2 Pin Description

2.1 Pin Names

Figure 3 Pin connection



2.2 Pin Functions

Table 2 Pin Functions

Pin number	Pin name	Description
1	CD/DIAG	Clip Detector / Diagnostic
2	OD	Offset Detector
3	IN2	Left Channel Input
4	SVR	SVR
5	PGND2	Power Ground 2
6	OUT2	Left Channel Output
7	VCC2	Supply Voltage 2
8	SGND	Signal Ground
9	HVCC	Half Supply Voltage Buffer
10	PGND1	Power Ground 1
11	OUT1	Right Channel Output
12	VCC1	Supply Voltage 1
13	STBY	STBY
14	IN1	Right Channel Input
15	PM	Play/Mute

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

3 Electrical Specifications

3.1 Absolute Maximum Ratings

Table 3 Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
VCC	Supply Voltage	-0.3 to 32	V
V_{SPK}	Peak supply voltage (t = 50ms) not operating	60	V
V_{DCS}	Not operating max DC supply voltage	36	V
PGND, SGND	Ground pins	-0.3 to 0.3	V
SVR	Supply voltage rejection filter	-0.3 to 20	V
IN1, IN2	Inputs	-0.3 to 5	V
OD, CD/DIAG	Offset Detector, Clip Detector/Diagnostic	-0.3 to VCC	V
PM	Play Mute	-0.3 to 5	V
Ptot	Power dissipation T_{case} = 85°C	85	W
T_{stg}, T_j	Storage and junction temperature range	-40 to 150	°C

3.2 Thermal Data

Table 4 Thermal Data

Symbol	Parameter	Value	Unit
$R_{th\ j\text{-}case}$	Thermal resistance junction-to-case Max.	2	°C/W

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

3.3 Electrical Characteristics

VCC = 28V, R_L = 4Ω, f = 1kHz, R_g= 0, T_{amb} = 25°C, unless otherwise specified.

