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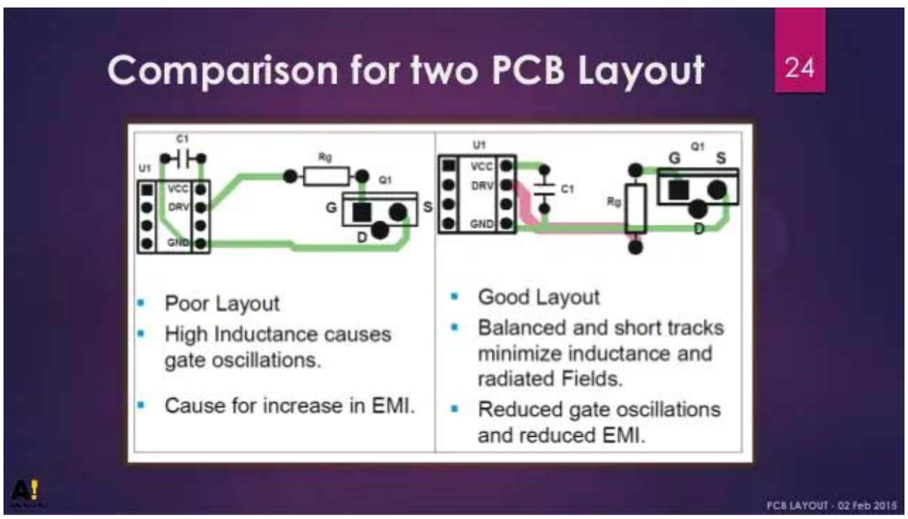

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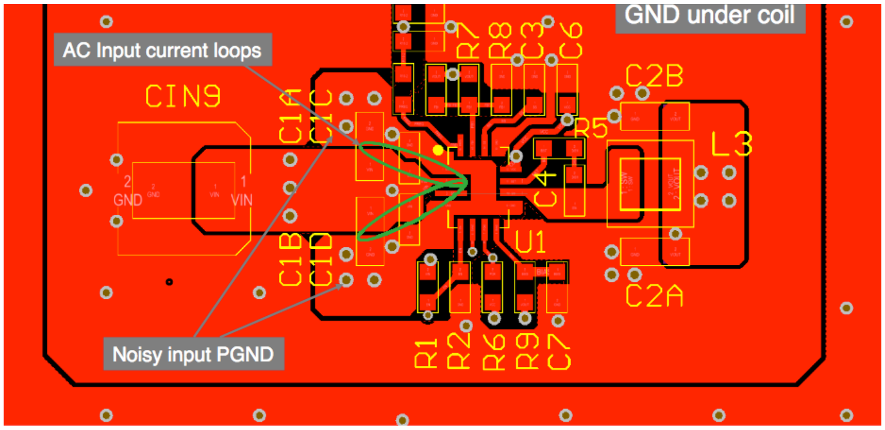

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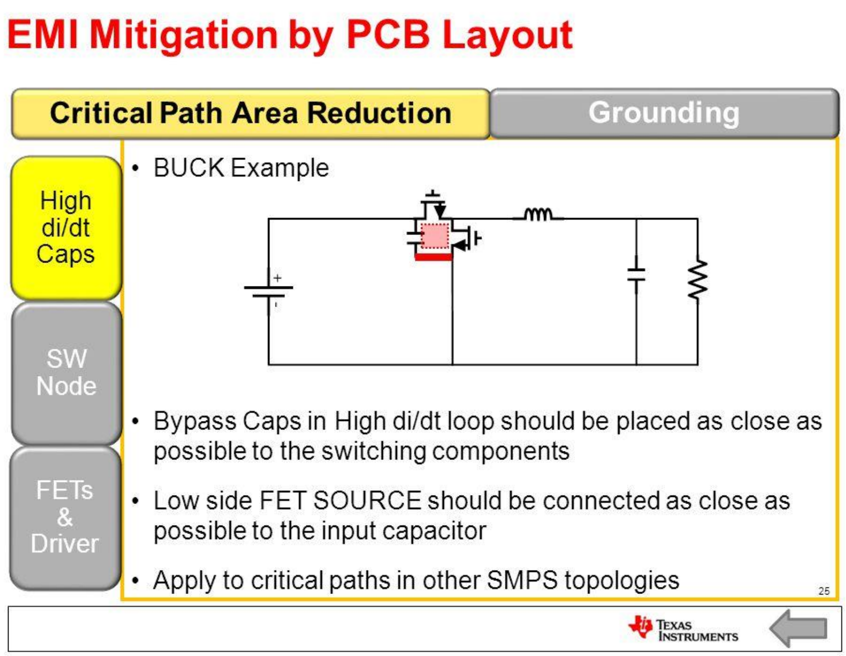

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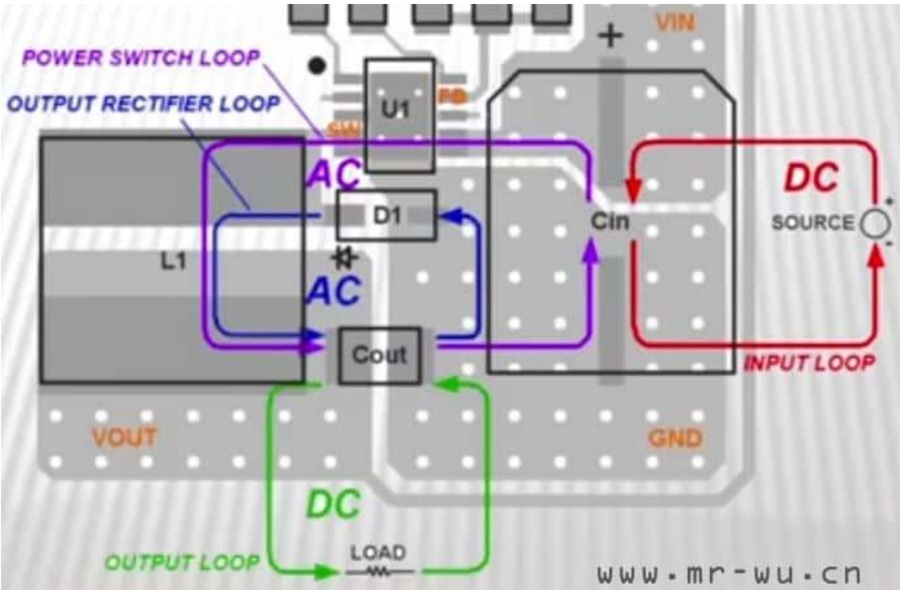

