wolfson® microelectronics

WAN_0214

External Component Requirements for Ground Referenced Outputs

INTRODUCTION

Many Wolfson audio devices now have ground referenced headphone and line outputs, rather than outputs referenced to VMID (i.e. midpoint of the analogue supply voltage). The ground referenced output is achieved using an internal charge pump to power the headphone amplifier. The charge pump has specific capacitor requirements as detailed in this document.

“Ground referenced” means that there can be a direct connection between the Wolfson device output and the headphone load. Although the charge pump itself has specific capacitor requirements, the charge pump capacitors are much smaller and cheaper than the large AC coupling capacitors typically required for a VMID referenced output.

There are also “phantom ground” devices, where the large AC coupling capacitors are removed and an amplifier drives a VMID-referenced “ground”. The down side to this is that more power is wasted in the extra amplifier.

Hence, compared to a VMID referenced output, the overall size and cost of the application is reduced with ground referenced outputs. Ground referenced outputs have other advantages such as reduced quiescent current and improved “pop click” performance, however these are not detailed further in this document.

RECOMMENDED EXTERNAL COMPONENTS

The recommended external components for WM8903 are shown in Figure 1. WM8903 has ground referenced headphone and line outputs. The specific components in Figure 1 which are generic to all Wolfson devices with ground referenced outputs are as follows:

1. C17/C18: VPOS/VNEG charge store capacitors. These pins may be referred to as CPVOUTP and CPVOUTN on other devices.
2. C16: CFB1-2 charge pump feedback capacitor. These pins may be referred to as CPCA and CPCB on other devices.
3. C4: CPVDD decoupling capacitor
4. C19-22: Zobel Network connected to each ground referenced output. The Zobel network is covered in more detail in WAN0212 “Class W Headphone Impedance Compensation”.

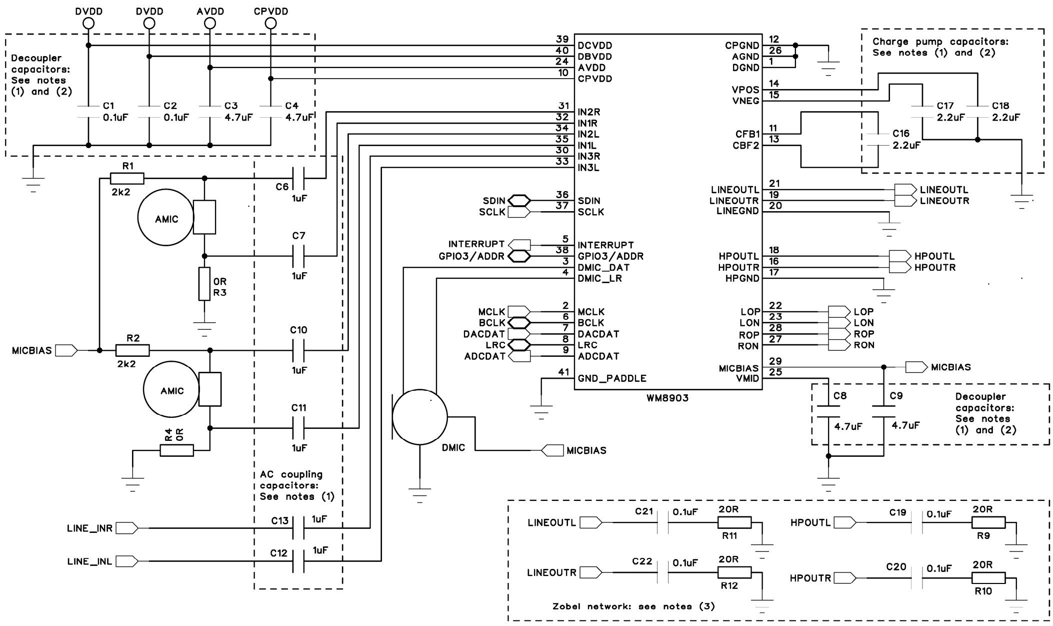

Figure 1 Recommended External Components

COMPONENT TYPES

As well as selection of correct capacitor values, together with careful PCB layout, it is important to select the correct capacitor *type* for the charge pump capacitors (C4, C16, C17, C18 as shown).

