Description of the Audio Hardware, Structure Design, and Component Selection for IPC Cube Cameras

Issue 01

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About This Document

Purpose

The audio effect of the consumer Internet Protocol camera (IPC) is related to audio algorithms as well as the product hardware, structure design, and performance of electric acoustic devices. This document describes the hardware, structure, and selection of the electric acoustic device for the HiSilicon cube cameras that are developed on the Hi3516A platform, and serves as a reference for customers and other HiSilicon programs.

NOTE

This document uses the Hi3516A as an example. Unless otherwise specified, the contents of the Hi3516A also apply to Hi3518A, Hi3518C, Hi3516C, Hi3518E V100, Hi3518E V20*X*, and Hi3516C V200.

Related Versions

The following table lists the product versions related to this document.

Product Name	Version
Hi3516A	V100
Hi3518A	V100
Hi3518C	V100
Hi3516C	V100
Hi3518E	V100
Hi3518E	V200
Hi3518E	V201
Hi3516C	V200

Intended Audience

This document is intended for:

- Technical support engineers

- Board hardware development engineers

Change History

Changes between document issues are cumulative. Therefore, the latest document issue contains all changes made in previous issues.

Issue 01 (2015-10-19)

This issue is the first official release.

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Figures

1 Overview

This document describes the considerations and detailed designs of the audio hardware, structure design, and component selection for the Hi3516A cube cameras, and serves as the design reference for other HiSilicon programs and cube camera products of customers.

2 Detailed Design

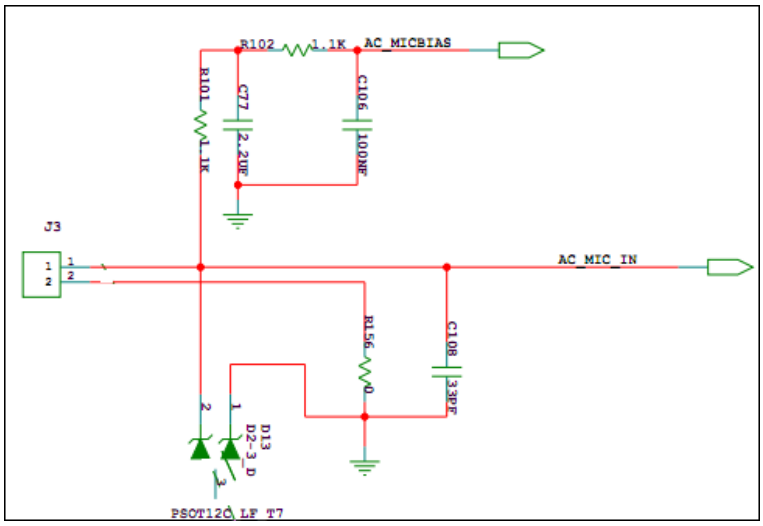
2.1 Board-Level Audio Circuit Design

In general, the microphone (MIC) audio inputs rather than the line-in audio inputs are used for the cube camera products. Therefore, the audio inputs in this document refer to the MIC inputs.

2.1.1 Schematic Circuit Design

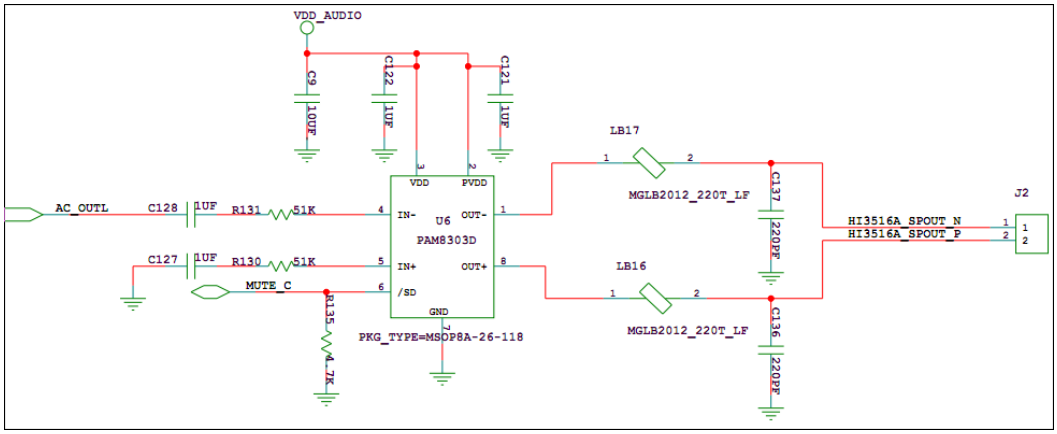
The design of the single-ended analog MIC circuit is simple, as shown in Figure 2-1.

Figure 2-1 MIC circuit used in the Hi3516A cube camera



The speaker is used to output the local sound of the cube camera. The audio coder/decoder (CODEC) integrated in the Hi3516A supports only the line-out output, whereas the speaker is required for local sound output of the cube camera product. Therefore, the differential operational amplifier is required in the hardware solution to drive the speaker. See Figure 2-2.