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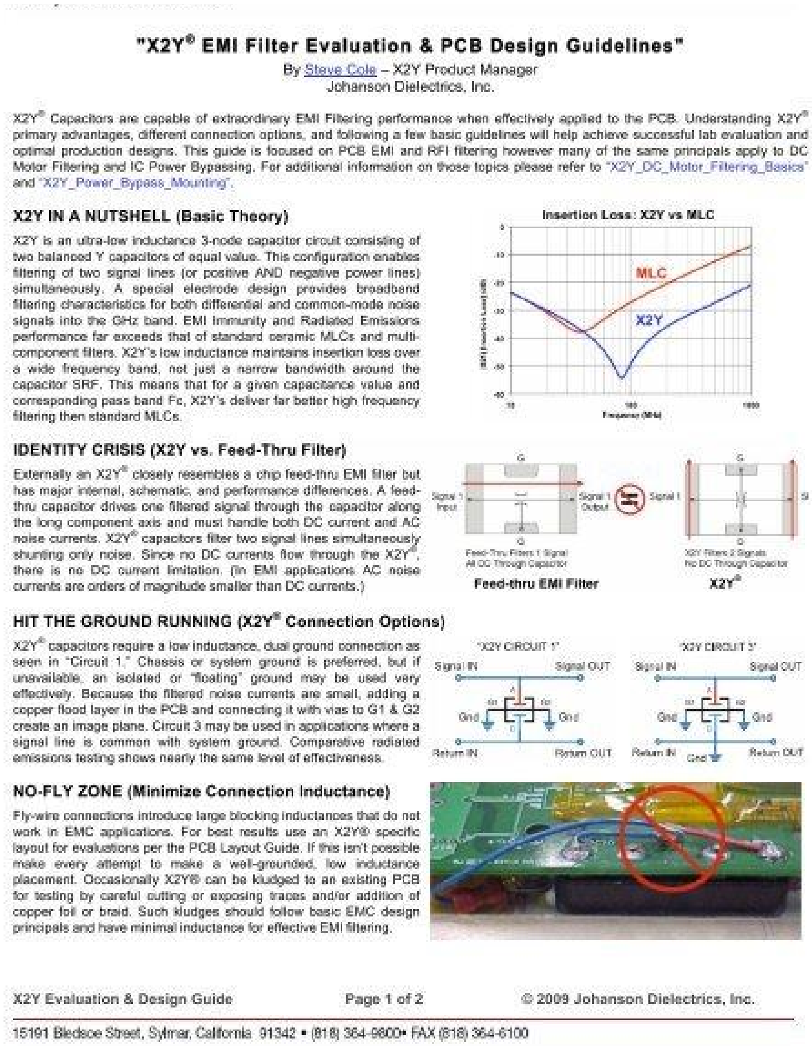

"X2Y® EMI Filter Evaluation & PCB Design Guidelines"

By Steve Cole – X2Y Product Manager
Johanson Dielectrics, Inc.

X2Y® Capacitors are capable of extraordinary EMI Filtering performance when effectively applied to the PCB. Understanding X2Y® primary advantages, different connection options, and following a few basic guidelines will help achieve successful lab evaluation and optimal production designs. This guide is focused on PCB EMI and RFI filtering however many of the same principals apply to DC Motor Filtering and IC Power Bypassing. For additional information on those topics please refer to "X2Y_DC_Motor_Filtering_Basics" and "X2Y_Power_Bypass_Mounting".

X2Y IN A NUTSHELL (Basic Theory)

X2Y is an ultra-low inductance 3-node capacitor circuit consisting of two balanced Y capacitors of equal value. This configuration enables filtering of two signal lines (or positive AND negative power lines) simultaneously. A special electrode design provides broadband filtering characteristics for both differential and common-mode noise signals into the GHz band. EMI Immunity and Radiated Emissions performance far exceeds that of standard ceramic MLCs and multi-component filters. X2Y's low inductance maintains insertion loss over a wide frequency band, not just a narrow bandwidth around the capacitor SRF. This means that for a given capacitance value and corresponding pass band Fc, X2Y's deliver far better high frequency filtering then standard MLCs.

IDENTITY CRISIS (X2Y vs. Feed-Thru Filter)

Externally an X2Y® closely resembles a chip feed-thru EMI filter but has major internal, schematic, and performance differences. A feed-thru capacitor drives one filtered signal through the capacitor along the long component axis and must handle both DC current and AC noise currents. X2Y® capacitors filter two signal lines simultaneously shunting only noise. Since no DC currents flow through the X2Y®, there is no DC current limitation. (In EMI applications AC noise currents are orders of magnitude smaller than DC currents.)

HIT THE GROUND RUNNING (X2Y® Connection Options)

X2Y® capacitors require a low inductance, dual ground connection as seen in "Circuit 1." Chassis or system ground is preferred, but if unavailable, an isolated or "floating" ground may be used very effectively. Because the filtered noise currents are small, adding a copper flood layer in the PCB and connecting it with vias to G1 & G2 create an image plane. Circuit 3 may be used in applications where a signal line is common with system ground. Comparative radiated emissions testing shows nearly the same level of effectiveness.

NO-FLY ZONE (Minimize Connection Inductance)

Fly-wire connections introduce large blocking inductances that do not work in EMC applications. For best results use an X2Y® specific layout for evaluations per the PCB Layout Guide. If this isn't possible make every attempt to make a well-grounded, low inductance placement. Occasionally X2Y® can be kludged to an existing PCB for testing by careful cutting or exposing traces and/or addition of copper foil or braid. Such kludges should follow basic EMC design principals and have minimal inductance for effective EMI filtering.

X2Y Evaluation & Design Guide Page 1 of 2

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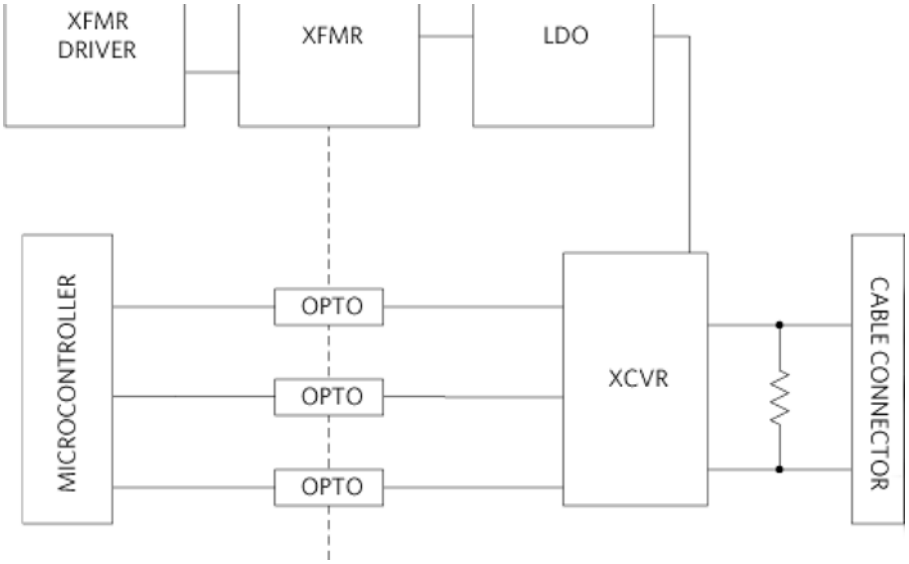