The requirements of each capacitor, and some example capacitor parts are detailed in Table 1. Note that capacitor case sizes are quoted in EIA format (see “Capacitor Case Sizes” for more detail).

CAPACITOR	REQUIRED CAPACITANCE	EXAMPLE OF CURRENT CAPACITOR TECHNOLOGY					
		VALUE	RATED VOLTAGE	DIELECTRIC	CASE SIZE	MANU-FACTURER	P/N
C16 (CFB1-CFB2)	1µF at 2vDC	2.2µF	6.3V	X5R ceramic	0402	Kemet	C0402C225M9PAC
						MuRata	GRM155R60J225ME15_EIA
C4, C17, C18 (VPOS, VNEG, CPVDD)	2µF at 2vDC	2.2µF	10V	X5R ceramic	0603	MuRata	GRM188R61A225KE34D
		4.7µF	6.3V	X5R ceramic	0402	MuRata	GRM155R60J475M_EIA

Table 1 Capacitor Examples

REQUIRED CAPACITANCE

The “Required capacitance” column of Table 1 is important. Capacitors generally reduce in value as the DC bias voltage across the capacitor is increased, this is known as the *voltage coefficient* of the capacitor. In general, a larger case size capacitor has a better voltage co-efficient, hence can achieve its rated capacitance at a higher DC voltage, compared to a lower case size capacitor.

Verifying that the required capacitance can be met at the specified DC voltage depends on the capacitor design, so the individual **capacitor datasheet must be consulted**, or if not specified, this data should be requested from the capacitor manufacturer. 2 typical capacitor DC co-efficient graphs are shown in Figure 2 and Figure 3. Note that capacitor case sizes are quoted in EIA format (see “Capacitor Case Sizes” for more detail).

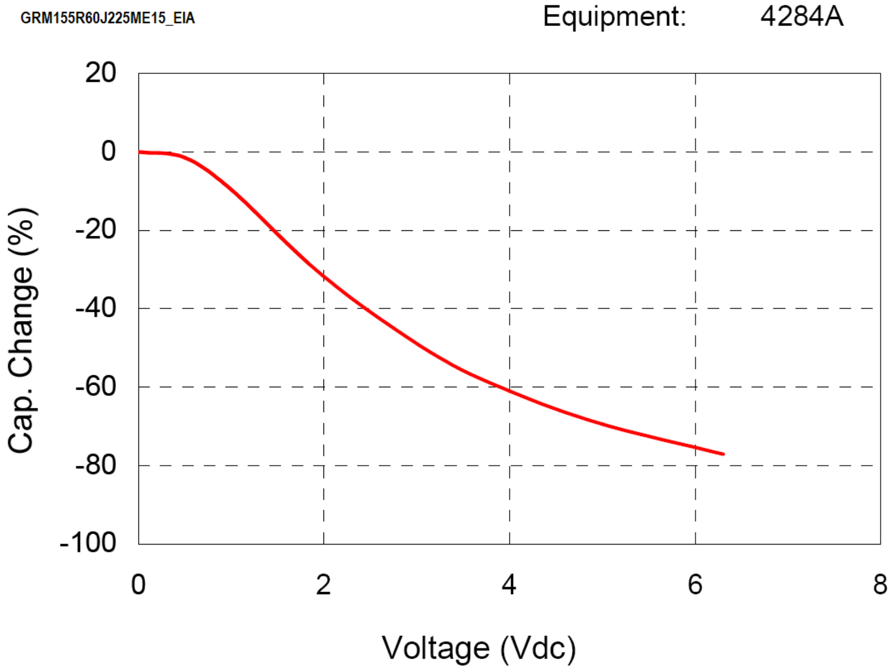

Figure 2 Capacitor DC Co-efficient Graph (GRM155R60J225ME15_EIA) (Source: MuRata datasheet)

