

24W MONO CLASS-D AUDIO AMPLIFIER WITH LOAD DUMP AND I2C DIAGNOSTICS



DESCRIPTION

The IS32AP2123A is a Class-D audio amplifier for driving a mono speaker in BTL (Bridge-Tied-Load) configuration. It is capable of delivering 20W into 4Ω speaker at less than 1% THD+N from a 14.4V power supply.

It is a mono Class-D audio amplifier designed for automotive applications, such as emergency call (eCall), telematics, and instrument cluster, and infotainment applications. With a wide operating voltage range of 4.5V to 24V makes it ideal for start/stop or backup battery operation.

The IS32AP2123A comes with onboard load diagnostic hardware accessible via a standard I2C port. The internal diagnostics evaluate the output impedance to check for shorts across the outputs, to the battery, or to ground. The I2C interface allows the system to read diagnostic and protection device parameters.

The integrated 40V load-dump protection reduces external voltage clamp cost and size, for reliable automotive audio systems. The highly efficient (85%) IS32AP2123A comes in a thermally enhanced eTSSOP-16 package requiring no heatsink for typical operation.

QUICK START

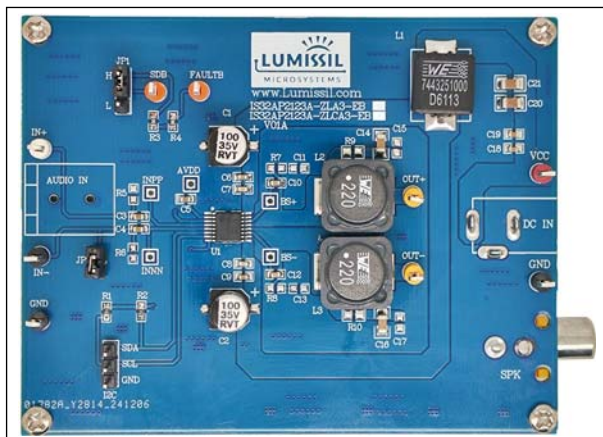


Figure 1 Photo of IS32AP2123A Evaluation Board

FEATURES

- 4.5V to 24V operating range
- Mono BTL digital power amplifier
- Differential analog input
- 24W output power at 10% THD+N into 4Ω
- 70dB power supply rejection ratio (PSRR)
- Up to 85% efficiency into 4Ω
- Support spread spectrum to optimize EMI
- I2C Interface
 - Query and set up critical device parameters
- Automatic load diagnostic functions during power up and after fault events:
 - Open and shorted output load
 - Output-to-power and -ground shorts
- Support AM avoidance (400 and 500kHz modulation frequency)
- AGC function with adjustable power limiter
- Protection and monitoring functions:
 - Short-circuit (to ground, VCC or output-to-output) protection
 - 40V load dump protection
 - Output DC level detection while music is playing
 - Over temperature protection
 - Over and under voltage protection
- Designed for automotive EMC requirements
- AEC-Q100 Qualified with Temperature Grade 1: -40°C to 125°C (IS32AP2123A-ZLA3-TR)
- AEC-Q100 qualification in progress with Temperature Grade 1: -40°C to 125°C (IS32AP2123A-ZLCA3-TR)
- RoHS & Halogen-Free Compliance
- TSCA Compliance
- -40°C to +125°C ambient operating temperature

RECOMMENDED EQUIPMENT

- 4.5~24V, 3A power supply (2.1mm adapter)
- Audio source with 3.5mm mini plug
- Speaker (4Ω or 8Ω) with RCA-type plugs

ABSOLUTE MAXIMUM RATINGS

- ≤ 24V power supply
- ≥ 2Ω speaker

Caution: Do not exceed the conditions listed above; otherwise the board will be damaged.

ORDERING INFORMATION

Part No.	Temperature Range	Package
IS32AP2123A-ZLA3-EB IS32AP2123A-ZLCA3-EB	-40°C to +125°C (Automotive)	eTSSOP-16, Lead-free

Table 1 Ordering Information

For pricing, delivery, and ordering information, please contact Lumissil's analog marketing team at analog@lumissil.com or (408) 969-6600.