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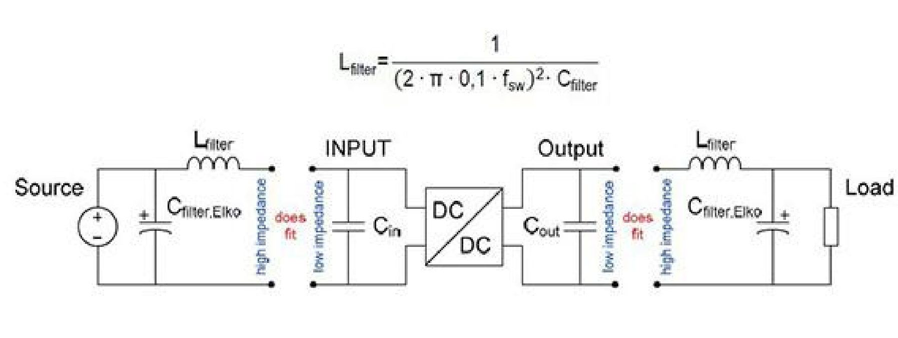

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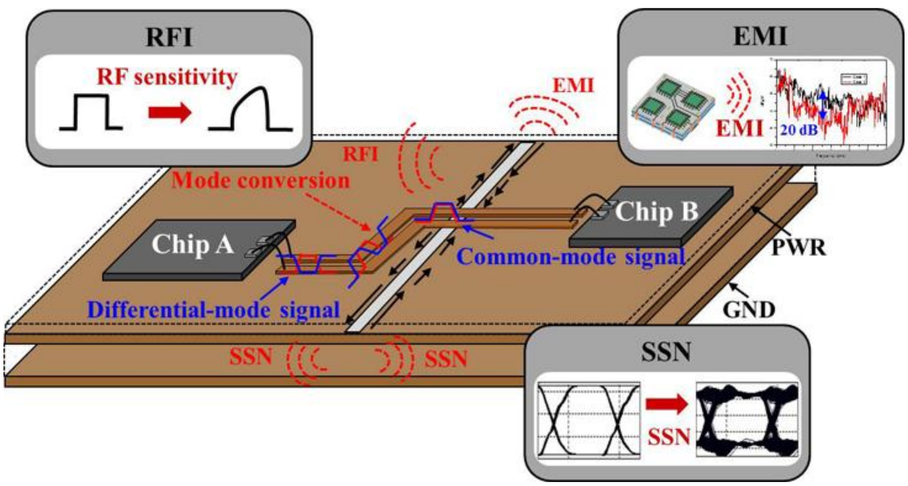

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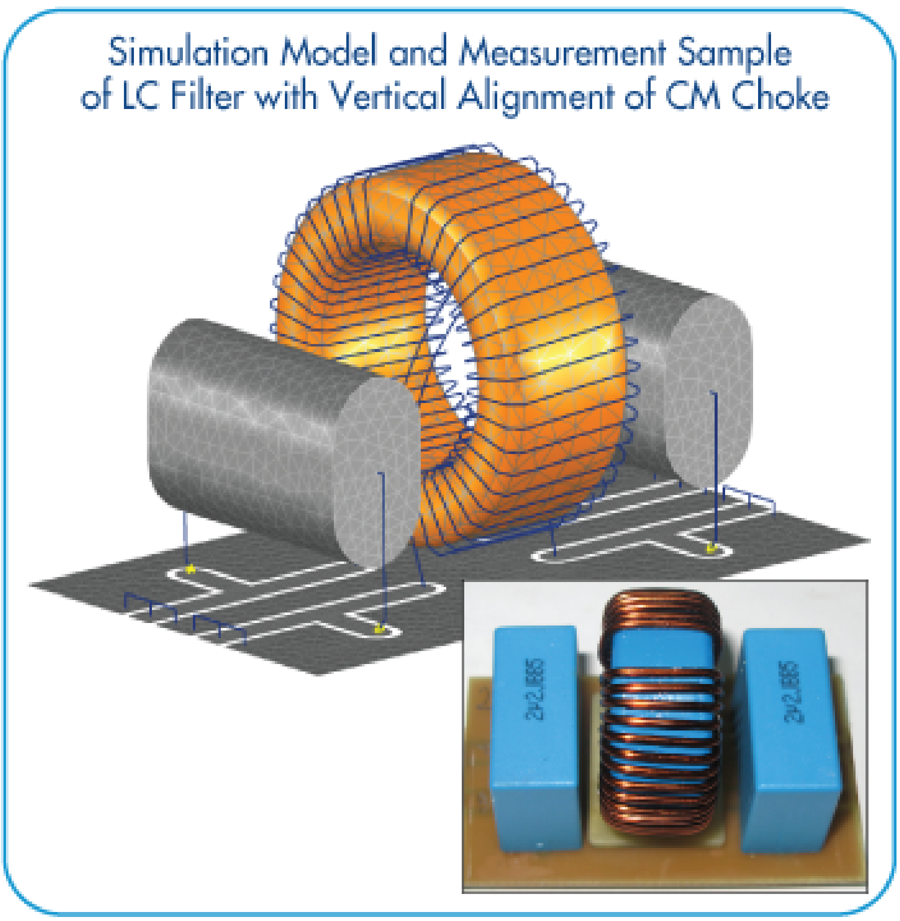

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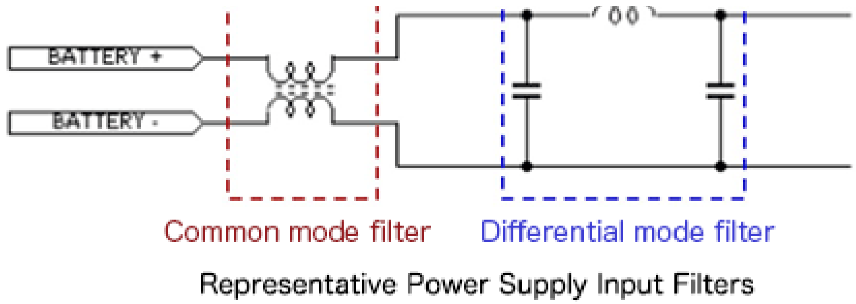

