Low No-Load Current, AM Suppression Function 155W Mono Class D Audio Power Amplifier

General Description

The IU8693E is a 145W mono Class D audio power amplifier. This device features a thermal pad designed on its top layer; when a heat sink is connected to the pad, it can achieve a continuous power output of over 145W and, under an appropriate power supply voltage, can drive loads as low as 2Ω. Equipped with advanced EMI suppression technology, the IU8693E adopts surface-mount technology (SMT) and requires only a small number of external components to enable the system to deliver high-quality audio output power.

The IU8693E has built-in overcurrent protection, short-circuit protection, and overtemperature protection, which effectively prevents the chip from being damaged under abnormal operating conditions. It can achieve an efficiency of over 92% at maximum, and its voltage withstand design of over 45V provides ultra-high reliability for the chip, effectively reducing the defect rate during the production process.

The IU8693E offers the EQB28 package option-with the same footprint as the SOP16 package and a heatsink on the top-for customers to choose from. The compact package size maximizes convenience for customers in saving PCB space and installing heat dissipation components. Its rated operating temperature range is from -40℃ to 85℃.

Package

- EQB28

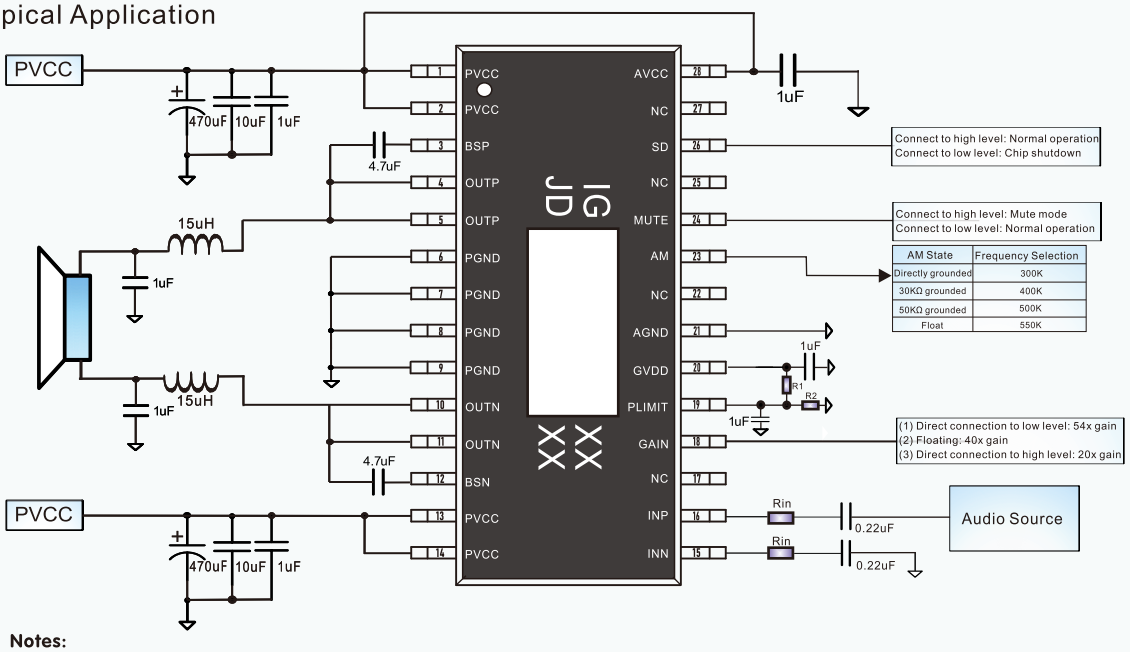
Features

- Output Power (THD+N=10%)
VDD=24V@RL=4Ω 75W; @RL=2Ω 145W instantaneous
VDD=28V@RL=4Ω 112W; @RL=3Ω 145W
VDD=30V@RL=4Ω 130W
VDD=32V@RL=4Ω 145W
VDD=34V@RL=4Ω 155W
VDD=36V@RL=8Ω 99W
- Single power supply with wide voltage range: 5V~36V
- High reliability design: 45V voltage withstand capability
- Efficiency: 92%@PVCC=15V PO=20W
- Three selectable gain levels
- Mute function control
- Audio system with filter network, quiescent current 15mA@24V
- Multiple switchable frequencies: AM suppression function
- Output pins facilitate wiring and layout
- Excellent short-circuit protection and temperature protection with automatic recovery function
- Good distortion performance and pop noise prevention Differential input
- Enhanced package design: Special design of top-layer thermal pad
- Meets automotive application requirements