PROCEDURE

The IS32AP2123A demo board is fully assembled and tested. Follow the steps listed below to verify board operation.

Caution: Do not turn on the power supply until all connections are completed.

- 1) Connect a of 4Ω (or 8Ω) speaker to the (SPK) RCA phono plug.
- 2) If using differential inputs, connect the differential audio inputs to (IN+, IN-) test points (remove JP2 if installed). If a single-ended input is used, then connect only the IN+ test point and close jumper JP2 or use the 3.5mm connector (AUDIO IN).
- 3) Connect the power supply ground to the GND test point and positive to the VCC test point or connect a power jack to DC IN.
- 4) Turn on the power supply.
- 5) Turn on the audio source.

PERFORMANCE DESCRIPTION

- 1) Pulling SDB pin low will put the IS32AP2123A in a shutdown low quiescent current mode (<20μA) with outputs muted. The evaluation board default is SDB pin tied high to a 3.3V LDO through a resistor.
- 2) The gain setting for the IS32LT2123A device is I2C programmable. The four gain options are 20 dB, 26 dB, 32dB, and 36 dB. Set the gain by modifying I2C control register 0x13. By default, the gain is 26 dB.
- 3) The PWM switching frequency is I2C programmable. The two $f_{(sw)}$ options are 400 kHz and 500 kHz. Programming the frequency in control register 0x13 via I2C. By default, $f_{(sw)}$ is 400 kHz.
- 4) The device incorporates load diagnostic circuitry designed for detecting and determining the status of the output connections. The device supports the following diagnostics:
 - Short to GND
 - Short to VCC
 - Short across load
 - Open load

The device reports the presence of any of the short or open conditions to the system via I2C register read. Enable or disable this function by LDC bit of 0x14 register, default is enabled.

The load diagnostic function runs at start-up or when the device is in a fault state (DC detect, overcurrent, overvoltage, under voltage, and over

temperature). During this test, the outputs are in a Hi-Z state. The device determines whether the output is a short to GND, short to VCC, open load, or shorted load. The load diagnostic biases the output, which therefore requires limiting the capacitance value for proper functioning; see the Recommended Operating Conditions. The load diagnostic test takes approximately 260ms to run. Note that the check phase repeats if a fault is present or a large capacitor to GND is present on the output. On detection of an open load, the output will still operate. On detection of any other fault condition, the output goes into a Hi-Z state, and the device checks the load continuously until removal of the fault condition. After detection of a normal output condition, the audio output is enabled.

- 5) AGC (Automatic Gain Control) Function - This is the function to limit the output power to fit different models of speaker, to protect the speakers from over stress of power. When output power goes over selected power limit level, AGC control function will be activated, the amplifier gain will decrease to bring output power back under the limit. Different to simple output power limit function, AGC control function of IS32AP2123A can limit power while not causing any clipping at the differential signal output. The sound quality will not be hurt when the AGC is activated. The power limit of the AGC can be selected through I2C. By default, this function is disabled.
- 6) FAULTB pin - This active-low open-drain output pin indicates the presence of a fault condition which requires the device to go into the high impedance mode. On assertion of this pin, the device has protected itself and the system from potential damage. The system can read the exact nature of the fault via I2C.
- 7) Spread Spectrum Function - To optimize the EMI performance, the IS32AP2123A includes a spread spectrum feature. In spread spectrum mode, the switching frequency keeps changing around a central frequency of 400 kHz/500kHz, reducing the wideband spectral contend, improving EMI emissions radiated by the speaker and associated cables and traces. To enable or disable this function in control register 0x13 via I2C. By default, this function is disabled.
- 8) Please refer to the IS32AP2123A datasheet for additional device information.

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JUMPER SETTING TABLE

Jumper	Options	Setting (Jumper on “H” for logic 1, on “L” for logic 0)
JP1	Enable/disable amplifier	Jumper on “H” enable, Jumper on “L” disable
JP2	Sets the single ended audio input	Insert jumper JP2 set negative audio input (IN-) to AC ground.