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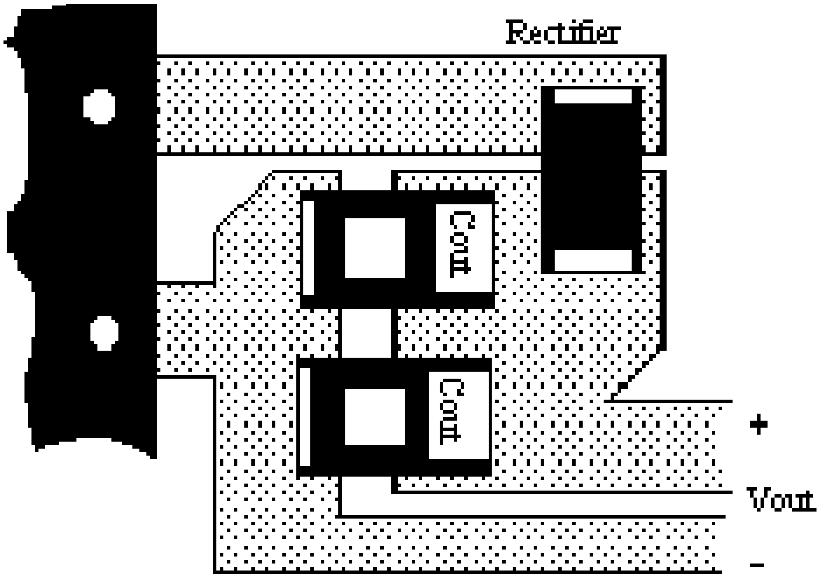

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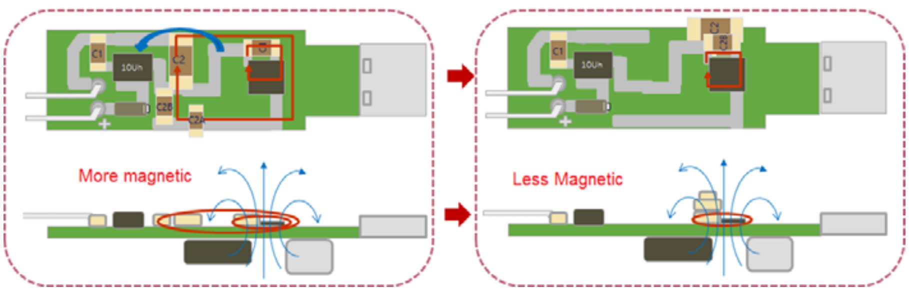

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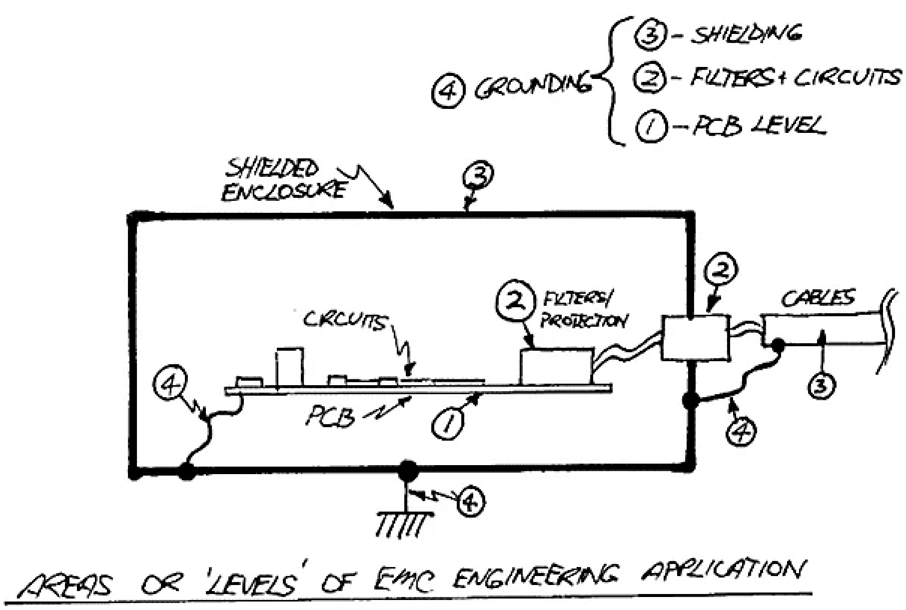
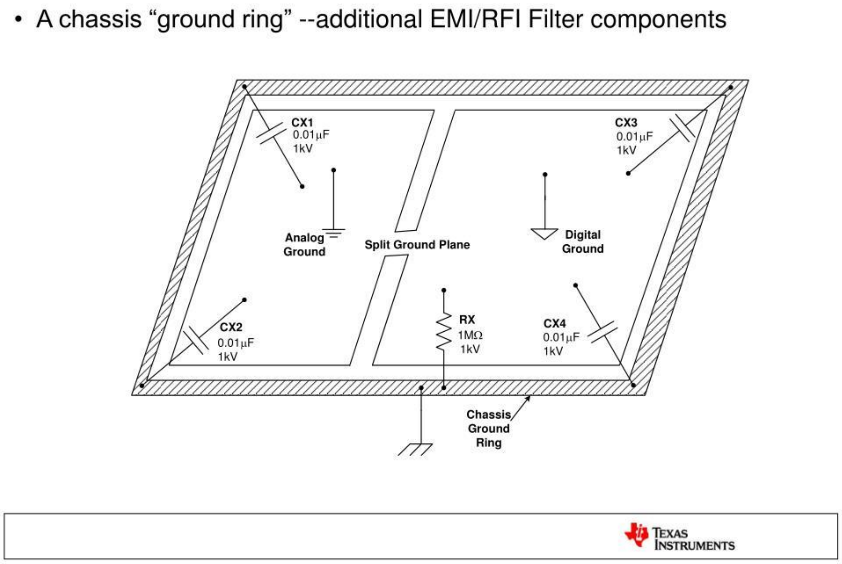