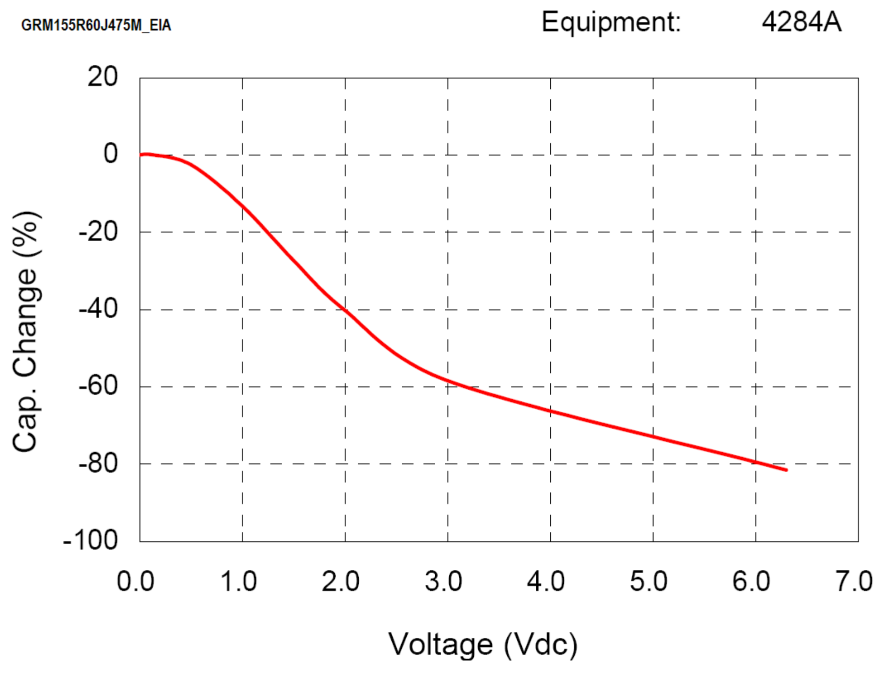

Figure 3 Capacitor DC Co-efficient Graph (GRM155R60J475M_EIA) (Source: MuRata datasheet)

Audio performance may be impacted if the capacitor does not meet the capacitance requirements at a given DC voltage. Capacitance which falls below the required value generally means less power can be delivered into the load. This would mean that the datasheet THD specification (for a given output power level and load impedance) cannot be met.

CAPACITOR CASE SIZES

PHYSICAL SIZE	EIA (GENERALLY USED IN USA)	METRIC (GENERALLY USED IN JAPAN)
0.4 x 0.2mm	1005	0402
0.6 x 0.3mm	0201	0603
1.0 x 0.5mm	0402	1005
1.6 x 0.8mm	0603	1608

Table 2 Capacitor Case Sizes

CAPACITOR POSITIONING

Decouplers and charge pump capacitors should be positioned as close to WM8903 as possible. Of the charge pump capacitors, the positioning of C16 is most important. C4, C17, C18 should also be very close to WM8903.

With all of these capacitors, track inductance should be kept to a minimum. Any track inductance between the IC pin and the capacitor, or between the capacitor and GND, will reduce the effective capacitance. The following recommendations apply:

- Where possible, tracks should be short and wide.
- Connections to GND to be made by a GND plane via very close to the capacitor.
- Long GND tracks are not recommended.
- Capacitor placement under the IC may reduce overall track length, but will add inductance due to each via.

Performance may be impacted if these recommendations are not followed.

ZOBEL NETWORK

The Zobel network (C19,20,21,22, R9,10,11,12 in Figure 1) is required on HPOUTL/R and LINEOUTL/R if the output is being used. Stability of either set of outputs across all process corners cannot be guaranteed without the Zobel network. The Zobel network requirement is detailed further in the applications note WAN_0212 “Class W Headphone Impedance Compensation”.

CONCLUSION

Ground referenced headphone and line outputs can give an overall cost and space saving compared to VMID referenced outputs.

By following these guidelines for capacitor selection, the specified performance can achieved at an overall system cost which is lower than that of audio devices with VMID referenced outputs.

APPLICATION SUPPORT

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

Email: apps@wolfsonmicro.com
Telephone Apps: +44 (0) 131 272 7070
Fax: +44 (0) 131 272 7001
Mail: Applications Engineering at the address on the last page

or contact your local Wolfson representative.

Additional information may be made available on our web site at:

http://www.wolfsonmicro.com

IMPORTANT NOTICE

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