Table 2 IS32AP2123A Control Guide

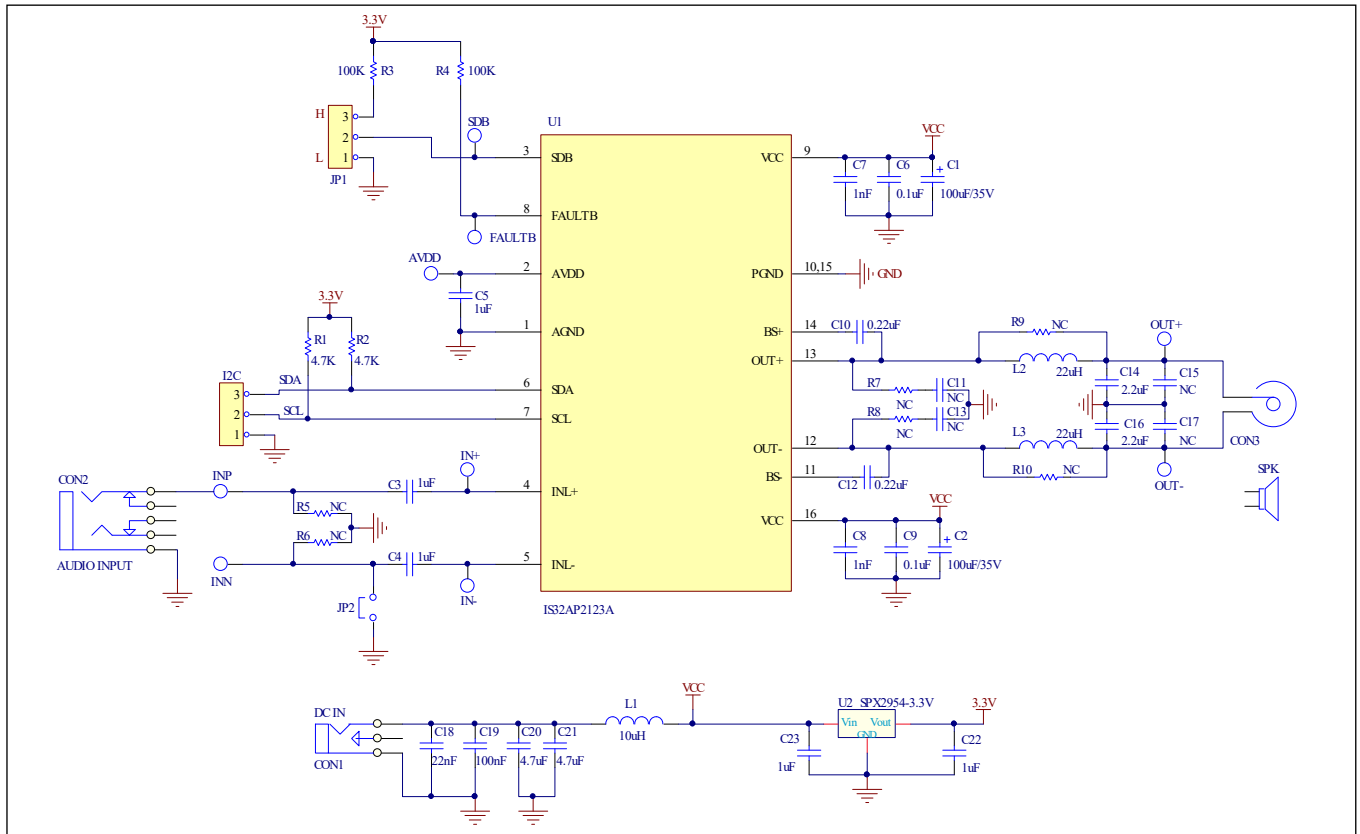


Figure 2 IS32AP2123A Application Schematic

24W MONO CLASS-D AUDIO AMPLIFIER WITH LOAD DUMP AND I2C DIAGNOSTICS



BILL OF MATERIALS

Name	Symbol	Description	Qty	Supplier	Part No.
IC	U1	24W MONO AUTOMOTIVE CLASS D AUDIO AMPLIFIER	1	Lumissil	IS32AP2123A
IC	U2	3.3V/250mA Low Dropout Voltage Regulator	1	Sipex	SPX2954AM3
Capacitor	C1~C2	CAP, 100 μ F, 35V, $\pm$ 20%	2		
Capacitor	C3~C5,	CAP, 1 μ F, 16V, $\pm$ 10%, SMD	3	Yageo	AC0603KRX7R7BB105
Capacitor	C6,C9,C19	CAP, 0.1 μ F, 50V, $\pm$ 10%, SMD	3	Yageo	AC0603KRX7R9BB104
Capacitor	C7,C8	CAP, 1nF, 50V, $\pm$ 10%, SMD	2	Yageo	AC0603KRX7R9BB102
Capacitor	C10,C12	CAP, 0.22 μ F, 50V, $\pm$ 10%, SMD	2	Yageo	AC0603KRX7R7BB224
Capacitor	C14,C16	CAP, 2.2 μ F, 50V, $\pm$ 10%, SMD	2	Yageo	AC1206KKX7R9BB225