Applications

- Car Audio
- Home Audio System
- Emergency Call

Typical Application

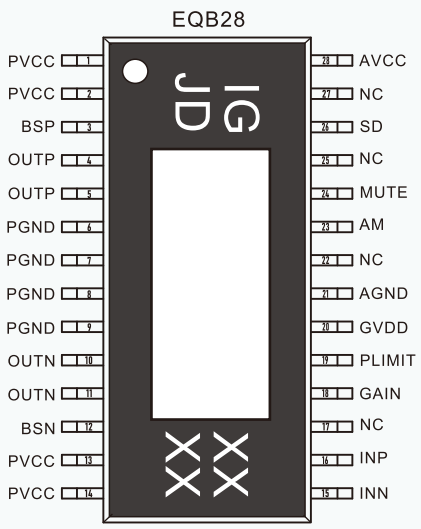


Notes:

- **It is recommended that the output inductor should have a saturation current of 6A or more.**
- **When the GAIN terminal is grounded, it integrates a 12K input resistor and a 650K feedback resistor; when the GAIN terminal is floating, it integrates a 15.2K input resistor and a 610K feedback resistor; when the GAIN terminal is connected to a high level, it integrates a 25.5K input resistor and a 510K feedback resistor.**

Pin Configuration and Functions

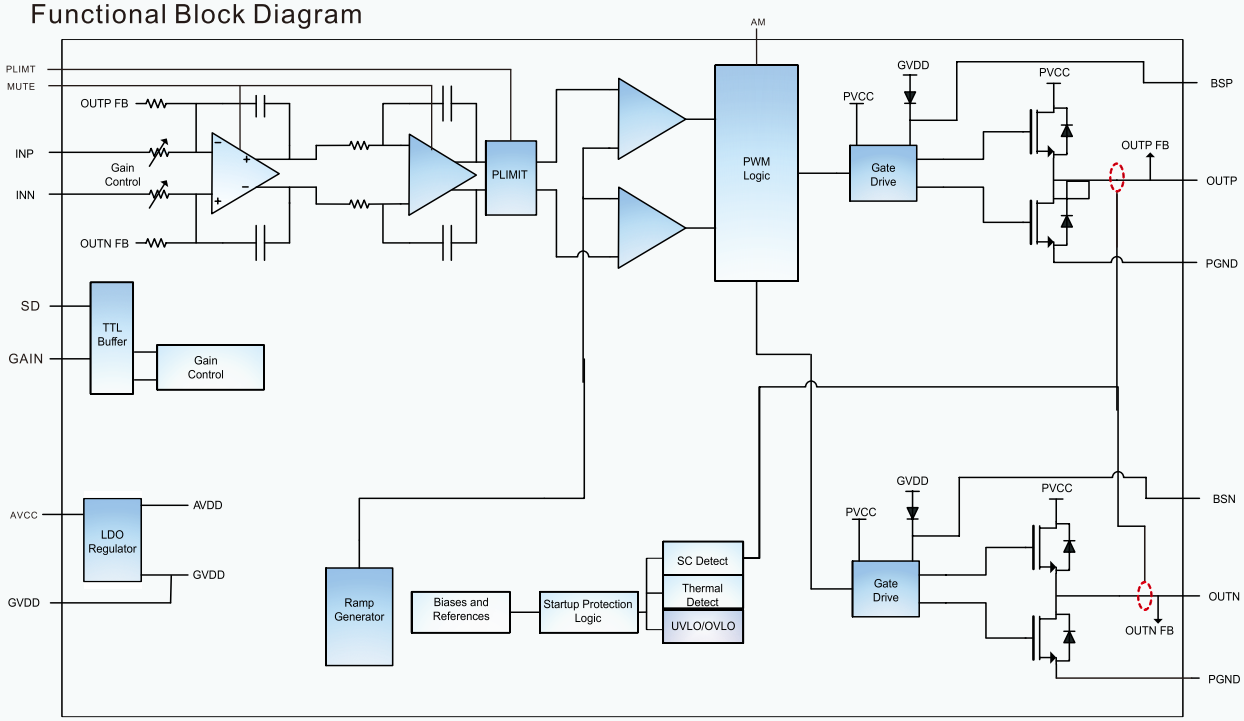
EQB28



Note:
- **The above diagram is a top view.**
- **The white frame in the diagram represents the top heatsink.**

