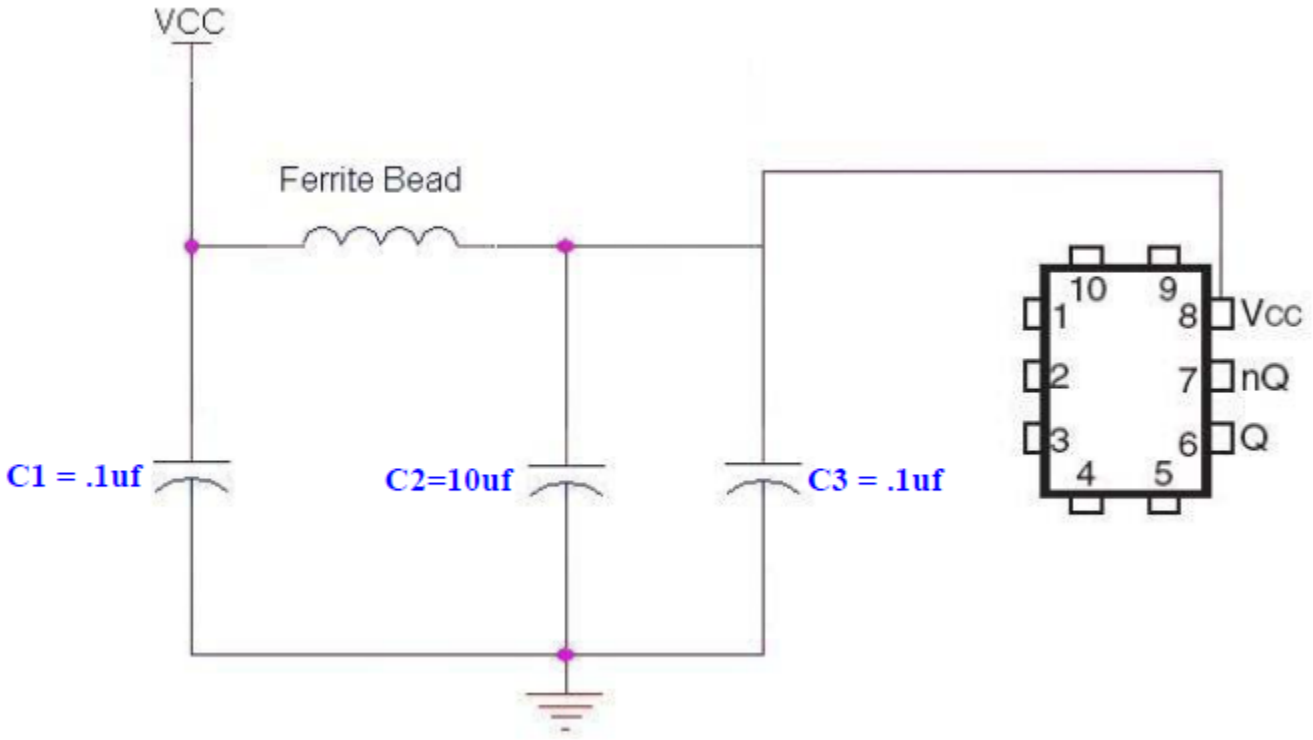
Introduction

This application note describes the recommended filtering technique for oscillators in surface mounted device (SMD) packages from IDT. This includes both ceramic and plastic packages which have one power pin that supplies the analog, core and output stages of the device. Since separate filtering can not be added to each stage, careful consideration must be taken to filter noise from entering into the device.

Figure 1. Simplified Circuit



Procedure

The filter configuration in Figure 1 is commonly used for SMD oscillator devices. It consists of a ferrite bead and 3 capacitors. The combination of the capacitors, parasitic resistance from the printed circuit board, and the resistive component of the ferrite bead will behave as a low pass filter and help suppress high frequency noise. The selection criteria for the capacitor values (C1, C2 and C3) was based on performance, values readily available and cost. Other values can be used to improve the rejection level of the low pass filter with an increase in cost and supplier lead times.