Capacitor	C18	CAP, 22nF, 50V, $\pm$ 10%, SMD	1	Yageo	AC0603KRX7R9BB223
Capacitor	C20,C21	CAP, 4.7 μ F, 50V, $\pm$ 10%, SMD	2	Yageo	CC1206KKX7R9BB475
Capacitor	C22,C23	CAP, 1 μ F, 50V, $\pm$ 10%, SMD	2	Yageo	AC1206KKX7R9BB105
Resistor	R1,R2	RES, 4.7K, 1/10W, $\pm$ 5%, SMD	2	Yageo	AC0603JR-0747KL
Resistor	R3,R4	RES, 100K, 1/0W, $\pm$ 5%, SMD	2	Yageo	AC0603JR-07100KL
Resistor	R5~R10,	Not installed			
Capacitor	C11,C13, C15,C17	Not installed			
Inductor	L1	10 μ H, $\pm$ 20%, Isat=12.5A, Rdc=27m Ω	1	Würth Elektronik	7443251000
Inductor	L2,L3	22 μ H, $\pm$ 20%, Isat=3.77A, Rdc=31m Ω	2	Würth Elektronik	744771122
Connector	DC IN	2.1mm DC connector	1		
Connector	SPK	RCA –type connector	1		
Connector	CON2	3.5mm min connector	1		

Bill of materials, refer to Figure 2 above.

