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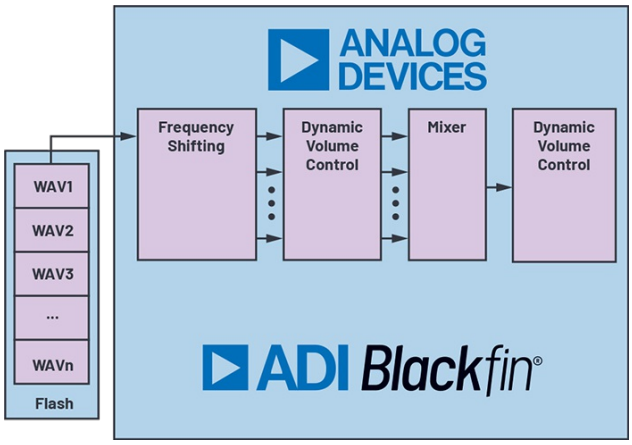
CAN NEWSLETTER MAGAZINE

Electric vehicle warning sound system

Analog Devices (AD) developed two solutions that can synthesize in-cabin engine sounds as well as external engine sounds and adjust them on the traveling speed.



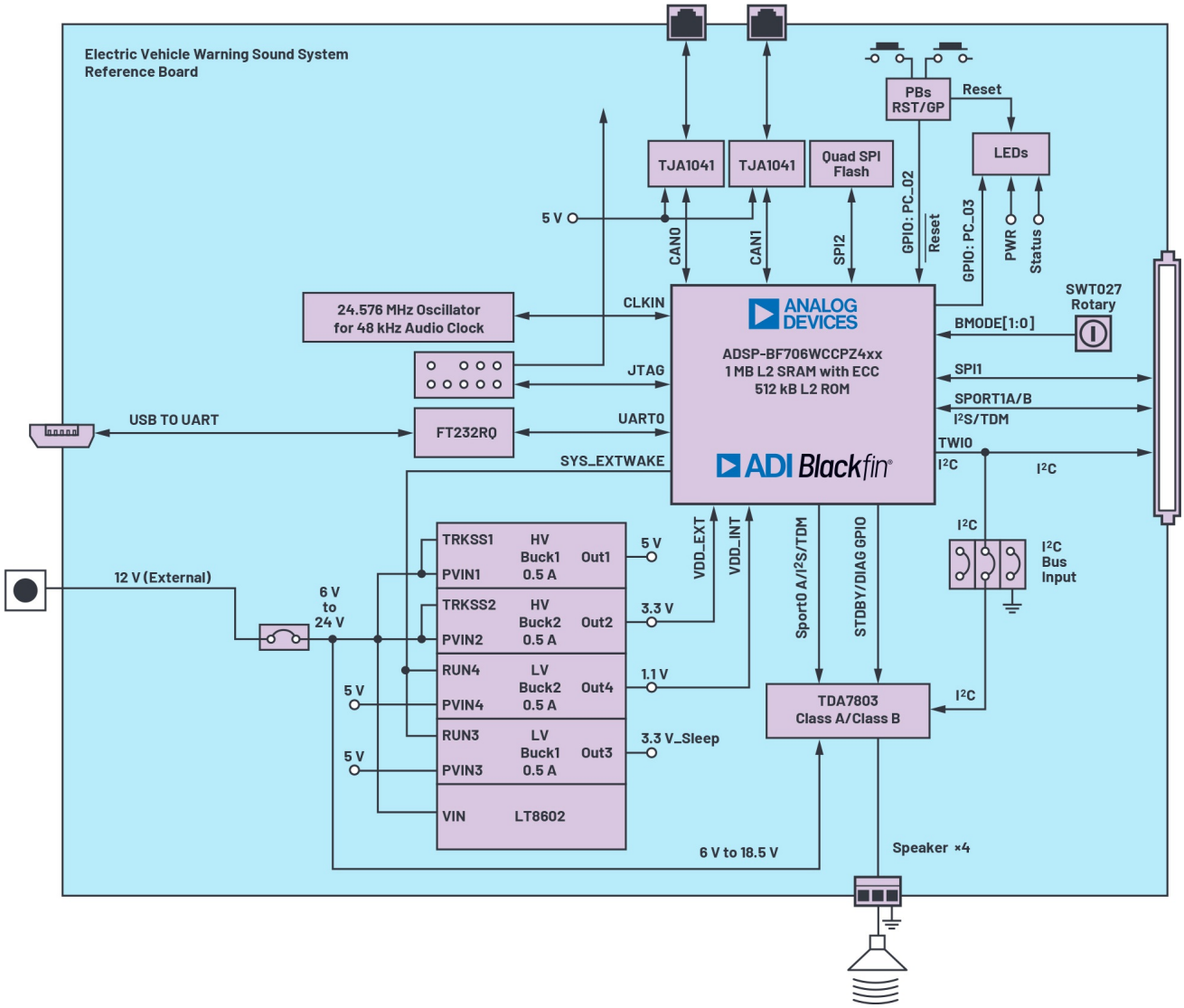
Processing blocks on Blackfin+ processor (Source: AD)