NO.	NAME	I/O	DESCRIPTION
1,2	PVCC	P	Power supply
3	BSP	I	Bootstrapping of the positive output high-side transistor
4,5	OUTP	O	Positive terminal of audio output
6,7,8,9	PGND	P	Power ground
10,11	OUTN	O	Negative terminal of audio output
12	BSN	I	Bootstrapping of the negative output high-side transistor
13,14	PVCC	P	Power supply
15	INN	I	Negative terminal of audio input
16	INP	I	Positive terminal of audio input
17,22,25,27	NC	P	No-connection pin
18	GAIN	I	Gain control pin
19	PLIMT	I	Output Power Limiting Pin
20	GVDD	I	High-side transistor gate drive voltage
21	AGND	I	Analog ground
23	AM	I	AM Frequency Control Pin
24	MUTE	I	Mute Mode Control Pin
26	SD	P	Shutdown Control Pin
28	AVCC	P	Analog power supply

Functional Block Diagram



Absolute Maximum Ratings[1]

			Value
V_{CC}	Power supply	PVCC	-0.3V to 45V
V_I	Input pin voltage	SD GAIN,PLIMT,AM,MUTE INN,INP	-0.3V to 45V -0.3V to 6.0V -0.3V to 6.0V
T_A	Operating temperature range		-40℃ to 85℃
T_J	Junction operating temperature range		-40℃ to150℃
T_{stg}	Storage temperature range		-40℃ to150℃

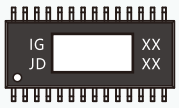
Recommended Operating Environment

Parameter	Description	Value	UNIT
PV_{CC}	Power supply voltage	5~36	V
T_A	Ambient temperature range	-40~85	℃
T_j	Junction temperature range	-40~150	℃

Thermal Characteristics

Parameter	Description	Value	UNIT
θ_{JA}	Package thermal resistance — Junction-to-ambient thermal resistance	45	℃/W
θ_{JC}	Package thermal resistance — Junction-to-case thermal resistance	10	℃/W

Ordering and Marking Information

Device	Package Type	Device Marking	Packing Type	Quantity
IU8693E	EQB28		Tube	50

ESD Susceptibility

ESD Susceptibility-HBM ---------- ±2kV

ESD Susceptibility-MM ---------- ±200V

1. The above parameters are only the limit values of device operation. It is not recommended that the working conditions of the device exceed the limit values. Otherwise, the reliability and life of the device will be affected, and even permanent damage will be caused.

Recommended Operating Conditions

Description		Test Conditions	MIN	MAX	UNIT
V_{CC}	Power supply	PVCC	5	36	V
V_{IH}	Input high level	SD,MUTE,AM,PLIMT,GAIN	2		V
V_{IL}	Input low level	SD,MUTE,AM,PLIMT,GAIN		0.2	V
I_{IH}	High-level input current	SD,MUTE,AM,PLIMT,GAIN,V_I=2V,V_{CC}=20V		50	uA
I_{IL}	Low-level input current	SD,MUTE,AM,PLIMT,GAIN,V_I=0.2V,V_{CC}=20V		5	uA
OVP	Overvoltage Protection			45	V

