Layout and EMI Recommendations for Automotive Applications

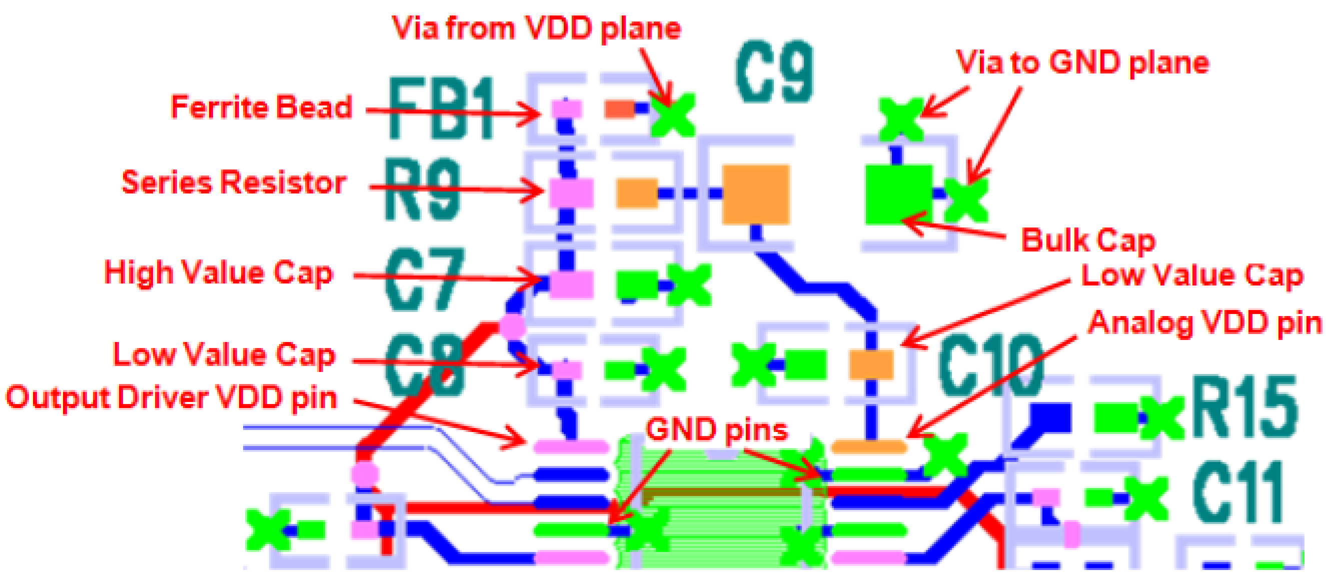
Introduction

- Layout goal: keep EMI as low as possible.
- Automotive applications require EMI to be 10–40dB lower than non-automotive applications due to more stringent reliability requirements.
- Automotive requirements are legislated by international laws and standards.
- Two main sources of EMI:
  - Clock & Data paths → Design PCB traces as transmission lines to contain the clock and data signals inside the traces.
  - Power Supply → Use power supply filtering to prevent noise from spreading through power planes.
- See AN-953 for a quick guide about output terminations.
- See AN-954 for a more detailed explanation of the following guidelines.

Guidelines

- Properly match PCB trace impedance and termination to avoid reflections.
- Maintain a certain characteristic impedance (50Ω) throughout the clock/data trace:
  - Do not obstruct the return current in the ground plane for the clock/data trace → Do not interrupt the ground plane(s) underneath or above a clock/data trace.
  - Avoid square (90°) corners in clock/data traces. Round the corners.
  - Avoid vias in clock/data traces.
- Bypass each power pin with a capacitor (0.01µF–0.1µF) to avoid ripple from clock and data signals on the power pin of the clock generator IC.
- Route power from a power plane to the bypass capacitor first, then to the power pin.

Figure 1. Layout Example Showing Recommended Routing of Power Traces



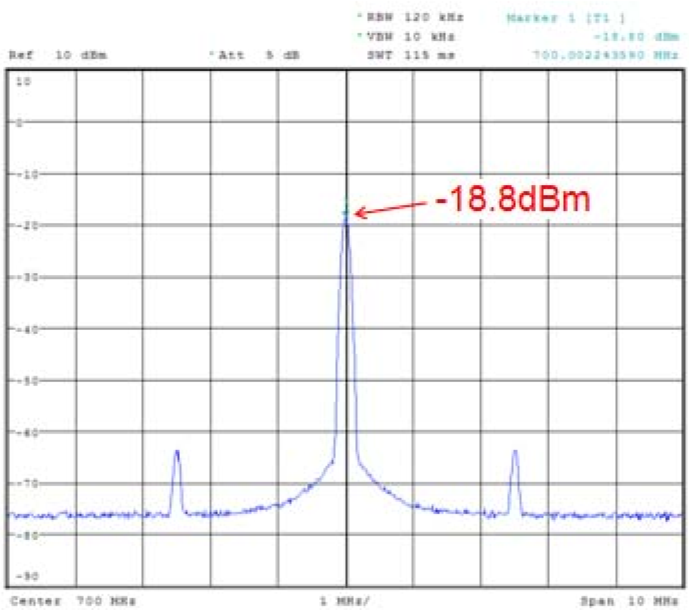
- The preferred ferrite bead for power supply filtering is a “signal bead” with a DC resistance in the range 0.3Ω to 0.5Ω. The DC resistance avoids ringing in the power supply filter.
- Note the DC current handling capability of the ferrite bead. The problem is not power dissipation, but rather, saturation of the ferrite material which compromises the filtering ability.

IDT Timing Device Features for Lowering EMI

- Spread spectrum modulation is an active method of EMI reduction with system wide impact. Radiated emissions from every clock and data signal that is derived from a spread spectrum clock is reduced. Conducted emissions will be reduced when a spread spectrum clock is used in a switch mode power supply regulator.
- Programmable clock edge slew rate reduces radiated emissions from that clock.
- Staggering edge rate at the start of each edge softens reflections and therefor reduces radiated emissions.
- V_{DD} and GND (V_{SS}) pins right next to each other to optimize bypassing and reduce both radiated and conducted emissions

Spread Spectrum Example

This example illustrates the EMI reducing ability of spread spectrum. The plots below show the 7th harmonic of a 100MHz clock without spread spectrum modulation on the left and with spread spectrum modulation on the right.



Spread spectrum modulation reduces the emissions at 700MHz with 13.5dB

Revision History

Table 1. Revision History

Revision Date	Description of Change
March 8, 2017	▪ Added link to AN-953. ▪ Updated “IDT Timing Device Features for Lowering EMI” section and added “Spread Spectrum Example” section.
February 28, 2017	▪ Initial release.

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