Figure 2-2 Speaker differential drive circuit in the Hi3516A cube camera



2.1.2 Precautions During PCB Circuit Design

During the PCB design of the audio signals, traces of the MICBIAS signal, MIC input analog signal, and audio output signal must be routed by referring to the ground (GND) plane that has no noise. The requirements on the audio hardware circuit design for the Hi3516A cube camera are as follows:

- All the audio signals (including audio input/output and MICBIAS signals) must use the GND as the reference plane. The current return path of the audio signals cannot be shared by other signals. Both the audio signals and their current return path must be kept away from digital signals.
- The GND of the audio signal must directly connect to the system GND through GND vias, and cannot connect to the GNDs of other modules or share the same GND via.
- The GND of the audio module does not need to be split from the system GND and connect to the GND through a single point. It is required that the audio analog GND has a complete GND plane and sufficient GND vias.

2.2 Selection of Audio Electric Acoustic Devices

2.2.1 MIC Selection

In terms of the cost, the lead-wire analog single-ended MIC (the cost of silicon MIC is too high) component is recommended for household consumer video surveillance cube cameras. The recommended specifications for MIC component selection are as follows:

- The signal-to-noise ratio (SNR) is greater than or equal to 58 dB (the performance of the MIC with the SNR greater than or equal to 62 dB is good).
- The sensitivity is about −26 dB.
- The omnidirectional MIC rather than the directional MIC (the directional MIC has limitations on sound pickup angles) is recommended.

2.2.2 Speaker Selection

The lead-wire speaker rather than the leaf spring contact-type speaker is recommended for the cube camera product. The recommended specifications are as follows:

- The sound pressure level (SPL) is greater than or equal to 89 dB. (The values less than 85 dB are not recommended. If good local audio effect is required, the speaker SPL cannot be less than 89 dB. A higher SPL indicates higher sensitivity.)
- The haplotype fundamental frequency (f_0) of the speaker must be lower than 1 kHz. As f_0 has a positive offset (the changed fundamental frequency cannot be greater than 1 kHz) after the structure sound chamber is combined, it is recommended that f_0 be set to about 600 Hz. The haplotype frequency response curve at the high-frequency band (higher than 1 kHz) needs to be as smooth as possible. The peak pulse waveforms at the high-frequency band need to be minimized.
- The recommended sensitivity is 94 dB/1 W/0.1 m.
- The recommended rated impedance at the 1 kHz frequency and 1 W power is 8 Ω.
- The maximum distortion rate at the 1 W power and 1 kHz frequency is 10%. This specification requirement is relatively high. If this requirement cannot be met or the estimated cost of meeting this distortion rate requirement is high, the distortion rate can be slightly higher than 10% on the condition that the tested audio effect meets customers' requirements.
- It is recommended that the speaker designed with a back sound chamber be used.

2.3 Structure Design

2.3.1 MIC Structure Design

Note the following requirements when designing the structure of the MIC:

- The MIC must have an independent sound chamber. The MIC needs to have an external shockproof rubber sleeve no matter whether its diameter is 6 mm or 4 mm. Theoretically, the thicker the rubber sleeve, the better the shockproof effect. The empirical value of the thickness of the rubber sleeve for the Hi3516A cube camera is 1.5 mm. The MIC sound chamber must be large enough to guarantee the 1.5 mm thickness.
- In the structure design, it is recommended that the orientation of the MIC be opposite to that of the speaker. The orientations can be mutually perpendicular if they cannot be opposite. The angle between the MIC and the speaker must ensure that the coupling degree of audio signals is as low as possible.
- Generally, the receiving hole of the MIC is a 0.8−1.2 mm circular hole.

2.3.2 Speaker Structure Design

Note the following requirements when designing the structure of the speaker:

- The speaker must have an independent sound chamber.
- The rubber shock pad is required for the speaker. The empirical value of the wall thickness of the shock pad for the Hi3516A cube camera is 1.2 mm (if the shock pad is too thin, the mechanical vibration of the speaker is transferred to the cover and MIC, which results in the cracking sound, and the echo cancelation effect is poor). The shock pad needs to enclose all the surroundings of the speaker as well as the front part (excluding the vibrating diaphragm) of the speaker.

- It is recommended that the distance between the maximum amplitude of the speaker vibrating diaphragm and the inner wall of the sound chamber be about 1 mm to 1.2 mm. This distance must be set to an appropriate value to prevent the vibrating diaphragm from hitting the inner wall of the cover.
- In the structure design, the total cross-sectional area of the sound generation hole needs to be greater than the area of the speaker vibrating diaphragm by 10%−15%. The hole or the density needs to be as large as possible on the condition that the dust proofing and appearance are guaranteed.
- No matter whether the speaker is fixed by using crews or through gluing, the sound chamber must be large enough to accommodate the shock pad and ensure that the shock pad is made full use of.

3 Summary

Due to the influence by the industry development status, most terminal vendors consider that the audio effect of the cube camera products depends only on the audio algorithms, which is quite one-sided. The audio effect of a product is a system-level design issue and is determined by factors such as hardware design, component features, structure design, and algorithms.