DC Parameters

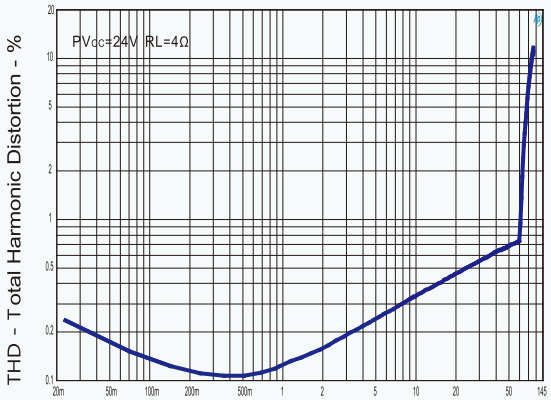
Description		Test Conditions		MIN	TYP	MAX	UNIT
$\|V_{OS}\|$	Output Offset Voltage	V_{IN}=0V，GAIN=36dB			6	15	mV
I_{CC}	Quiescent Current	SD=2V,4Ω speaker ,PV_{CC}=18V			15	18	mA
$I_{CC(SD)}$	Standby Current	SD=0V,No Load and No Filter,PV_{CC}=24V			50	300	uA
$r_{DS(on)}$	Drain-Source On-Resistance	V_{CC}=21V,I_O=500mA, T_J=25℃	Upper Transistor		100		mΩ
			Lower Transistor		100		
t_{on}	Turn-On Time	SD=2V			210		ms
t_{OFF}	Turn-Off Time	SD=0V			2		us
GVDD	Gate Drive Voltage	I_{GVDD}=100 mA		4.25	4.75	5.25	V
Vo	Maximum Output Voltage Under Power Limitation	$V_{(PLIMIT)}$ = 2V; V_I = 1Vrms			6.5		V
f_{OSC}	Oscillation Frequency	AM Directly grounded		270	300	330	KHz
		AM 30KΩ grounded		360	400	440	
		AM 50KΩ grounded		450	500	550	
		AM Float		500	550	600	

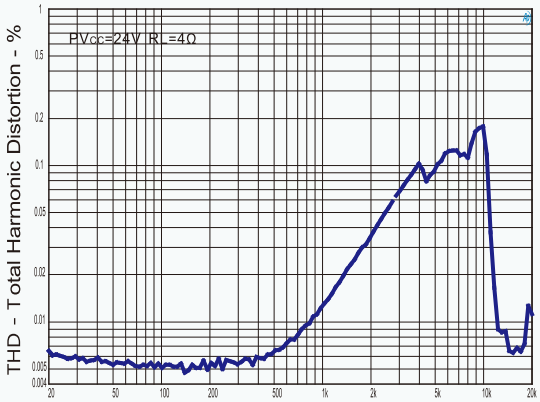
AC Parameters

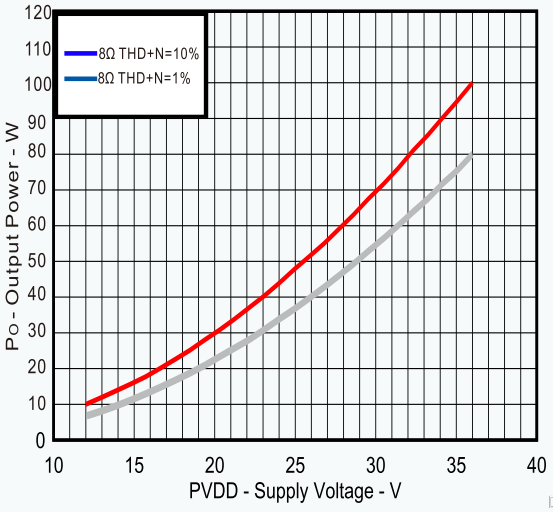
Description		Test Conditions	MIN	TYP	MAX	UNIT
K_{SVR}	Power Supply Rejection Ratio	1kHz，200mVpp Ripple，Gain=20dB Input AC-Coupled to Ground		70		dB
THD+N	Total Harmonic Distortion plus Noise	PV_{CC}=24V， f=1kHz, Po=20W		0.05		%
	Output Noise	20~22kHz， Aweight，Gain=20dB		100		uV
				-78		dBV
	Efficiency	PV_{CC}=15V， f=1kHz, Po=20W		92		%
SNR	Signal-to-Noise Ratio	Maximum Output at Gain = 20dB，THD+N < 1%，f=1kHz		102		dB
	Thermal Protection Temperature			170		℃
	Hysteresis Temperature			15		℃

