WAN_0197

Improving the PSRR in Wolfson CODECs

INTRODUCTION

PSRR is a measure of the device's immunity to variations in power supply voltage. A high ratio represents a high degree of tolerance to supply rail variation.

In a typical application, the power supply rail cannot be assumed to be perfectly stable or noise-free under all operating conditions. Therefore, designers must take note of the impact that any power supply variations may have on the signal of interest. Some causes of the power supplies being non-ideal are:

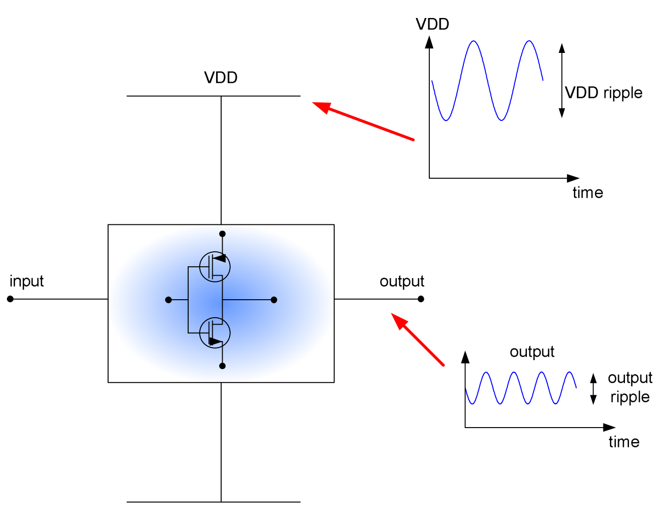
- Battery voltage may droop under different or transient load conditions.
- Mains-derived voltages may contain unfiltered noise at multiples of the AC supply frequency.
- The output of DC-DC converters may have ripple (there is a designed-in trade-off between high regulation and high efficiency).
- Heavy load or inductive components (such as motors) may lead to electrical noise on the supply rails.
- Switching circuits (such as GSM) may generate noise and cause supply voltage transients.

In audio products, these factors can result in degradation of the audio fidelity, in the form of audible tones, distortion or increased noise level.

Wolfson CODECs are designed with inherent characteristics of power supply rejection, but the PSRR is also affected by certain optional configuration settings. This Application Note describes the recommended method to configure the devices for the highest possible power supply rejection.

DEFINITION OF PSRR

Power Supply Rejection Ratio is defined as the ratio of the variation in an amplifier's output to a variation in its power supply. This ratio is likely to vary according to the frequency and amplitude of the power supply modulation. Therefore, a PSRR figure is only valid for a given set of test conditions. In audio systems, it is normal for PSRR to be quoted at a frequency of 1kHz and/or the frequency of potential interference such as 50Hz AC mains or 217Hz GSM switching.



$$PSRR = 20 \log \left(\frac{\text{VDD ripple}}{\text{Output ripple}} \right)$$

Figure 1 Illustration of PSRR in a Basic Amplifier

The equation in Figure 1 shows the calculation of PSRR in dB.

Different conventions exist for the specification of PSRR. Wolfson datasheets use the above convention, where a high, positive number represents a high ratio of VDD supply ripple to output signal ripple; this equates to a high level of rejection of the supply noise.

Note that alternative definitions exist, where the same rejection ratio may be expressed as a negative number, normally representing the output voltage as a fraction of the supply variation. In the context of an amplifier specification, it is usually apparent which convention has been used.

CONFIGURING THE VMID AND MICBIAS IN WOLFSON CODECS

Wolfson CODECs provide a microphone bias circuit to enable easy interfacing with electret condenser microphones. The bias current is usually provided on a pin named MICBIAS. These CODECs also generate a mid-rail DC reference voltage to which most of the analogue signal paths are referenced. This mid-rail voltage is usually present on a pin named VMID.

VMID is generated internally from AVDD via a configurable resistor divider. MICBIAS is generated from VMID and is therefore also affected by the same resistor circuit. The VMID reference is typically generated using 5kΩ, 50kΩ or 250kΩ resistors, as selected by the VMID_MODE register field. (In some devices, other register names may apply, such as VMIDSEL.) The combination of the selected resistor and the external VMID capacitor will determine the charge-up time for VMID.

The resistor divider circuit is illustrated in Figure 2 for a typical Wolfson CODEC. Each of the available settings is described in turn in the following paragraphs.