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PCB LAYOUT

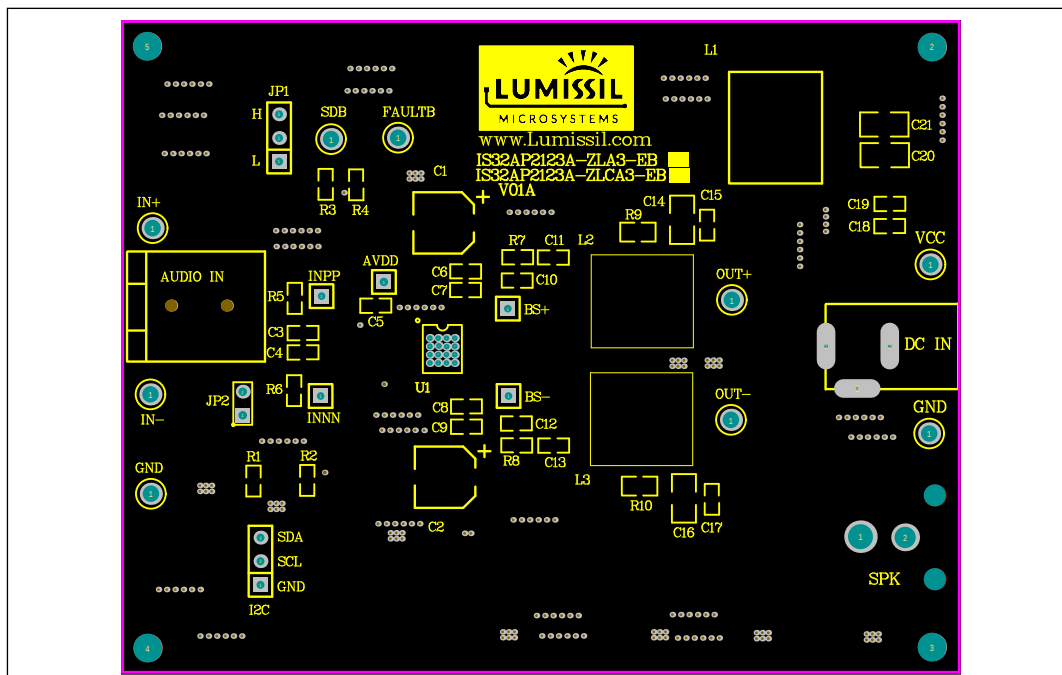


Figure 3 Board Component Placement - Top Layer

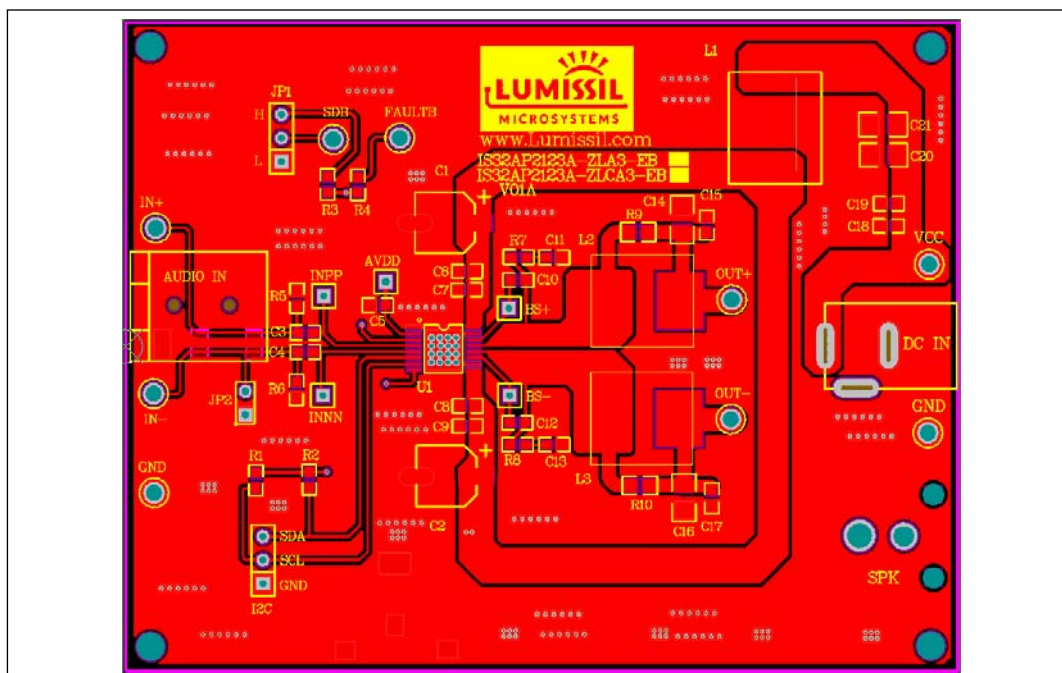
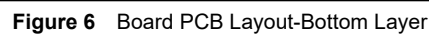
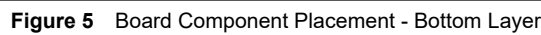


Figure 4 Board PCB Layout - Top Layer



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Rev. A, 12/25/2024

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REVISION HISTORY

Revision	Detail Information	Data
A	Initial Release	2024.12.25