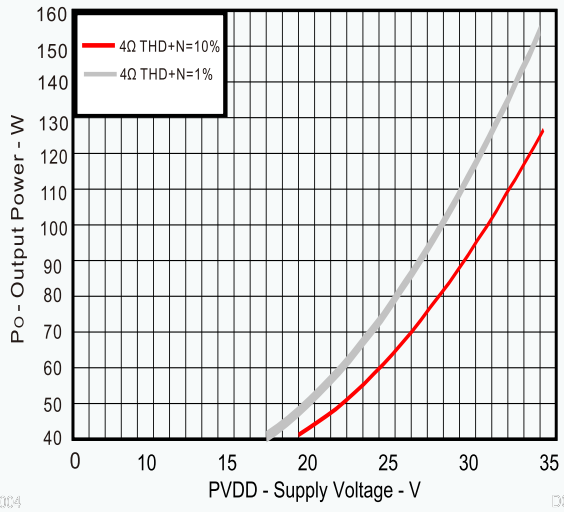
Po	Output Power	V_{DD} = 24V@RL = 4 Ω	THD+N=10%@P_O=75W	THD+N=1%@P_O=60W
		V_{DD} = 24V@RL = 2 Ω	THD+N=10%@P_O=145W	THD+N=1%@P_O=113W
		V_{DD} = 28V@RL = 4 Ω	THD+N=10%@P_O=112W	THD+N=1%@P_O=92W
		V_{DD} = 28V@RL = 3 Ω	THD+N=10%@P_O=145W	THD+N=1%@P_O=118W
		V_{DD} = 30V@RL = 4 Ω	THD+N=10%@P_O=130W	THD+N=1%@P_O=106W
		V_{DD} = 32V@RL = 4 Ω	THD+N=10%@P_O=145W	THD+N=1%@P_O=117W
		V_{DD} = 34V@RL = 4 Ω	THD+N=10%@P_O=155W	THD+N=1%@P_O=126W
		V_{DD} = 36V@RL = 8 Ω	THD+N=10%@P_O=99W	THD+N=1%@P_O=80W

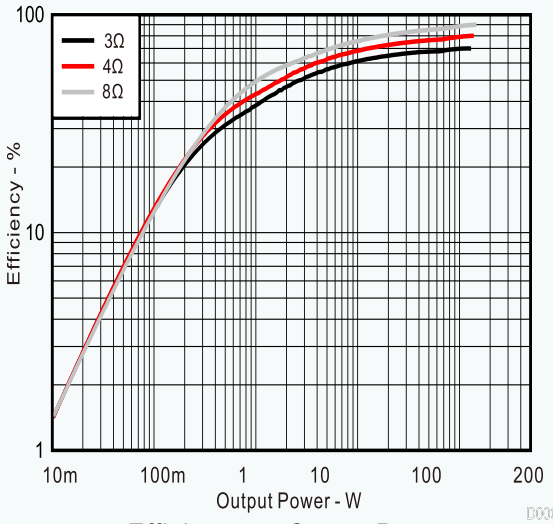
Typical Operating Characteristics All tests are based on a 1KHz signal (unless otherwise specified)



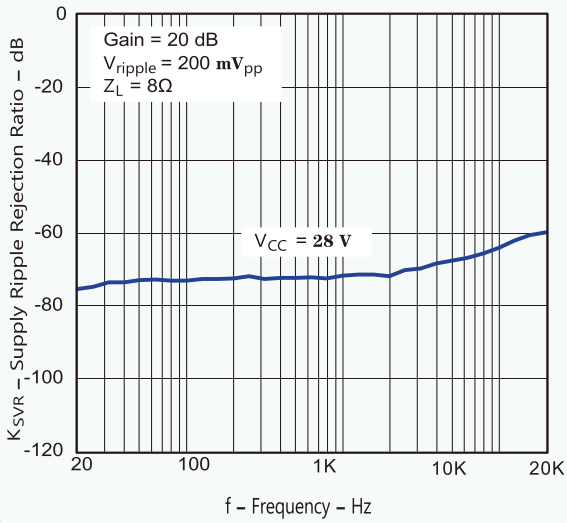








Efficiency vs Output Power



SUPPLY RIPPLE REJECTION RATIO vs FREQUENCY

IU8693E Application Points

The IU8693E is a 145W mono Class D audio amplifier. This device features a thermal pad designed on its top layer; when a heat sink is connected to this pad, it can achieve a continuous power output of over 145W, and can drive loads as low as 2Ω under a suitable power supply voltage.

The IU8693E is equipped with advanced EMI suppression technology. It adopts surface-mount technology (SMT) and requires only a small number of external components, enabling the system to deliver high-quality audio output power.

Additionally, the IU8693E has built-in over-current protection, short-circuit protection, and over-temperature protection, which effectively prevents the chip from being damaged under abnormal operating conditions.

With a maximum efficiency of over 92%, the IU8693E also incorporates a voltage-withstanding design of over 45V. This design provides the chip with ultra-high reliability and can effectively reduce the defect rate during the production process.