Practical Shielding Emc Emi Noise Reduction Earthing And



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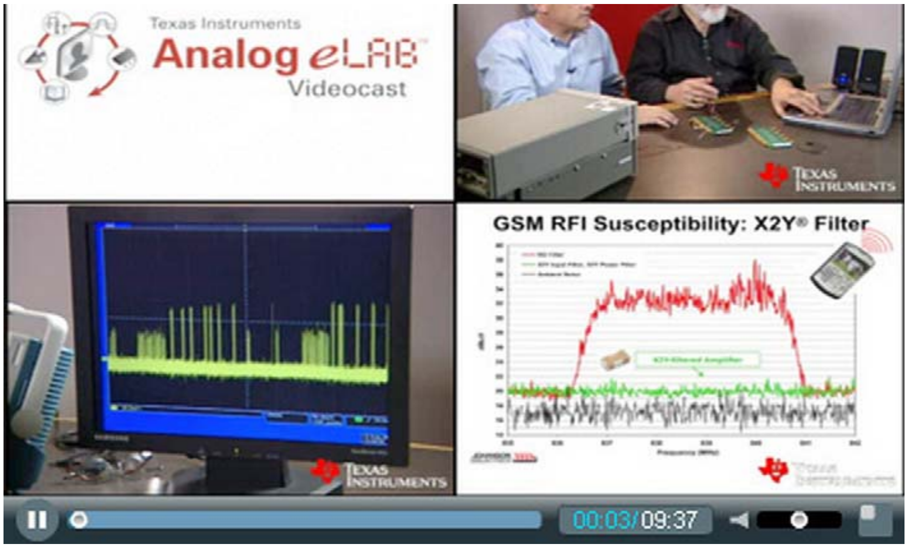
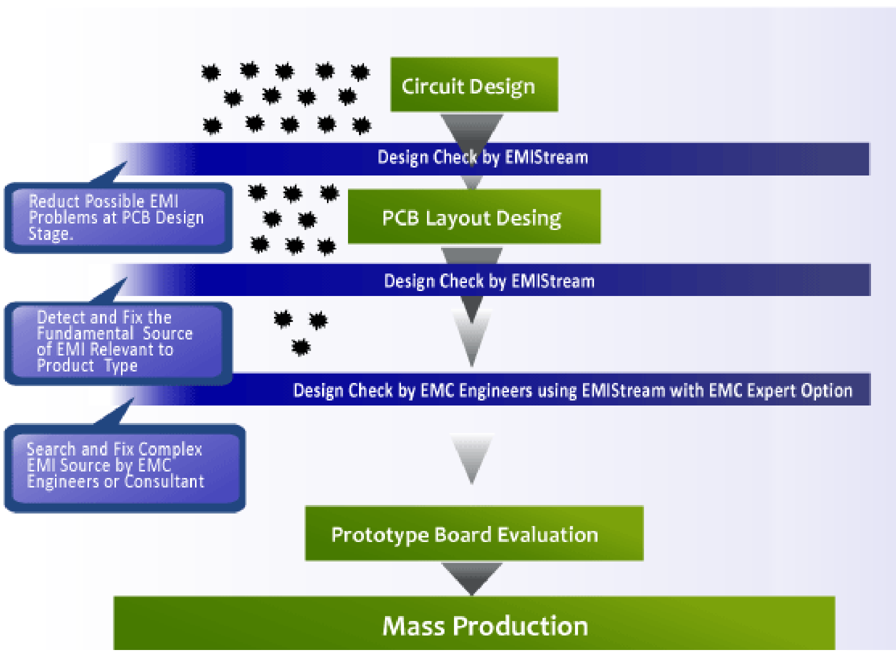


X2y Attenuators Emi Filtering



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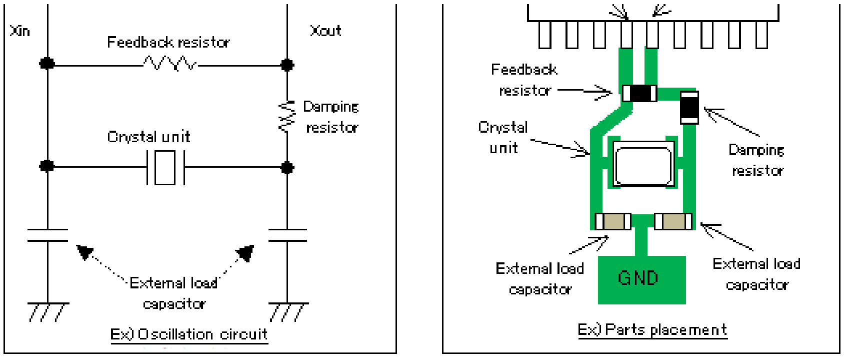
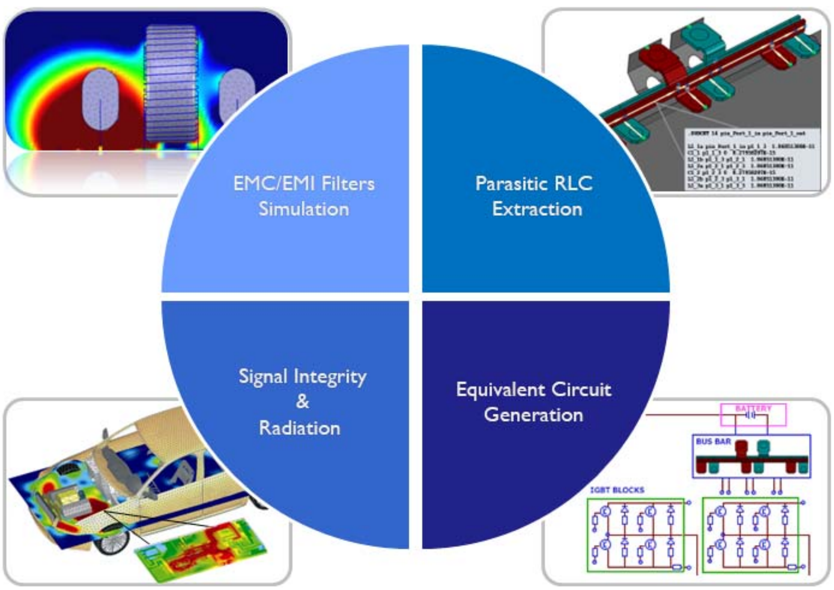


Notice For Soldering And Mounting Crystal Units Murata



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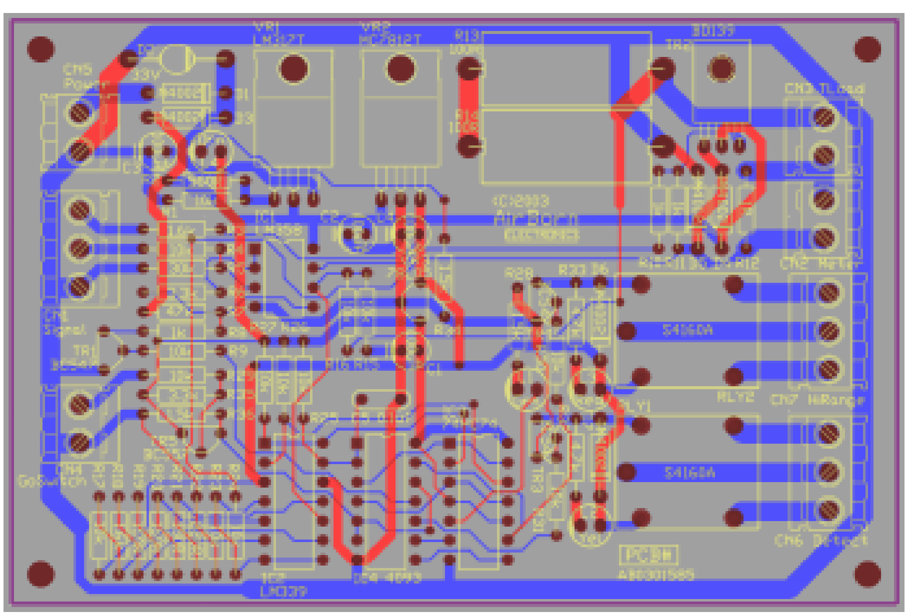

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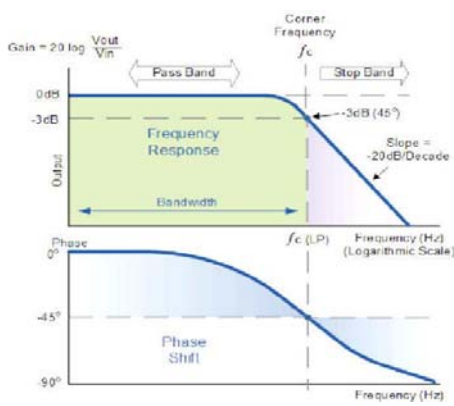