The complete article is published in the March issue of the CAN Newsletter magazine 2021. This is just an excerpt.

Traditional combustion engine vehicles emit engine sound, even at low travel speeds. Typically, pedestrians and other traffic participants recognize an approaching or departing vehicle through sight and auditory identification of tire sounds and other emitted noise when the vehicle is out of sight.

Electric vehicles (EVs) do not emit engine sound. Hybrid electric vehicles (HEVs) or plug-in hybrid electric vehicles (PHEVs) move almost silently when traveling at low speeds and before the conventional internal combustion engine kicks in. These vehicles are difficult to hear when travelling at speeds less than 30 km/h. At greater speeds, the tire sound becomes dominant.

Global governing bodies are exploring legislation that seeks to establish a minimum level of sound for EVs so that visually impaired people, pedestrians, and cyclists can hear these vehicles approach and determine from which direction these vehicles are approaching. An example of this legislation can be found on the National Highway Traffic Safety Administration (NHTSA, United States) website.

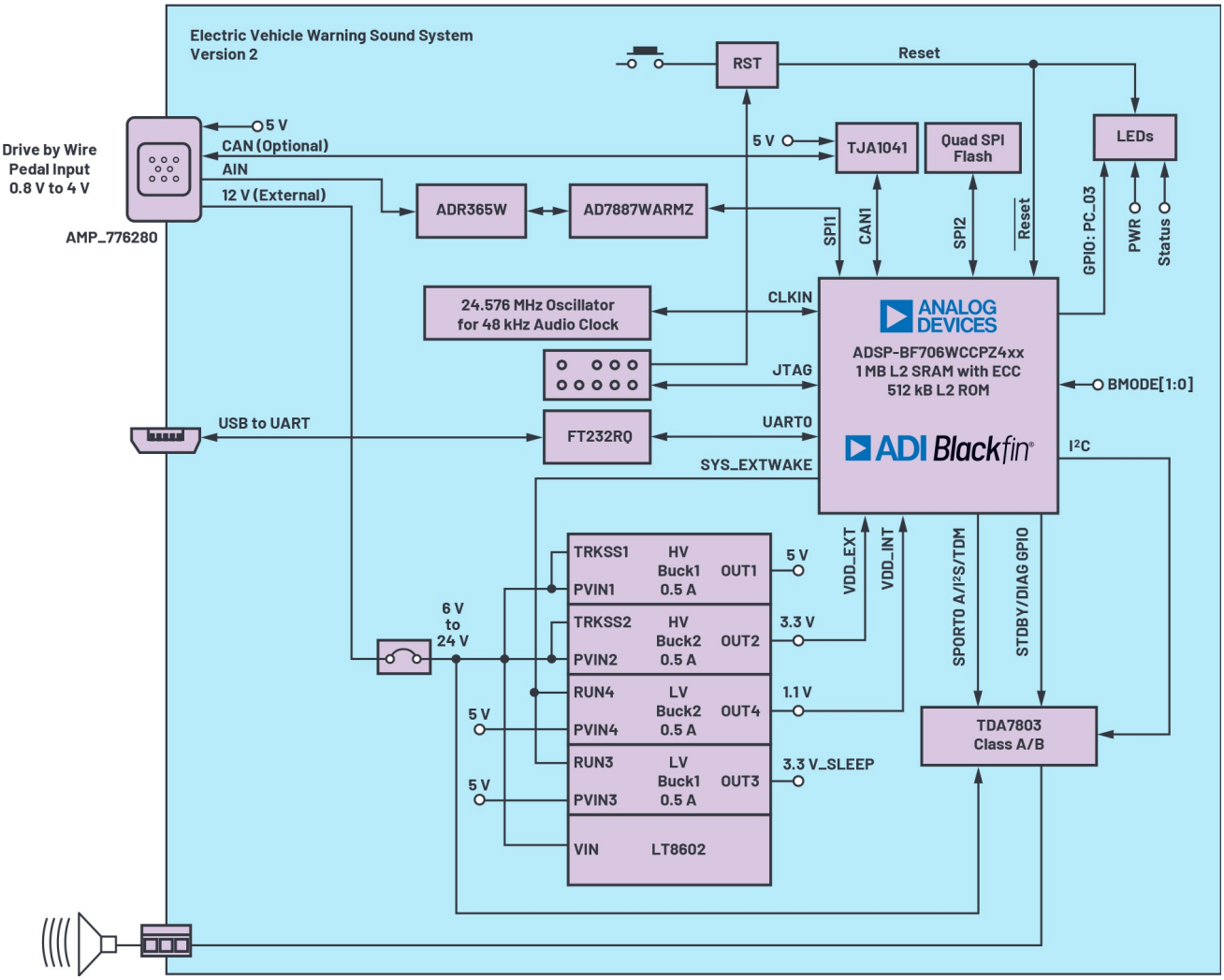


Detailed system block diagram with a Blackfin+ processor on a full-featured board (Source: AD)

An electric vehicle warning sound system (EVWSS) produces a series of sounds designed to alert pedestrians to the presence of EVs, HEVs, and PHEVs. The driver can initiate warning sounds (similar to the sound from a car horn, but less urgent); however, the

sounds must automatically be enabled at low speeds. These sounds vary from artificial tones to realistic sounds that mimic engine noise and tires moving over gravel. Analog Devices offers two different solutions for applications with an in-cabin engine sound and an external engine sound.