Gain Setting

The IU8693E is equipped with a gain control pin (labeled GAIN). The table below outlines the gain control methods of the IU8693E, along with the corresponding integrated input resistor values and feedback resistor values.

GAIN State	Gain	Input R	Feedback R
Directly connected to low level	54X	12K	650K
Float	40X	15.2K	610K
Directly connected to high level	20X	25.5K	510K

Short-Circuit Protection and Automatic Recovery

The IU8693E provides protection against overcurrent conditions caused by a short circuit at the output. When a short circuit occurs, the IU8693E immediately shuts down the output. Once the short-circuit fault at the output is resolved, the IU8693E will automatically recover after a 110ms delay.

Temperature Protection

The temperature protection function of the IU8693E prevents device damage when the temperature exceeds 170°C. There is a ±15°C tolerance range among devices at this temperature point. Once the temperature exceeds the set threshold, the device enters a shutdown state with no output. When the temperature drops by 20°C, the temperature protection is deactivated, and the device resumes normal operation.

Mute Function and Shutdown Control

For the IU8693E, the SD (Shutdown) input pin should be at a high level during normal operation. When the SD pin is pulled to a low level, the output is turned off and the circuit enters standby mode. The maximum voltage that can be applied to the SD pin is PVCC.

For the IU8693E, the MUTE (Mute) input pin should be at a low level during normal operation. When the MUTE pin is pulled to a high level, the output stage of the IU8693E is turned off and the IU8693E enters mute mode. The maximum voltage withstand capacity of the MUTE pin is 6V.

AM Suppression Function

The IU8693E enables the selection of MOS switching frequencies through the control of the AM pin, as shown in the table below:

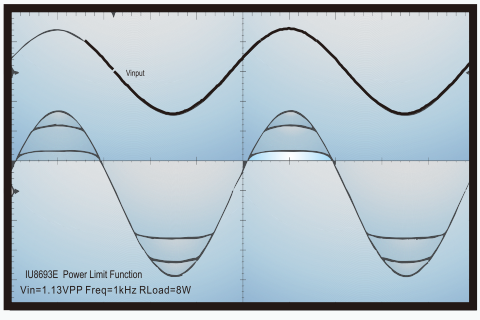
AM State	Frequency Selection
Directly grounded	300K
30KΩ grounded	400K
50KΩ grounded	500K
Float	550K

Power Limitation

The principle of the power limitation function is to restrict the maximum duty cycle of the power amplifier's output PWM (Pulse-Width Modulation), thereby limiting the maximum output power. Users can control the value of the maximum duty cycle by setting the voltage on the PLIMIT pin, which in turn determines the set value of the maximum power.

The result of the power limitation method that restricts the maximum duty cycle is similar to reducing the PVCC supply voltage: the output waveform becomes a distorted clipping waveform, as shown in the figure. During power limitation, if the input analog signal increases further, the distortion of the output waveform will increase, and the power will rise slowly.

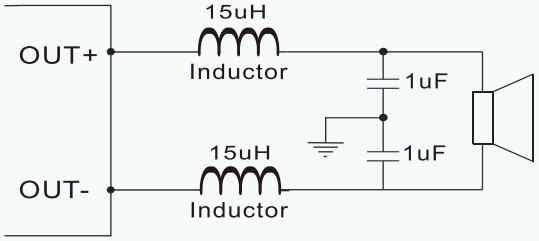
A voltage divider resistor can be added between GVDD and ground to set the voltage of Pin 21 (PLIMIT) for limiting the output power. The higher the voltage divided to Pin 21, the greater the allowable output power. Additionally, a 1μF capacitor should be connected between Pin 21 and ground.



IU8693E Power Limitation Waveform

Inductors and Capacitors

The IU8693E requires inductors and filter capacitors to be connected to its output terminals. It is recommended that the inductors used have a saturation current of 6A or higher during operation. The specific parameters are shown in the figure below:



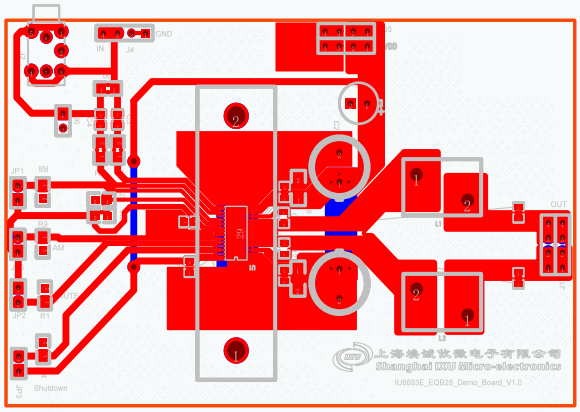
IU8693E PCB Design Guidelines

To ensure the reliable performance of the audio system design, please pay special attention to the following points when designing the PCB layout for the IU8693E:

The high-current path of the chip is: VIN → chip PVCC → GND. The routing rule for the high-current path is to make the traces as thick as possible to reduce the impedance caused by PCB traces.

