Quiet driving

By using highly integrated semiconductor technology it is possible, according to Kieran McDonald, to implement more effective automotive microphone biasing and fault detection

Kieran McDonald

There are growing consumer demands for more advanced automotive infotainment systems with higher levels of functionality and better quality audio. Buyers are also starting to expect lower noise levels within the cabin. As a result it is becoming increasingly commonplace for engineers to specify microphones into their system designs to give vehicle occupants a better user experience while travelling.

Typically there are two in-vehicle applications that require a microphone - these are voice detection and active noise cancellation (ANC).

Voice detection is required for voice streaming to cell phones and it is typically carried out via Bluetooth wireless synchronous transmission. ANC, meanwhile, is employed for road noise cancellation (RNC) and engine order cancellation (EOC), to reduce road and engine/exhaust noise respectively. It is done through the utilization of advanced digital signal processing (DSP) algorithms, along with the infotainment system's amplifiers and load speaker outputs to produce amplified anti-phase noise. The adoption of ANC techniques is increasing principally in internal combustion engine vehicles.

While voice transmission tends to use a single microphone of an omni- or uni-directional type, three-dimensional ANC mainly relies on multiple error microphones positioned in different parts of the cabin. Critical to both of these is a very low noise biasing. Furthermore, due to their location outside the infotainment unit, effective fault detection is also required.

Key microphone supply requirements

Normally the current drawn by an automotive microphone is relatively low, depending upon microphone impedance and the type of integrated amplification stage. It can be as low as 0.5 mA, for a uni-directional microphone, or up to 20 mA for an omni-directional beam-forming microphone. The supply voltage tends to vary between 1.0 V and 15.0 V based upon the signal-to-noise ratio (SNR) required and the type of integrated amplifier, however most supply voltage levels will be within the 5.0 V to 8.0 V range. Biasing the microphone input lines requires the power supply to be specified for low noise and high power supply rejection ratio (PSRR), particularly in the human audible range. Such requirements call for a low noise linear regulator.

Further complications stem from the microphone being located remotely from the infotainment system. The load being external introduces risk of misconnection during assembly and maintenance. As a result the microphone power supply needs to be able to both detect and protect itself from faulty connections.

Principles of microphone power supply

An integrated microphone regulator device offers an attractive, beneficial alternative to discrete circuitry or high side switches. A built-in current mirror provides it with the ability to detect the microphone and diagnose fault conditions in the load - something that is of particular importance in vehicle assembly and maintenance, where potentially there is a risk that the infotainment system, the microphone or the cabling between them may either be

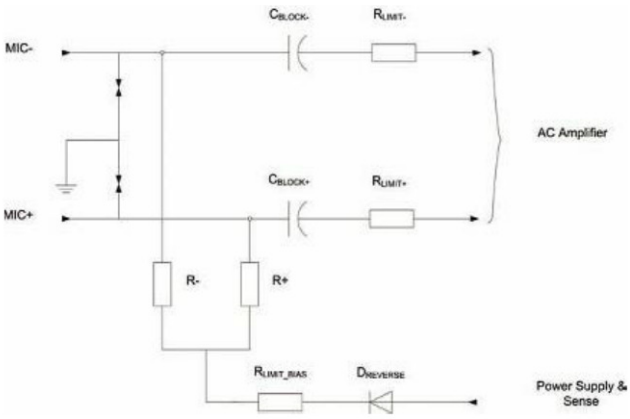

Figure 1: *Example of a discrete microphone bias circuit (Without detection or fault diagnosis)*

faulty or misassembled. As a result the possibility exists that the microphone regulator output (VOUT) could be shorted to ground, left open or, shorted to battery.

Microphone regulator benefits

A typical discrete diagnosis and protection circuit might consist of up to 20 discrete components and constitute high assembly costs, complex failure modes and effects analysis, as well as consuming valuable microcontroller resources for the carrying out of command and control functions. Conversely an integrated microphone regulator is a single IC, requiring just a handful of external small signal components. Additionally, it has carefully controlled process parameters, such as current limit accuracy and current mirror ratio, which make the creation of a fault strategy, fault detection thresholds and worst case analysis, much more straightforward.

The flexibility, in terms of circuit programmability, that is inherent in a discrete circuit design can be achieved by the microphone regulator possessing a programmable output voltage and current limit levels as well as an IC enable. The provision of accurate and adjustable output voltage regulation, including well defined limits of loop stability means that the fully protected output can be set to a target output voltage that correlates to the input requirement of the microphone, with a loop that is stable with a low cost and standard equivalent series resistance (ESR) output capacitor.

Conclusion

Next generation current sensing regulator ICs provide a simple integrated solution to power most types of external microphones in automotive audio and infotainment applications. They have the ability to monitor the status of the load, thus enabling highly effective fault diagnosis. They can also provide protection from key fault conditions, should they arise.

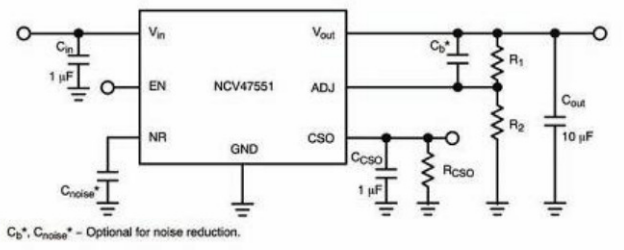

Figure 2: *Devices such as ON Semiconductor's NCV47551 integrated low dropout microphone regulator reduce the number of components required for active noise cancellation and voice detection applications and has low noise, low output current performance*

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