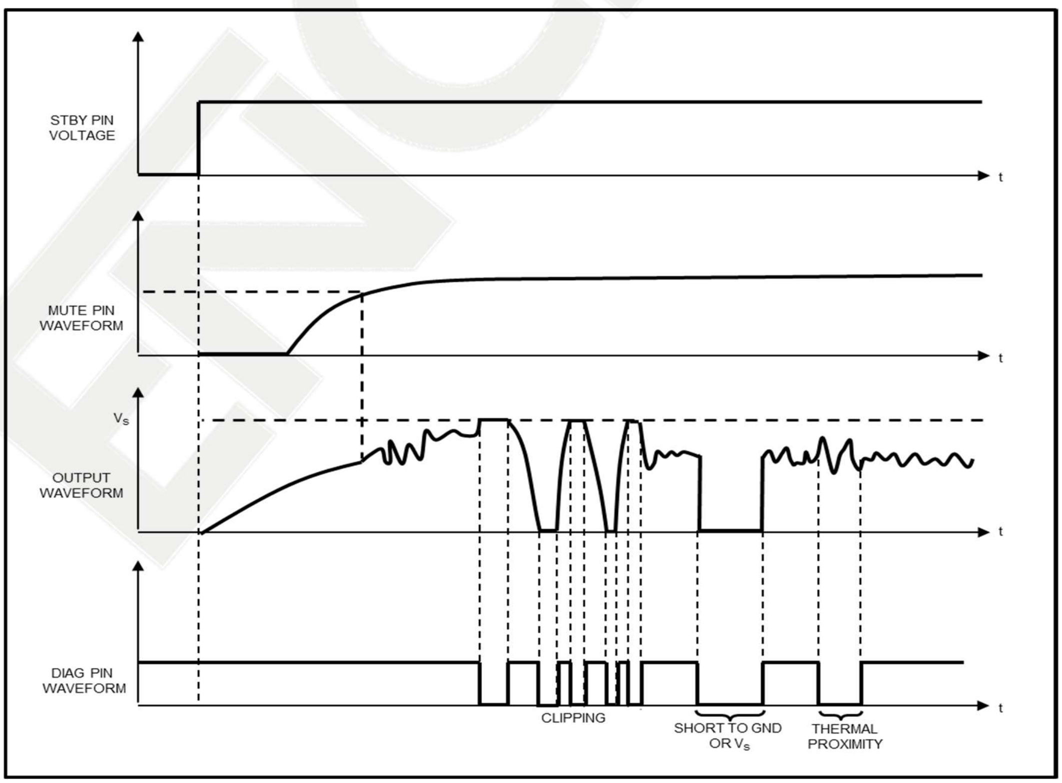
Table 5 Electrical Characteristics

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
General						
VCC	Supply voltage	-	8	-	32	V
I_q	Total quiescent current	R_L = ∞	-	90	130	mA
I_{STBY}	Standby current consumption	0 < V_{STBY} < 1.2V	-	-	10	μA
R_{IN}	Input impedance	-	50	55	-	kΩ
V_{OS}	Offset voltage	-	-100	-	+100	mV
V_{dth}	Dump threshold	-	~~3336~~	36~~37.5~~	~~39~~	V
I_D	Dump current	VCC = 60V	-	53~~18~~	~~40~~	mA
Audio section						
P_O	Output power	THD = 1%	20	22	-	W
		THD = 10%	25	28	-	
$P_{O\ MAX}$	Maximum output power	Square wave input	43	45	-	W
THD	Distortion	P_o = 4W; f = 1kHz	-	0.05	0.1	%
CT	Cross talk	f = 1kHz; P_O = 4W	50	65	-	dB
		f = 10kHz; P_O = 4W	45	60	-	dB
G_V	Voltage gain	-	25	26	27	dB
E_{NO}	Output noise voltage	22Hz to 22kHz, Mute mode	-	60	100	μV
SVR	Supply voltage rejection	f = 1kHz; V_R = 1Vpk	-	50	-	dB
Standby						
V_{SBIN}	Standby input threshold voltage		-	-	1.2	V
V_{SBOUT}	Standby output threshold voltage		2.6	-	-	V
ASB	Standby attenuation		90	110	-	dB
I_{PIN}	Standby pin current	Play mode	-1	-	1	μA

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

Mute pin						
A_M	Mute attenuation	-	90	100	-	dB
$V_{M\ IN}$	Mute input threshold voltage	Mute mode	-	-	1.2	V
$V_{M\ OUT}$	Mute output threshold voltage	Play mode	2.6	-	-	V
$V_{AM\ IN}$	Vs auto-mute threshold	Play mode Attenuation = -3dB V_{OUT} = 2V_{RMS}; f = 1kHZ	6.7	7.25	8.0	V
Clipping Detector (not guaranteed for Vs < 10V)						
CD_{THD}	Clipping detector threshold	10V < VCC < 32V	-	2	-	%
CD_{SAT}	Clipping detector saturation voltage	10V < VCC < 32V Cd On; I_{CD} = 1mA	-	-	0.2	V
Offset Detector						
O_D	Offset detector threshold	Play mode AC input = 0	±1	±2	±3	V
V_{OFF_SAT}	Offset detector saturation voltage	V_O – V_{HVCC} > 3V, I_{OD} = 1mA	-	-	0.2	V