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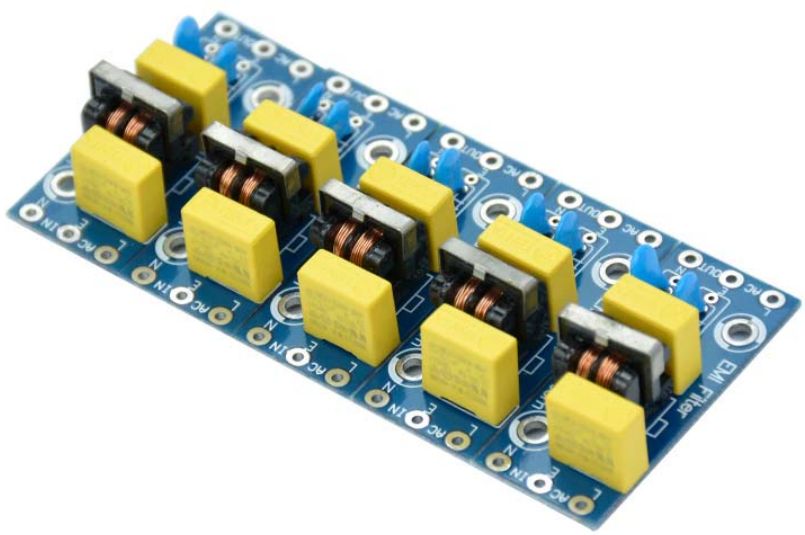

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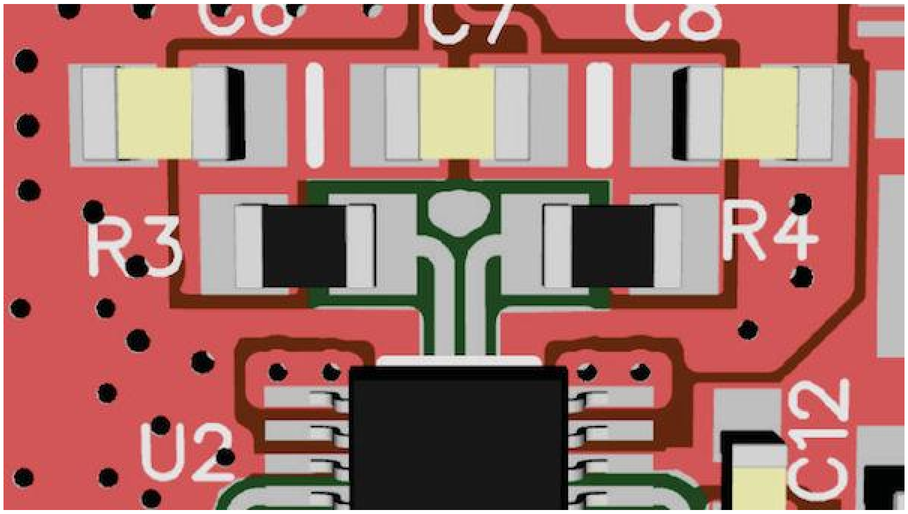

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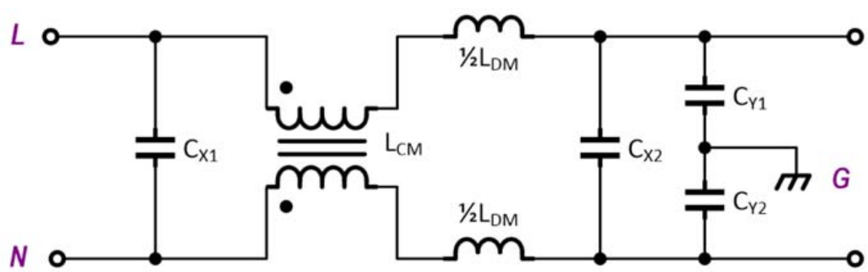

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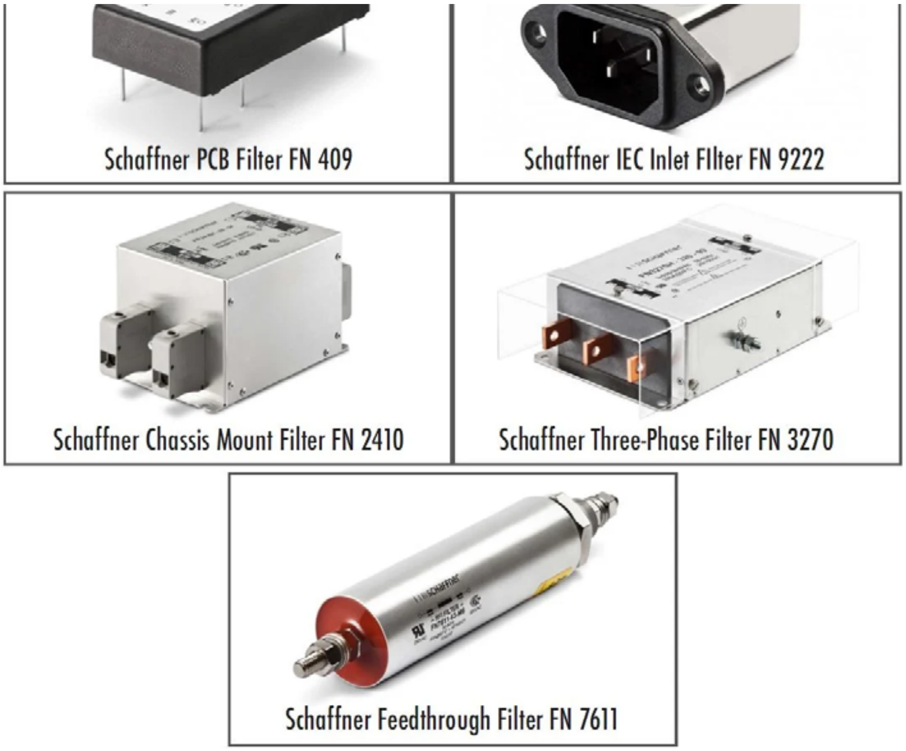

Emi Filter Design

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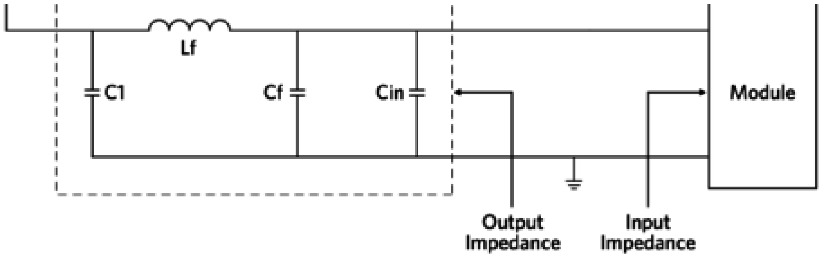

