

## CODEC Printed Circuit Board Layout Considerations

Because of the wide dynamic range and the typical environment in which the CODEC is used, PC board layout is very important. It is important with any mixed-signal device but CODECs are often in very “noisy” environments with many digital, and radio frequency (RF) signals, running about the board.

Sources of noise can be the power supply and ground lines, digital noise from the circuitry in the CODEC chip (or other chips) being coupled into the analog circuitry, and noise induced from nearby digital or RF lines on the PCB.

The first step is the one that has been taken by the designers of the chip. The integrated circuit layout is done very carefully to minimize coupling between digital and analog circuitry inside the chip. Many of these techniques are very similar to what you, as the PCB designer, will be doing outside the chip on a much larger scale.

- A. It is important to use good bypassing techniques. One should use bypass capacitors of the ceramic monolithic type, values of about 0.1  $\mu\text{F}$ , from  $V_{\text{DD}}$ ,  $V_{\text{AG}}$ , and/or  $V_{\text{REF}}$  to  $V_{\text{SS}}$ . These capacitors should have the shortest trace lengths possible to minimize resistance and inductance. In fact, on some double-sided boards it might be best to mount these bypass (or decoupling) capacitors directly under the part between the pins.
- B. Always keep the digital and analog traces as far apart as possible. When possible, run ground traces between them to help isolate them from each other.
- C. Use short, low inductance traces for the audio signals to minimize their sensitivity to digital and RF noise. Remember that the audio traces can be nice receiving “antennas” for the RF. (A quarter wavelength at 2.450 GHz is only 3.1 cm. or 1.2 inches.)
- D. Use short, low inductive traces for the digital and RF traces to reduce capacitive, inductive or RF coupling to the analog or power supply lines. These lines become transmit “antennas” and need to be approached as transmission lines with proper termination to reduce RFI emissions. [Remember the wavelength!]
- E. Physical separation is good for isolating the analog from the RF circuitry in handsets. One approach is to have the radio circuitry on one side of the board and the analog circuitry on the other. Or, to use metal (or plastic impregnated with metal) shield cans over the RF sections as is done in cell phones, cordless phones, etc.
- F. The VAG pin is the reference for all analog signal processing within the chip. In some applications, the audio signal to be encoded may be referenced to the VSS ground. To reduce the susceptibility to noise at the input of the encoder section, the three-terminal input op amp will convert a single-ended signal to a differential signal internally to provide level conversion from the VSS ground to the VAG ground. The same op amp may be used for more than 35 dB of gain in microphone interface circuits, which will require a compact layout with minimum trace lengths as well as isolation from noise sources. It is recommended that the layout be as symmetrical as possible to avoid any imbalances that would reduce the noise canceling benefits of this differential op amp circuit. Refer to the application schematics in the data sheets for examples of this circuitry. If possible, reference audio signals to the VAG pin instead of to the VSS pin. Handset receivers and telephone line interface circuits using

transformers may be audio signal referenced completely to the VAG pin. Refer to the application schematics for examples of this circuitry.

- G. Use a short, wide, low inductance trace to connect the VDD power supply pin to the positive power supply. Depending on the application, a double-sided PCB with VDD bypass capacitors to the VSS ground plane may complete the low impedance coupling for the power supply. For a multilayer PC board with a power plane, connecting all of the VDD pins to the power plane would be the optimal power distribution method.
- H. Use a short, wide, low inductance trace to connect the VSS ground pin to the power supply ground. The VSS pin is the digital ground and the most negative power supply pin for the analog circuitry. All analog signal processing is referenced to the VAG pin, but because digital and RF circuitry will probably be powered by this same ground, care must be taken to minimize noise in the VSS trace. Depending on the application, a double-sided PCB with a VSS ground plane connecting all of the digital and analog VSS pins together would be a good grounding method. A multilayer PC board with a ground plane connecting all of the digital and analog VSS pins together would be the optimal ground configuration. These methods will result in the lowest resistance and the lowest inductance in the ground circuit. This is important to reduce voltage spikes in the ground circuit resulting from the high-speed digital current spikes. These voltage spikes may be hundreds of times larger than the analog signal the device is expected to digitize.

Based on the above suggestions one may design a PCB layout that performs reasonably well the first time. However, as with many things, “fine tuning” the PCB may yield additional improvement in noise performance. This applies to noise in the analog domain and noise in the RF or EMI area, as well.

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