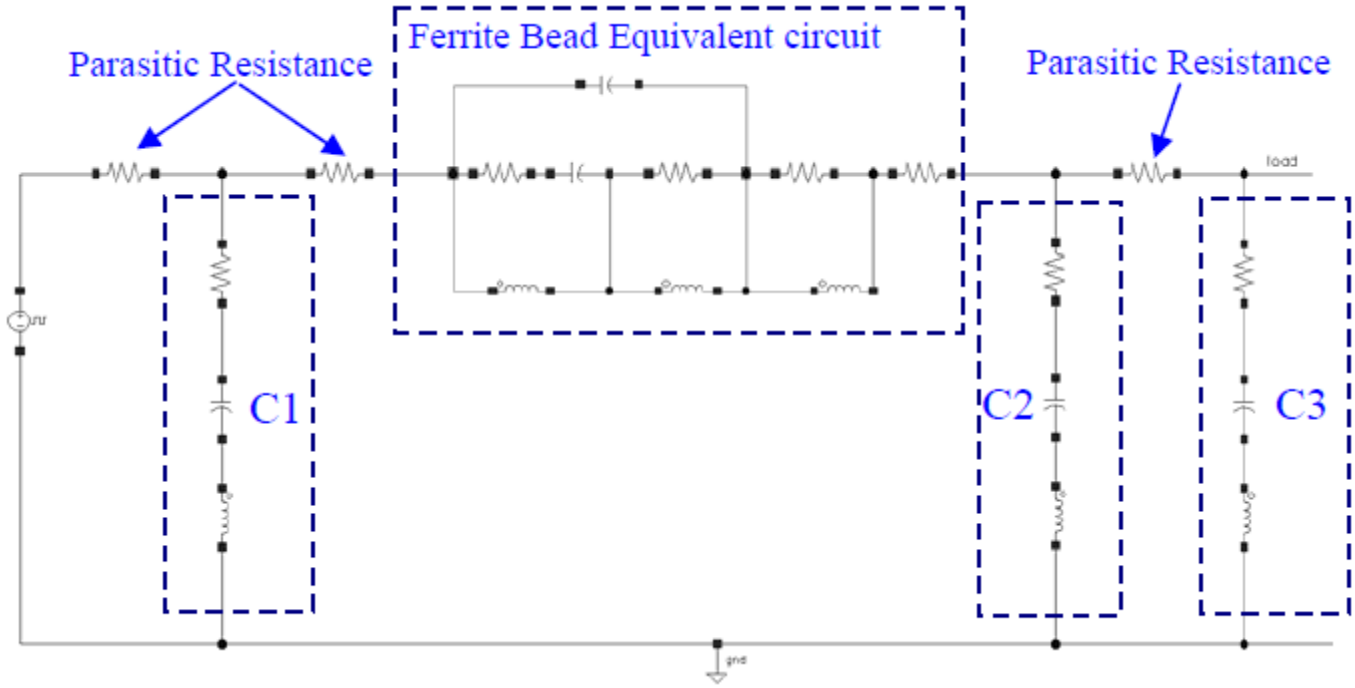
The filter was simulated with three different Murata ferrite beads. Refer to Table 1. The primary difference between them is the impedance at 100MHz, rated current and DC resistance. The conditions for the simulation were taken using nominal voltage and temperature on Cadence Spectre.

Table 1: Murata Ferrite Bead Datasheet Parameters

Part Number	Impedance (at 100MHz/20°C)	Rated Current	DC Resistance	Operating Temperature Range
BLM18BB121SN1	120Ω ±25%	500mA	0.30Ω max	-55 to +125°C
BLM18BB151SN1	150Ω ±25%	450mA	0.37Ω max	-55 to +125°C
BLM18BB221SN1	220Ω ±25%	450mA	0.45Ω max	-55 to +125°C

In order to properly simulate a low pass filter, a small signal equivalent circuit must be generated. Refer to Figure 2. In addition, the parasitic resistance from the filter printed circuit board traces must be calculated and simulated. This has a first order effect on the attenuation of the filter.