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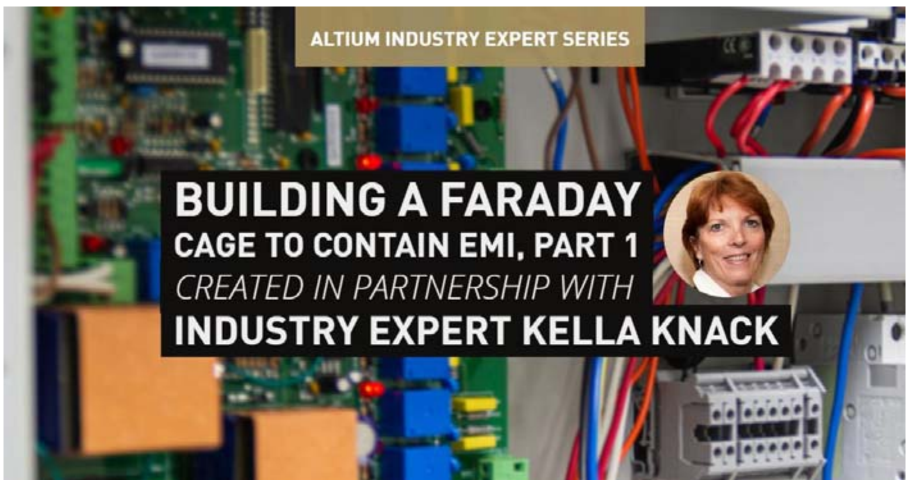

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TEXAS INSTRUMENTS

Application Report

SNVA755–June 2016

Simple Success with Conducted EMI and Radiated EMI for LMR160X0

Vincent Zhang

ABSTRACT

Electromagnetic Interference (EMI) is an unwanted effect between two electrical systems as a result of either electromagnetic radiation or electromagnetic conduction. EMI is the major adverse effect caused by the application of switch-mode power supplies (SMPS). In switching power supplies, EMI noise is unavoidable due to the switching actions of the semiconductor devices and resulting discontinuous currents. EMI control is one of the more difficult challenges in SMPS design, beyond functional issues, robustness, cost, thermal and space constraints.

First, this application note introduces the overview of LMR160X0 family products and conducted EMI knowledge. Second, step by step differential filter parameters design will be introduced to suppress conducted EMI noise. Third, a reference PCB layout based on LMR160X0 is presented. Finally, both conducted EMI and radiated EMI test with and without input filter were provided and compared to verify the theories. This approach also could be applied to the LMR140X0 family.

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Simple Success With Conducted Emi And

Conducted EMI Issues in a 600-W Single-Phase Boost PFC Design

Leopoldo Rossetto, *Member, IEEE*, Simone Buso, *Member, IEEE*, and Giorgio Spiazzi, *Member, IEEE*

***Abstract*—This paper presents the results of experimental activity concerned with the development of a 600-W boost power-factor corrector (PFC) complying with the EMC standards for conducted EMI in the 150-kHz–30-MHz range. In order to accomplish this task, different circuit design and layout solutions are taken into account and their effect on the conducted EMI behavior of the converter is experimentally evaluated. Common-mode and differential-mode switching noise, together with input filters' design and topology and with the printed circuit board layout (in terms of track length and spacing, ground and shielding planes, etc.) are the key aspects which have been considered. In particular, the paper reports the conducted EMI measurements for different filter capacitor placements and values, for different power switch drive circuits, together with several other provisions which have turned out to be decisive in the reduction of the generated EMI.**

***Index Terms*—Conducted EMI, power-factor-corrector rectifier, printed circuit board layout.**

I. Introduction

THE employment of boost power-factor correctors (PFC's) in order to comply with the IEC 1000-3-2 low-frequency EMC standard [1]–[3] is becoming more and more ordinary in a large variety of industrial applications of switch-mode power supplies (SMPS's). This solution, however, increases the conducted interference generation of the power supply in the high-frequency range. As a consequence, while the low-frequency harmonic content of the current driven from the utility grid is normally well controlled and compliant with the aforementioned IEC standard, the high-frequency currents generated by the converter on the grid may be beyond the corresponding standard limits [4]–[7]. To avoid this, it is very important to properly design the EMI filters and the circuit layout so as to minimize the effects of the switching converter on the line pollution. This paper discusses the design of a 600-W boost PFC complying with the EMC standards for conducted EMI in the 150-kHz–30-MHz range [8]. Different circuit design and layout solutions are taken into account and their effect on the conducted EMI behavior of the converter is experimentally evaluated. Common-mode and differential-mode switching noise, together with input filters' design and topology and with the printed circuit board (PCB) layout (in terms of track length and spacing, ground and shielding planes, etc.) are the key aspects which have been considered. In particular, the paper reports the conducted EMI measurements for different filter capacitor placements and values, different power switch drive circuits, together with several other provisions, which have turned out to be decisive in reducing the conducted EMI level of the converter [9]. By means of this design example, which employes two-layer PCB technology, the paper also shows that the application of the theoretically derivable EMC basic design rules, which, in principle, should guarantee the limitation of the EMI in a switching power converter, may, in some cases, become partially ineffective because of second-order effects (e.g., resonances, component parasitics, connections). The experimental results illustrate these unexpected outcomings and the validity of the adopted provisions which allow one to design a fully compliant power supply.

II. Basic Scheme of the Converter

Fig. 1 shows the basic scheme of the considered boost PFC. The ratings of the converter are reported in Table I. These represent the typical characteristics of a PFC designed for a large variety of applications (e.g., telecom applications). A conventional and simple design procedure can be adopted to derive the necessary passive components' values, required to guarantee the continuous conduction mode of operation for the converter practically during the whole line period and a suitable output voltage ripple level. Also, the selection of the required switch and diode is almost straightforward, given the current and voltage stresses, which are easily determined analyzing the converter's typical waveforms. The resulting list of adopted components is reported in Table II.

III. Considerations on the Power Stage Design

The considered topology is simple and well known [10]–[13]. However, when it comes to EMI control, it is necessary to adopt particular care in the definition of the layout of the power stage [14]–[18].

Of course, the main sources of EM noise can be easily identified in the power switch and diode. The reduction of the wire lengths for the current return paths and for the high dv/dt circuit branches, together with the reduction of the areas embraced by high di/dt loops, as shown in Fig. 2, appear to be fundamental provisions. It is, therefore, fundamental that the area between the power switch and the two high-frequency bypass capacitors, which are used to drain the current pulses generated during the

Paper IPCSD 99–79, presented at the 1998 IEEE International Telecommunications Energy Conference, San Francisco, CA, October 4–8, and approved for publication in the IEEE Transactions on Industry Applications by the Industrial Power Converter Committee of the IEEE Industry Applications Society. Manuscript submitted for review November 3, 1998 and released for publication November 5, 1999.

