

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.

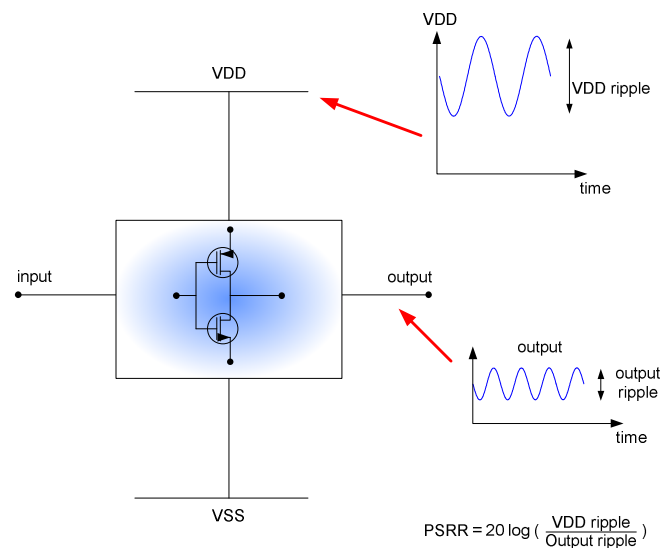


Figure 1 Illustration of PSRR in a Basic Amplifier

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 5k Ω , 50k Ω or 250k Ω 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.

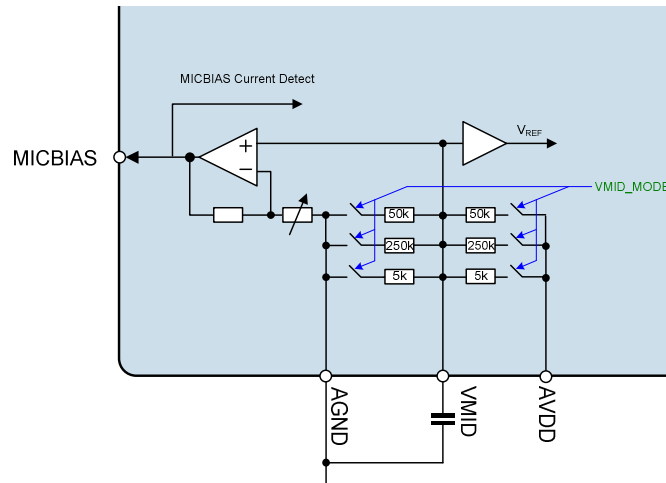


Figure 2 VMID Configuration Circuit

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 5k Ω , 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 50k Ω , this results in a longer start-up time and less pop. This setting is recommended for many applications.

If VMID_MODE is set to 250k Ω (or 300k Ω , 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 250k Ω (or 300k Ω) 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 50k Ω chain be selected initially. After the VMID capacitor has fully charged, the 250k Ω (or 300k Ω) should then be selected for its PSRR benefits. With the 50k Ω resistor chain selected, a 4.7 μ F 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 250k Ω VMID_MODE selection, especially in the region of 100Hz (typical rectified mains interference frequency) and 217Hz (GSM switching frequency).

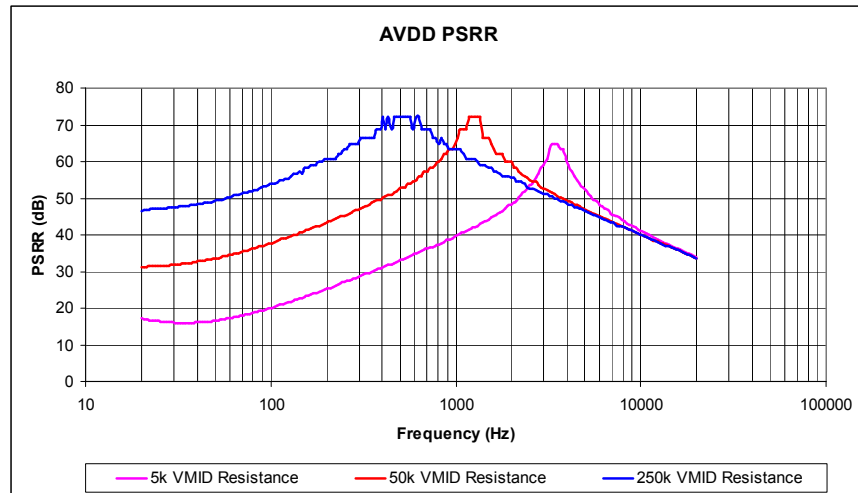


Figure 3 AVDD PSRR Response

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:

Email: apps@wolfsonmicro.com
 Telephone Apps: (+44) 131 272 7070
 Fax: (+44) 131 272 7001
 Mail: Applications at the address on the last page.

Or contact your local Wolfson representative.

Additional information may be made available from time to time on our web site at <http://www.wolfsonmicro.com>

IMPORTANT NOTICE

Wolfson Microelectronics plc ("Wolfson") products and services are sold subject to Wolfson's terms and conditions of sale, delivery and payment supplied at the time of order acknowledgement.

Wolfson warrants performance of its products to the specifications in effect at the date of shipment. Wolfson reserves the right to make changes to its products and specifications or to discontinue any product or service without notice. Customers should therefore obtain the latest version of relevant information from Wolfson to verify that the information is current.

Testing and other quality control techniques are utilised to the extent Wolfson deems necessary to support its warranty. Specific testing of all parameters of each device is not necessarily performed unless required by law or regulation.

In order to minimise risks associated with customer applications, the customer must use adequate design and operating safeguards to minimise inherent or procedural hazards. Wolfson is not liable for applications assistance or customer product design. The customer is solely responsible for its selection and use of Wolfson products. Wolfson is not liable for such selection or use nor for use of any circuitry other than circuitry entirely embodied in a Wolfson product.

Wolfson's products are not intended for use in life support systems, appliances, nuclear systems or systems where malfunction can reasonably be expected to result in personal injury, death or severe property or environmental damage. Any use of products by the customer for such purposes is at the customer's own risk.

Wolfson does not grant any licence (express or implied) under any patent right, copyright, mask work right or other intellectual property right of Wolfson covering or relating to any combination, machine, or process in which its products or services might be or are used. Any provision or publication of any third party's products or services does not constitute Wolfson's approval, licence, warranty or endorsement thereof. Any third party trade marks contained in this document belong to the respective third party owner.

Reproduction of information from Wolfson datasheets is permissible only if reproduction is without alteration and is accompanied by all associated copyright, proprietary and other notices (including this notice) and conditions. Wolfson is not liable for any unauthorised alteration of such information or for any reliance placed thereon.

Any representations made, warranties given, and/or liabilities accepted by any person which differ from those contained in this datasheet or in Wolfson's standard terms and conditions of sale, delivery and payment are made, given and/or accepted at that person's own risk. Wolfson is not liable for any such representations, warranties or liabilities or for any reliance placed thereon by any person.

ADDRESS:

Wolfson Microelectronics plc
Westfield House
26 Westfield Road
Edinburgh
EH11 2QB
United Kingdom

Tel :: +44 (0)131 272 7000

Fax :: +44 (0)131 272 7001

Email :: apps@wolfsonmicro.com