Figure 4 Audio Section Waveforms

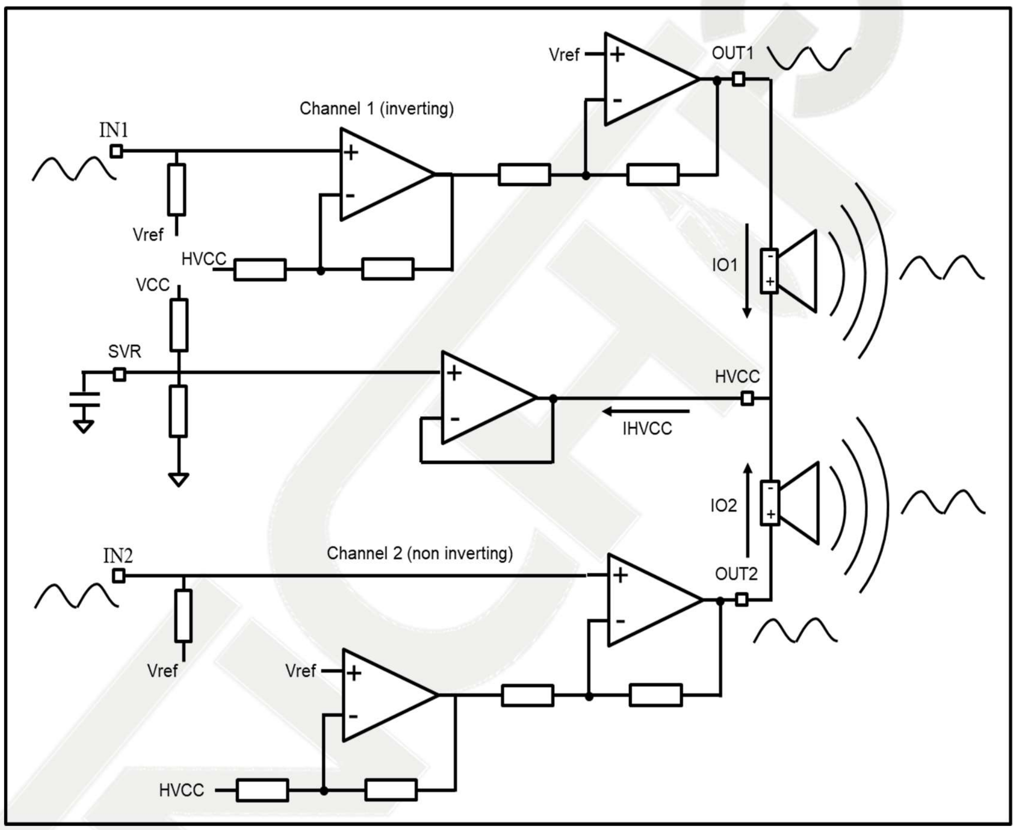


Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

4 Principle of Operation

The AXPA47576 is an innovative stereo audio amplifier meant for typical 24V battery vehicles. The amplifier works in a single-ended configuration without the large decoupling capacitors on the outputs normally required by the single-ended topology. Its principle of operation is depicted in Figure 5.

Figure 5 Amplifier Structure



Channel 1 is electrically inverting its input signal whereas channel 2 is not. If the speakers are connected with the positive pole of speaker 2 connected to OUT2 and the negative pole of speaker 1 connected to OUT1, then the two channels both behave as non-inverting. Speaker 1 and speaker 2 have one terminal in common and further connected to a half VCC (HVCC) buffer.

If the signals at IN1 and IN2 are identical, then the voltage at OUT1 and OUT2 is identical in magnitude but inverted (OUT1 = -OUT2), and the current flowing through speaker 1 is all coming from speaker 2, with no current going into the HVCC buffer. If the signal at IN1 is not identical to that at IN2, then the signal at the two outputs will not be identical either, and some current will flow into or out of the HVCC buffer, keeping the voltage at HVCC constant.

This structure allows therefore the amplifier to operate in a single-ended configuration with no need for decoupling capacitors.

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

Mathematically this can be expressed as:

$$V_{L1} = -G * Vin1$$
$$V_{L2} = +G * Vin2$$
$$I_{HVCC} = Io1 + Io2 = V_{L1}/RL + V_{L2}/RL = G\ (Vin2 - Vin1) / R_L$$

where $V_{L1,2}$ is the voltage across speaker 1 or 2, G is the gain of the amplifiers and RL is the load resistance (supposed identical for the two speakers).

In the common practice the two channels of the amplifier are used for the left and the right audio parts of the stereo signal, and therefore the two outputs are not identical. This means that it is never mathematically true that all the current into one speaker comes from the other speaker, so the HVCC buffer will always have to provide a certain amount of difference current.

Apart from the fact that the left and the right audio channels are not identical unless the program is monophonic, other reasons why the HVCC buffer has to provide current are: imbalance in the level of the L and the R channel, equalization-induced delay in one channel compared to the other.

