

Audio Output Specifications for Handheld Electronic Devices Though Built-In Speakers and Headphone Peripherals.

Introduction

Handheld electronic devices utilize many different types of outputs to users in order to convey information. This paper specifically covers different types of audio outputs physically built into the devices, primarily speakers and 3.5 mm audio jacks for external peripherals. Design challenges and constraints are compared in order to convey strengths and weaknesses of each type.

Audio Specifications for Current Devices.

In audio engineering, it is accepted that the human ear on average can hear sounds between the frequencies of 20 Hz and 20 kHz. This range of frequencies is called the audio band. Within the audio band in general, sounds produced at the lower and upper frequencies are perceived by humans to be quiet while sounds produced in the midrange frequencies are perceived to be louder by humans. Single speakers are often not optimized in order to account for all sounds at all frequencies. There are usually three general types of speakers in the market: low-range or woofers, mid-range, and high-range or tweeters. Each speaker is designed to correct the built-in transfer function of a human auditory system, work together, and make sounds of all frequencies the same perceived loudness.

Speaker Output

Modern micro speakers have a permanent magnet and a voice coil that is attached to a diaphragm that pushes the air to create sound [2]. Handheld devices that are used for entertainment and media purposes most of the time do not contain enough room for different sets of low, mid, and high range speakers. Typically in micro speakers, the maximum possible excursion level or displacement of the speaker diaphragm is typically around 0.4 mm [2]. In order to achieve an equal level of high, mid, and low range frequencies, the excursion level must increase respectively. Lower bass range frequencies require the largest speaker diaphragms and largest excursion levels because bass tones have the largest wavelengths out of the three ranges of tones. This requires more air particles to produce the required frequency. Because of the micro size, this in turn reduces the amount of total frequencies the speaker can span, specifically in the low-range category. One disadvantage to traditional built-in speakers is that the audio quality is external noise and layout of the environment. Some smartphones and portable music players incorporate active noise cancellation (ANC) to reduce the apparent level of background noise. One kind of ANC system uses two microphones: a reference microphone to pick up background noise, and a second error microphone located near the program output transducer [3]. Utilizing a series of

microphones to create noise cancellation however does not factor for the maximum possible output internal speakers will operate. Maximizing efficiency converts as much power as possible into sound. However, much is still wasted as heat in the voice coil. This 'self-heating' is directly related to the current in the voice coil. If the temperature climbs too high, the glue holding the voice coil together can be torn apart [2]. There are current efforts to solve heat dissipation problems such as patent 9,092,204. If cooling is needed (to the internal speakers), and if the headphone jack is unused, then a fan exhausts air through the jack opening. A second fan can exhaust air through the speaker sound hole if the speaker is idle [3].

Headphone and Earbud Peripherals

Handheld devices that are used for entertainment and media purposes usually contain external connections such as a headphone jack for additional options for sound output. In handheld devices, audio jacks are usually designed where the speaker output is switched off when an audio jack is inserted. The 10-pin SJ-357XN 3.5 mm audio jack uses a double pole, double throw switch that is activated when the audio cable is plugged in, allowing the stereo signal to be passed through the headphone or earbud peripherals [6]. There are different models of 3.5 mm audio plugs for specific audio application. The TS audio jack is a two-ringed terminal for mono audio applications. The TRS audio jack is a three-ringed terminal for stereo audio applications, and the TRRS audio jack is a four-ringed terminal for stereo audio applications with the addition of microphone signal input [7].

The largest difference between an on-board speaker system and an external peripheral such as headphones or earbuds is that amount of privacy the listener receives. According to Weber, Headphones nowadays represent privacy and autonomy [4]. Instead of noise isolation, sometimes headphones or earbuds utilize internal microphones in order to notify listeners of ambient noise, essentially an augmented audio reality (AAR) in order to avoid hazards [5]. The use of headphones allows greater flexibility for audio output quality because the speakers are not limited to the design constraints of the device itself. Between headphones or earbuds. The biggest advantage with headphones is that they deliver superior sound quality, especially when it comes to capturing bass tones [1]. Earbuds are typically less expensive than headphones, much lighter and far less bulky [1], while in turn the size of the earbud construction has the limitations of the micro speakers regarding a limitation to low-range frequencies. High quality “insertable” earbuds sometimes employ separate low frequency and high-frequency transducers to cover the full range of audible frequencies [3]. This in turn gives similar performance to headphones. Overall, the external peripherals feature is only limited to the signal processing power inside the internal electronics of the handheld device. The audio quality otherwise is determined solely on choice of peripherals.

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