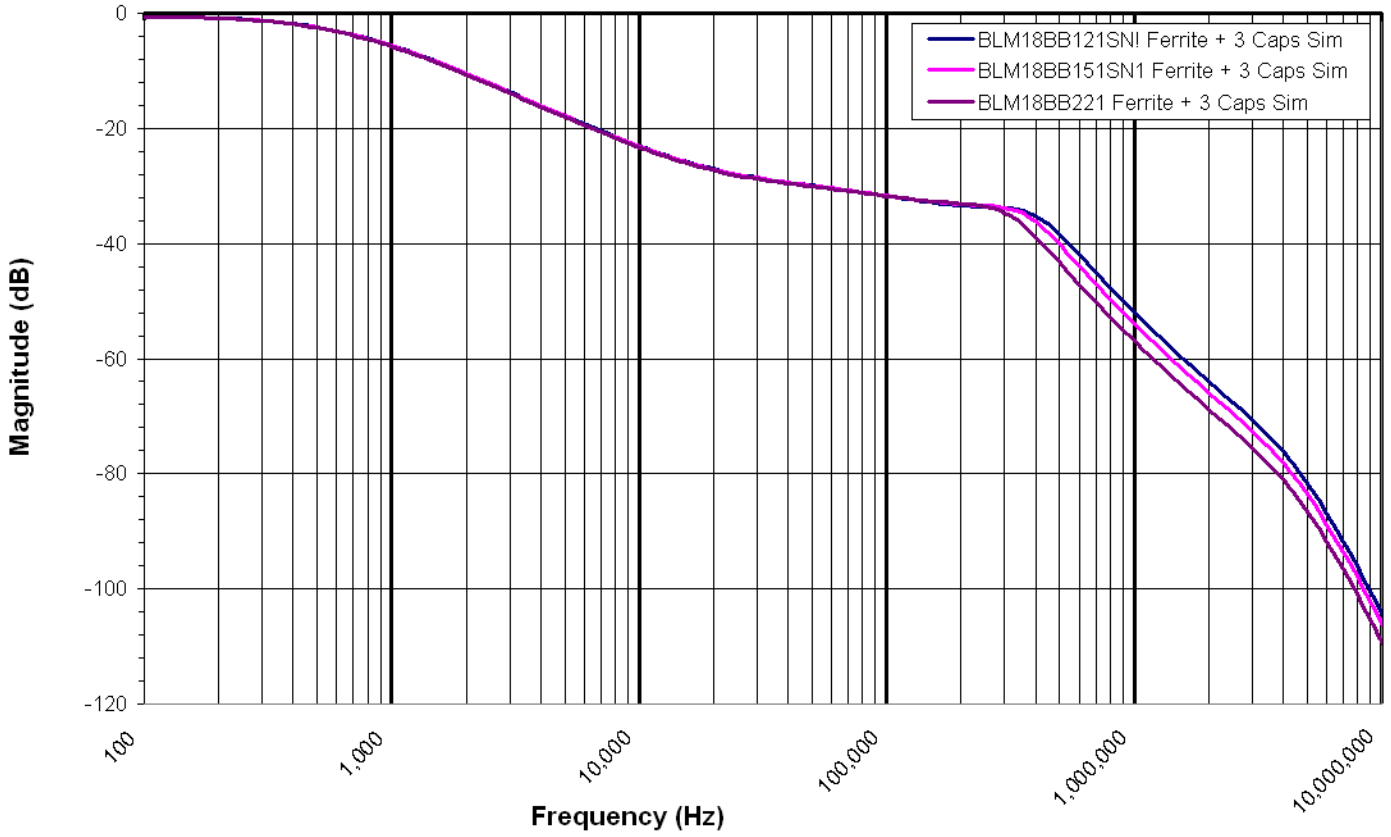
Figure 2. Simulation Circuit – Small Signal Equivalent Circuit



Results

Figure 3 shows the simulation results for the three ferrite beads. They track to approximately 300kHz, after that, the BLM18BB221 has better filtering performance than the other two. This is due to the higher impedance.

Figure 3. Loop Filter Simulation Results



Conclusion

A good number of switch-mode power supplies have transient frequencies ranging between 100kHz and 600kHz. Note that at 100kHz, the filter has approximately 30dB of attenuation. Though the simulations are using ideal conditions, Figure 3 shows the general trend of the filter. The filter recommendations are a general guideline to be used for reducing external noise from coupling into the device. The filter performance is designed for a broadband of power supply noise. If the frequency noise component is known and is out of the filter range, it is recommended that additional filtering be added and the component values adjusted. In order to achieve the best possible filtering, the placement of the components should be on the same layer as the device and be as close to the power pin as possible. If considering using a ferrite bead or inductors other than what is recommended, take special precaution. The combination of a capacitor, inductor and random noise can cause unwanted oscillations. In addition to localized filtering, bulk capacitance should be added in the general area of the device.

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.