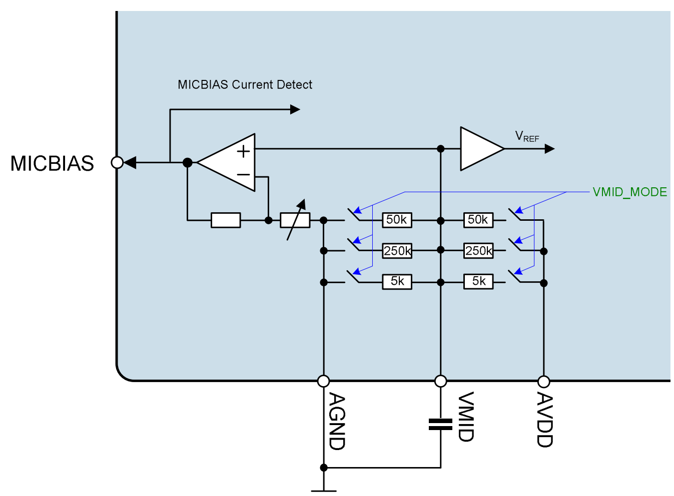


Figure 2 VMID Configuration Circuit

If VMID_MODE is set to 'disabled', this disconnects the resistor chain. In this mode, VMID and MICBIAS are not generated, power consumption is reduced, but all DC-biased analogue audio circuits will also be disabled.

If VMID_MODE is set to 5kΩ, this allows a fast charge-up time for VMID and MICBIAS. This results in a fast wake-up from 'power down' to 'active', but may also result in an audible pop due to the frequency content of the capacitor charging transient.

If VMID_MODE is set to 50kΩ, this results in a longer start-up time and less pop. This setting is recommended for many applications.

If VMID_MODE is set to 250kΩ (or 300kΩ, depending on the device) the start-up time is longer still (in excess of 1s). Although this setting provides the greatest level of pop suppression, the slow start-up characteristic will be unacceptable in many applications.

OPTIMISING WOLFSON CODECS FOR PSRR

A useful application of the 250kΩ (or 300kΩ) setting is to gain benefits in terms of PSRR. Together with the VMID decoupling capacitor, the resistor chain has a low-pass filtering effect on the VMID and MICBIAS reference sources. This improves the circuit's tolerance to variations in power supply voltage, delivering improved PSRR.

To make use of this capability, it is recommended that the 50kΩ chain be selected initially. After the VMID capacitor has fully charged, the 250kΩ (or 300kΩ) should then be selected for its PSRR benefits. With the 50kΩ resistor chain selected, a 4.7μF VMID capacitor can be assumed fully charged after 1s following start-up.

The PSRR of a typical DAC-to-Headphone path with respect to variations in AVDD under different VMID_MODE conditions is illustrated below. It can be observed that large improvements in PSRR improvement can be achieved when using the 250kΩ VMID_MODE selection, especially in the region of 100Hz (typical rectified mains interference frequency) and 217Hz (GSM switching frequency).

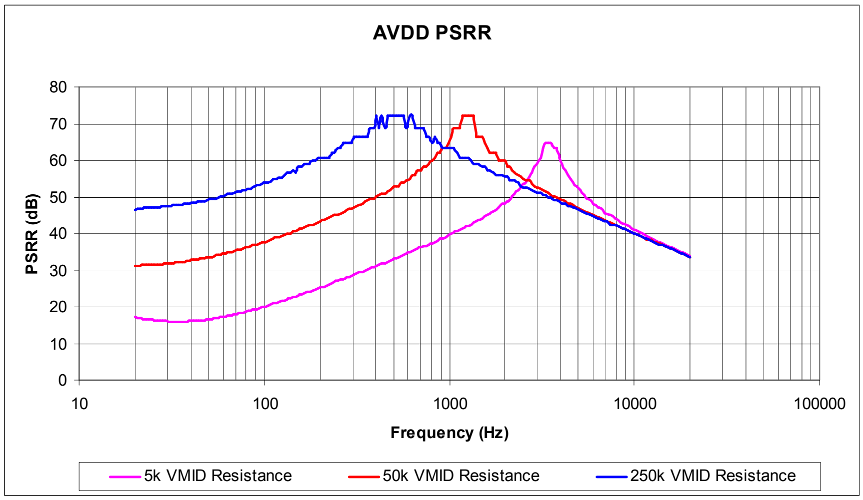


Figure 3 AVDD PSRR Response

CONCLUSION

All of the VMID-referenced analogue audio paths in a CODEC will be influenced by the VMID PSRR characteristics.

Electret condenser microphones connected to the MICBIAS output will be particularly affected by PSRR as the low level microphone signals will typically be subject to very high gain as they pass through the signal chain; any PSRR effects will be amplified also.

PSRR effects are not limited to electret microphone inputs. Inadequate filtering of the VMID reference can also degrade other circuits within the CODEC.

It is strongly recommended to use an intelligent start-up sequence as defined earlier. The improvements in PSRR will be particularly beneficial to microphone input circuits.

APPLICATION SUPPORT

If you require more information or require technical support please contact Wolfson Microelectronics Applications group through the following channels:

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