The advanced engine sound system solution is based on the ADSP-BF706 Blackfin+ processor. For entry-level systems, a solution based on the ADAU1450 SigmaDSP was developed. These solutions can synthesize sound and adjust frequency, sound volume, and other parameters depending on the traveling speed. Then the audio signal is sent to an audio power amplifier. The warning sound can be simulated using combustion engine sounds or any other synthesized tones.



Detailed system block diagram with a Blackfin+ processor on a board with reduced components (Source: AD)

Blackfin-based solution

The ADSP-BF706 Blackfin+ processor provides a single-chip solution for audio processing and interfacing to the CAN network. AD developed a CAN software stack that runs on the ADSP-BF706, which enables users to build automotive-grade demonstrations using e.g., a CAN stack by Vector. Additionally, AD provides a hardware and software reference design and Sigmastudio compatibility for the live tuning of parameters. Figure 1 shows the different processing blocks inside the ADSP-BF706. External waveform audio files (WAVs, up to 25) store signature engine sounds or audio tones. These files are frequency-shifted and mixed internally in the digital signal processor (DSP) before adding the dynamic volume control.

The ADSP-BF706 utilizes a memory-mapped SPI (serial peripheral interface) that provides access to the external memory, which eliminates the need for an external double data-rate (DDR) memory for this application. Up to 25 WAV files can be accessed simultaneously from the SPI flash memory. The large number of accessible WAV files helps to create more realistic engine sounds.

The ADSP-BF706 can also implement up to 16 pitch shifting variants (recommended from NHTSA), which increases the frequency of the output sounds as the vehicle speed value is provided from the in-vehicle CAN network. Figure 2 shows a detailed system block diagram. A power-by-linear LT8602 step-down regulator provides all voltage rails required in the system supplied by the 12-V_{DC} car battery.

If you would like to read the full article from Andrea Pellkofer, Jagannath Rotti, and Danny Ko (all Analog Devices) you can download it free of charge or you download the entire magazine.

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