The authors are with the Department of Electronics and Informatics, University of Padova, 35131 Padova, Italy (e-mail: pel@dei.unipd.it; simone@dei.unipd.it; spiazzi@dei.unipd.it).

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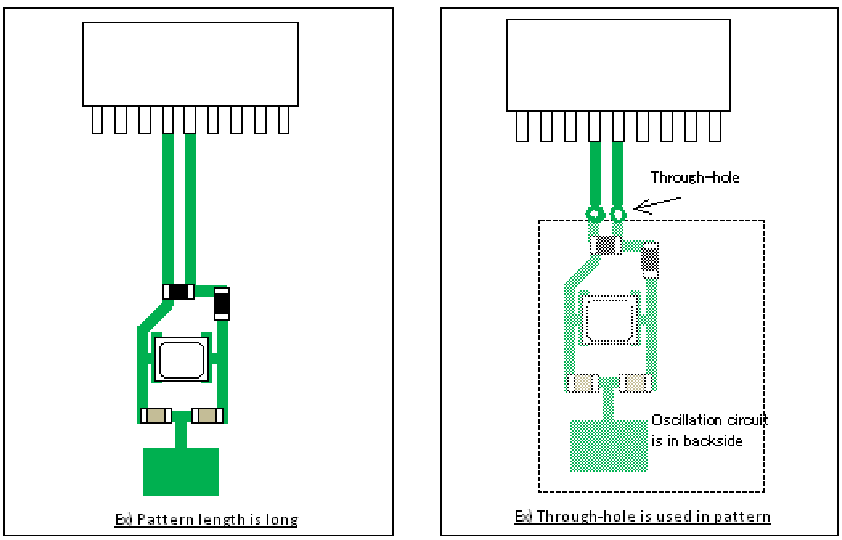
Pdf Conducted Emi Issues In A 600 W Single Phase Boost Pfc Design

Esd Design Harden Equipment For Esd Immunity Part Ii



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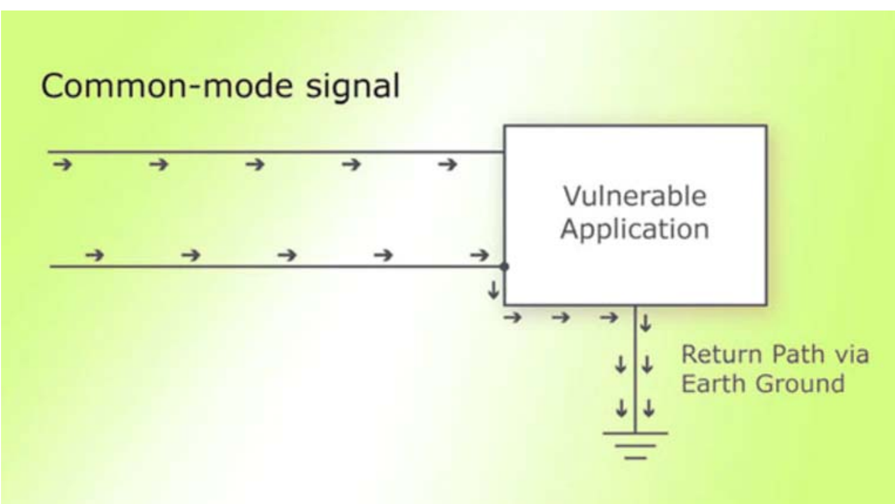

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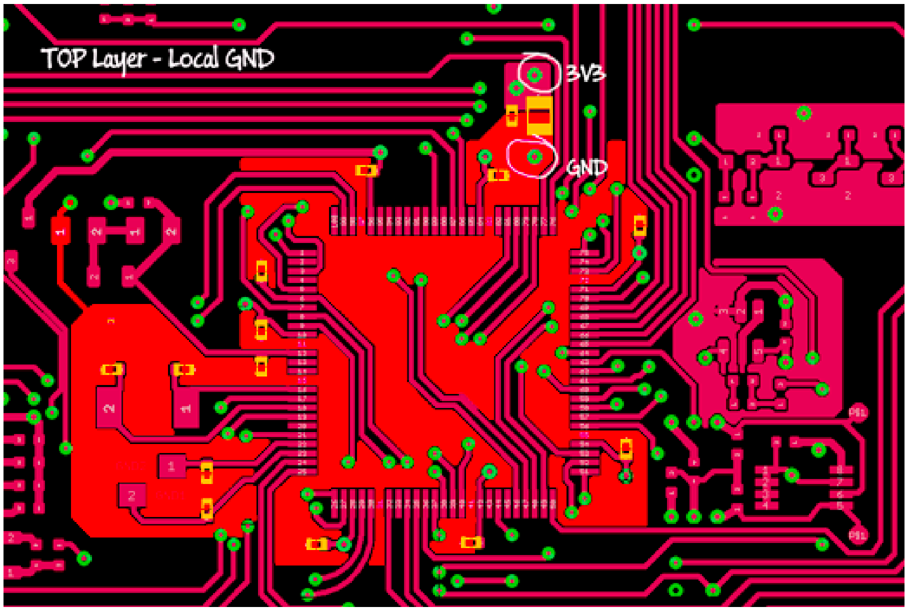

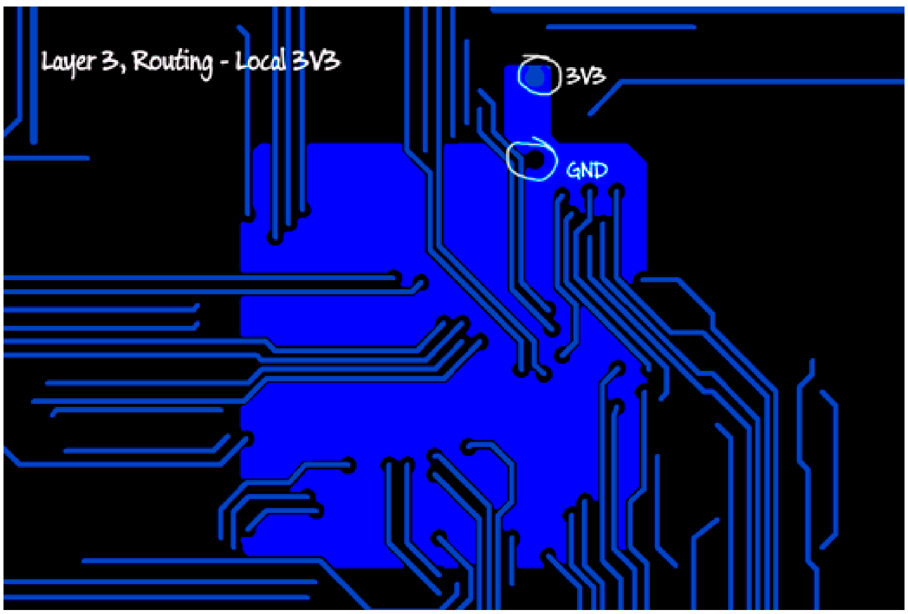

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