The current provided by the HVCC buffer leads to non-negligible power dissipation inside the IC: this should be added to power dissipation the output stages 1 and 2. It is necessary to keep this additional dissipation in mind when dimensioning the car radio heat sink.

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

5 Power Dissipation Computation

The instantaneous power dissipated by each output stage is given by the formula below:

$$P_{D1,2}(t) = 1/R_L |V_{L1,2}(t)| (VCC/2 - |V_{L1,2}(t)|)$$

with $V_{L1,2}(t)$ being the output signal on each of the two channels $V_{L1,2}(t) = G * V_{in1,2}(t)$.

If the two input signals are not identical, as seen in Section 4, a current IHVCC flows into or out of the half VCC buffer, this current causes dissipation within the HVCC buffer given by:

$$P_{DHVCC}(t) = VCC/(2R_L) | V_{L2}(t) - V_{L1}(t) |$$

which is obviously 0 when the two channels have identical signals.

The total instantaneous power dissipation inside the AXPA47576 is therefore given by:

$$P_{dtot}(t) = P_{D1}(t) + P_{D2}(t) + P_{DHVCC}(t)$$

The dimensioning of the heat sink of the system must take into consideration these three components.

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

6 Functional Description

6.1 Diagnostics pins description

The AXPA47576 includes an offset detector pin and a clip detector/diagnostic pin.

DC offset detector is intended to avoid that an anomalous DC offset on the inputs of the amplifier may be multiplied by the gain and result in a dangerous large offset on the outputs. This may lead to speakers damage due to overheating.

The feature works with the amplifier unmuted and no signal at the inputs.

Moreover, there is a pin named CD/Diag: the behavior of this pin is showed on Figure 4.

Whenever a failure condition (between thermal warning, output waveform clipping, short circuit to GND or V_{CC}) is verified by the IC, the level of this pin goes true (low).

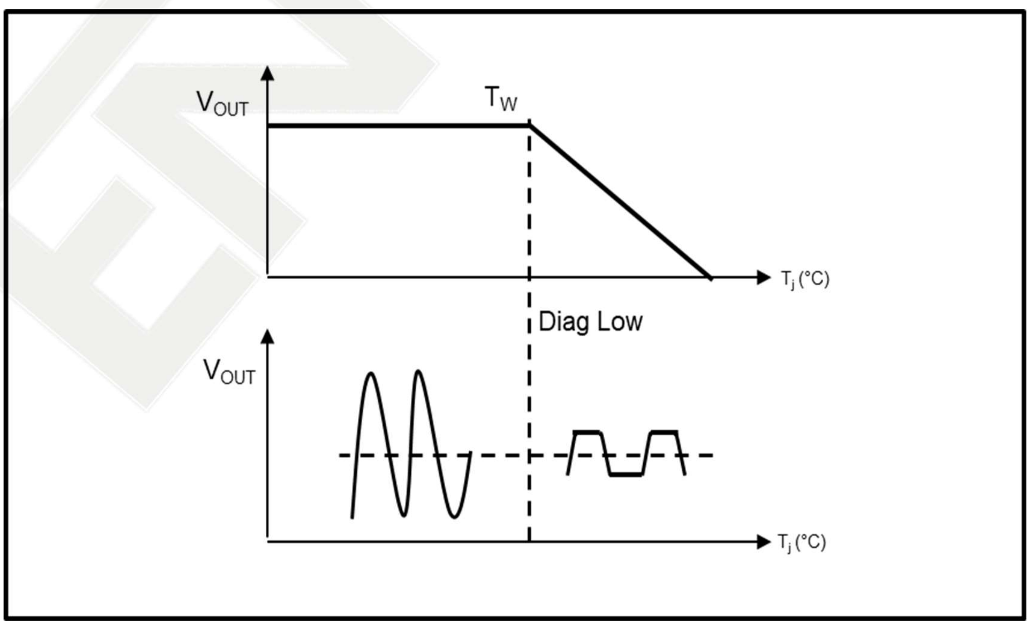
6.2 Thermal protections

Thermal protection function is triggered when junction temperature rises above the normal operating range, thus avoiding chip damaging.