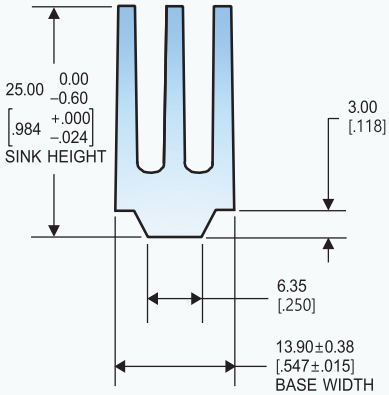
The power supply pins of the IU8693E must be connected with two ceramic capacitors (10uF and 1uF), which should be placed as close as possible to the chip pins. It is recommended to use a 470uF/50V electrolytic capacitor for power supply.

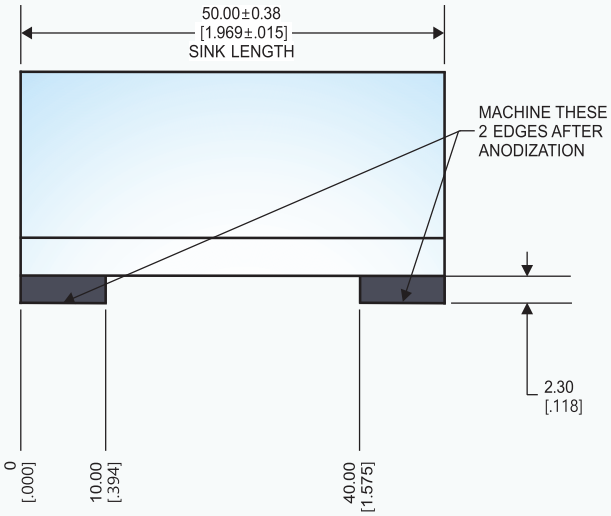
All GND connections, including the GND of each capacitor, should be well connected. They can be connected to the large-area GND copper foil nearby to minimize the ground loop impedance and inductance as much as possible.

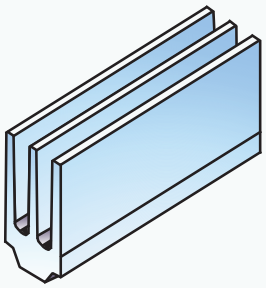


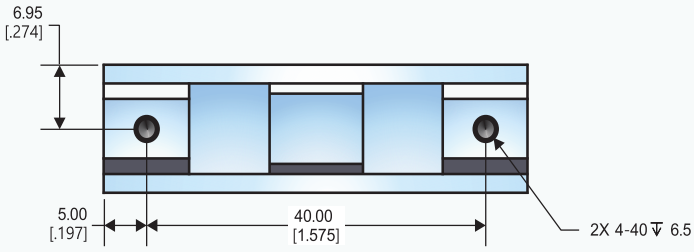
Explanation of the DEMO Heat Sink

The heat sink used on the EVB (Evaluation Board) of the IU8693E is an aluminum heat sink with dimensions of 14mm × 25mm × 50mm. Its specific dimensions are as follows:



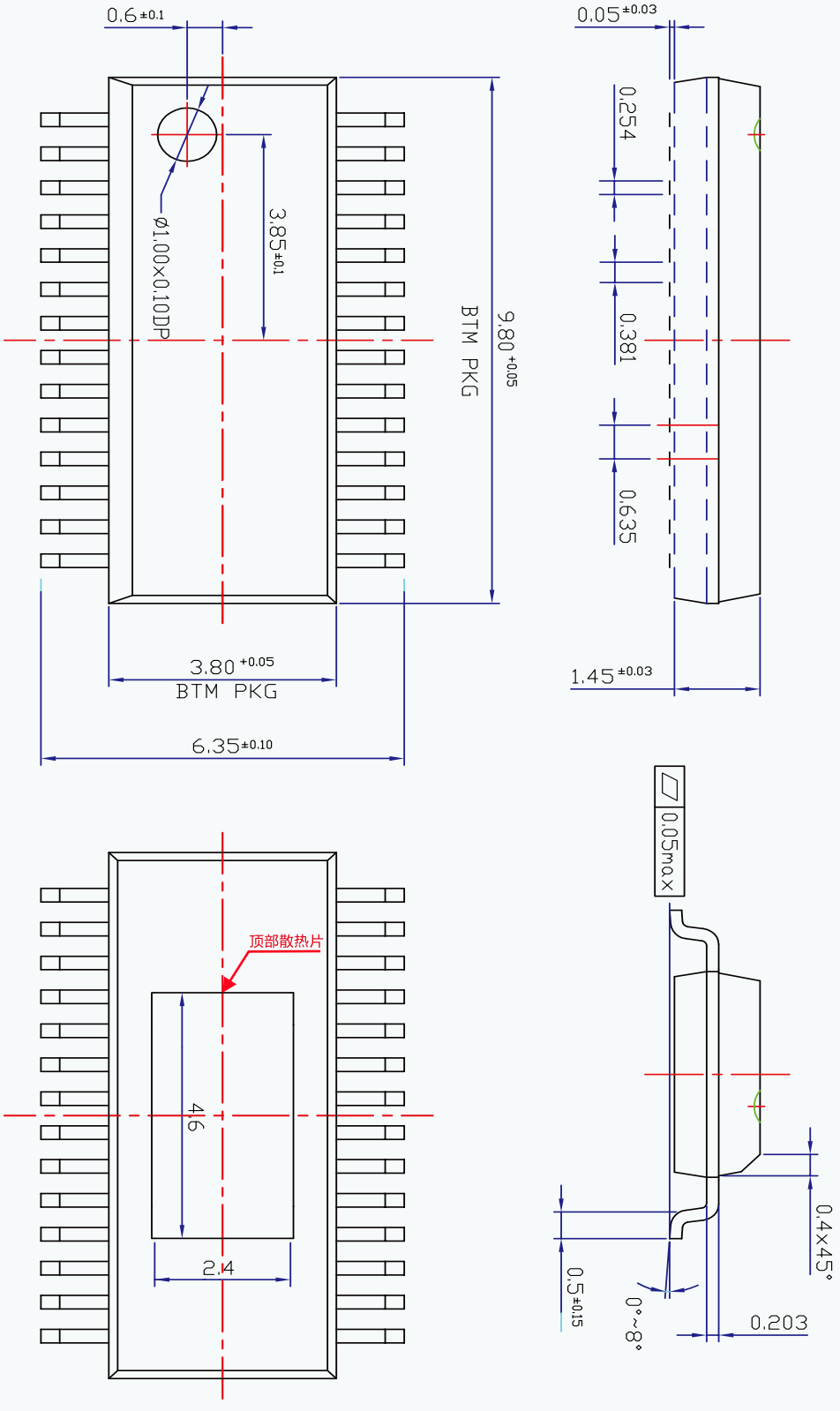






Package Information

IU8693E PACKAGE OUTLINE DIMENSIONS (units:mm)



Precautions for MOS Circuit Operation:

Static electricity can be generated in many places. The following precautions can effectively prevent MOS circuit from being damaged due to the sound of electrostatic discharge:

- Operators shall be grounded through anti-static wrist strap.
- The equipment enclosure must be grounded.
- Tools used during assembly must be grounded.
- Conductor packaging or anti-static materials must be used for packaging or transportation.

Declaration:

- Shanghai IXU Micro-electronics Co., Ltd. reserves the right to make changes to the manual without prior notice! Customers should obtain the latest version of the material before use and verify whether the relevant information is complete and up-to-date.
- Any semiconductor product has a certain possibility of failure or malfunction under specific conditions. The buyer is responsible for complying with safety standards and taking safety measures when using products from Shanghai IXU Micro-electronics Co., Ltd. for system design and complete machine manufacturing, in order to avoid potential risks of failure that may cause personal injury or property damage!
- The pursuit of enhancing product quality is endless. Shanghai IXU Micro-electronics Co., Ltd. will wholeheartedly provide customers with even better products!