For behavior description, refer to Figure 4 and 6. When the temperature reaches thermal warning (T_W = 140°C typ) the CD/Diag pin is driven low. Thermal foldback begins limiting the audio input to the amplifier stage. This effectively limits the output power capability of the device, thus reducing the temperature to acceptable levels without totally interrupting the operation of the device. Thermal mute is temperature when -6dB output attenuation is reached (T_m = 160°C typ).

The output power will decrease to the point at which thermal equilibrium is reached. Thermal equilibrium will be reached when the reduction in output power reduces the dissipated power so that the die temperature falls below the thermal foldback threshold.

Figure 6 Thermal Protection Diagram



Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

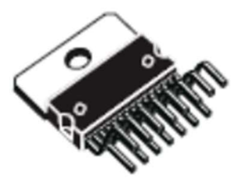
7 Package information

7.1 Package Outline Dimensions

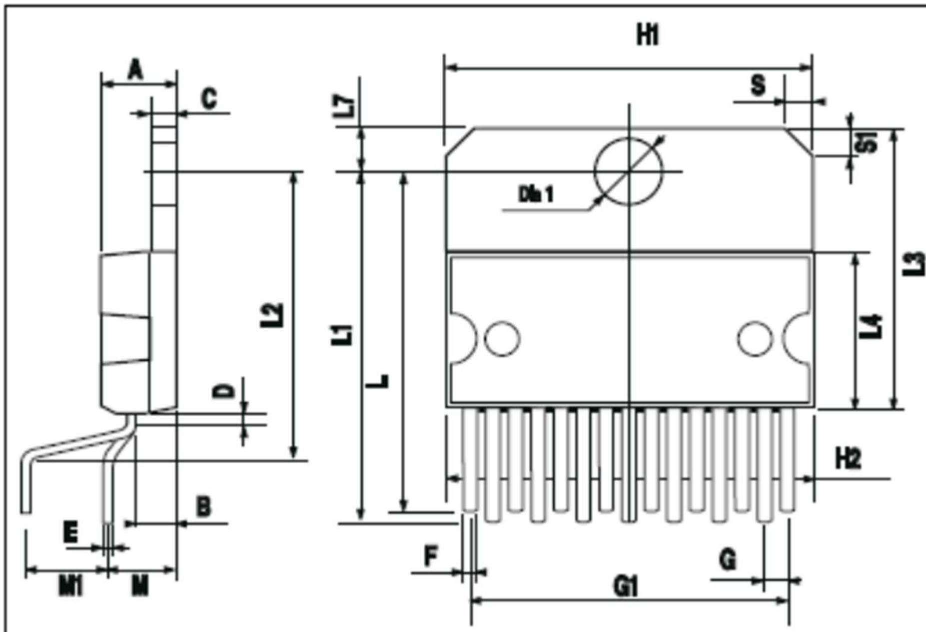
Figure 6 HZIP15 vertical mechanical data and package dimensions

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.66		0.75	0.026		0.030
G	1.02	1.27	1.52	0.040	0.050	0.060
G1	17.53	17.78	18.03	0.690	0.700	0.710
H1	19.6			0.772		
H2			20.2			0.795
L	21.9	22.2	22.5	0.862	0.874	0.886
L1	21.7	22.1	22.5	0.854	0.87	0.886
L2	17.65		18.1	0.695		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.25	4.55	4.85	0.167	0.179	0.191
M1	4.73	5.08	5.43	0.186	0.200	0.214
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152

OUTLINE AND MECHANICAL DATA



HZIP 15



Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

7.2 Package Marking Information

Figure 7 HZIP15 Marking Information

3 lines of alphanumeric coding:

Line 1: "AXPA" characters

Line2: "47576" characters to indicate AXPA47576

Line 2: "ww" to indicate week of production

"yy" to indicate year of production

"H" to indicate the location of assembly

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

8 Packing Information

Figure 8 Tube Packing Information

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd

9 Revision History

Table 6 Document Revision History

Date	Version	Description
Feb 2022	Draft	Preliminary version.

Copyright © 2022, Shenzhen EnChip Semiconductor Co. Ltd