

Common Mode Filter Design Guide

Introduction

The selection of component values for common mode filters need not be a difficult and confusing process. The use of standard filter alignments can be utilized to achieve a relatively simple and straightforward design process, though such alignments may readily be modified to utilize pre-defined component values.

General

Line filters prevent excessive noise from being conducted between electronic equipment and the AC line; generally, the emphasis is on protecting the AC line. Figure 1 shows the use of a common mode filter between the AC line (via impedance matching circuitry) and a (noisy) power converter. The direction of common mode noise (noise on both lines occurring simultaneously referred to earth ground) is from the load and into the filter, where the noise common to both lines becomes sufficiently attenuated. The resulting common mode output of the filter onto the AC line (via impedance matching circuitry) is then negligible.

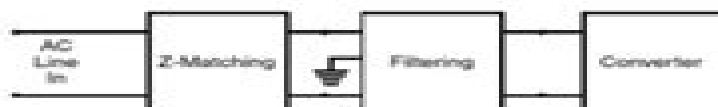


Figure 1. Generalized line filtering

The design of a common mode filter is essentially the design of two identical differential filters, one for each of the two polarity lines with the inductors of each side coupled by a single core:



Figure 2. The common mode inductor

For a differential input current ((A) to (B) through L1 and (B) to (A) through L2), the net magnetic flux which is coupled between the two inductors is zero.

Any inductance encountered by the differential signal is then the result of imperfect coupling of the two chokes; they perform as independent components with their leakage inductances responding to the differential signal; the leakage inductances attenuate the differential signal.

When the inductors, L1 and L2, encounter an identical signal of the same polarity referred to ground (common mode signal), they each contribute a net, non-zero flux in the shared core; the inductors thus perform as independent components with their mutual inductance responding to the common signal; the mutual inductance then attenuates this common signal.

The First Order Filter

The simplest and least expensive filter to design is a first order filter; this type of filter uses a single reactive component to store certain bands of a spectral energy without passing this energy to the load. In the case of a low pass common mode filter, a common mode choke is the reactive element employed.

The value of inductance required of the choke is simply the load in Ohms divided by the radian frequency at and above which the signal is to be attenuated. For example, attenuation at and above 4000 Hz into a 50Ω load would require a 1.99 mH ($50/(2\pi \times 4000)$) inductor. The resulting common mode filter configuration would be as follows:



Figure 3. A first order (single pole) common mode filter

The attenuation at 4000 Hz would be 3 dB, increasing at 6 dB per octave. Because of the predominant inductor dependence of a first order filter, the variations of actual choke inductance must be considered. For example, a $\pm 20\%$ variation of rated inductance means that the nominal 3 dB frequency of 4000 Hz could actually be anywhere in the range from 3332 Hz to 4999 Hz. It is typical for the inductance value of a common mode choke

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Common Mode Filter Design Guide

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Transformer and Inductor Design Handbook Colonel Wm. T. McLyman, 2017-12-19 With its practical approach to design Transformer and Inductor Design Handbook Fourth Edition distinguishes itself from other books by presenting information and guidance that is shaped primarily by the user's needs and point of view Expanded and revised to address recent industry developments the fourth edition of this classic reference is reorganized and improved again serving as a constant aid for anyone seeking to apply the state of the art in transformer and inductor design Carefully considering key factors such as overall system weight power conversion efficiency and cost the author introduces his own new equation for the power handling ability of the core intended to give engineers faster and tighter design control The book begins by providing the basic fundamentals of magnetics followed by an explanation of design using the Kg or Ap techniques It also covers subjects such as laminations tape cores powder cores and ferrites and iron alloys In addition new topics include Autotransformer design Common mode inductor design Series saturable reactor design Self saturating magnetic amplifier Designing inductors for a given resistance With the goal of making inductors that are lighter and smaller but still meet requirements this book helps users avoid many antiquated rules of thumb to achieve a better more economical design Presenting transformer design examples with step by step directions and numerous tables and graphics for comparison it remains a trusted guide for the engineers technicians and other professionals who design and evaluate transformers and inductors It also serves as an ideal primer for students illustrating the field for them from the ground up

CDOT Design Guide: Drainage design manual Colorado. Department of Transportation, 1995

Applied Embedded Electronics Jerry Twomey, 2023-11-14 And Conclusions Further Reading Chapter 3 Robust Digital Communication Digital Signals Physical Considerations and Connections Limitations of Ground Referenced Digital Signals Low Voltage Differential Signaling Organizing Interconnects for Speed and Signal Integrity Lumped Versus Distributed Networks Clock Distribution Digital Communication Parallel Versus Serial Ports Clocking Methods for Serial Ports Starting Edge Synchronization Parallel Clock Manchester Code Self Clocking Embedded Clock and Run Length Limited Codes

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Analog Filter and Circuit Design Handbook Arthur Williams, 2013-10-30 A single source design reference providing expert guidance on analog filter and circuit design Analog Filter and Circuit Design Handbook emphasizes the operational amplifier op amp as the key building block and provides a strong foundation of understanding of how op amps work and what their limitations are The book

contains numerous circuit examples that provide mathematical functions on analog signals in both a linear and non linear manner Audio applications such as audio power amplifiers and cross over networks are included Extensive coverage of both active and passive filters Discusses audio power amplifiers various types of waveforms and non linear amplifier applications Leads you through how IC operational amplifiers work their critical parameters and how to properly choose the appropriate amplifier for a given application Tables help you select the proper device for your requirements combining amplifiers made by different manufacturers into a single table saves you from having to perform extensive searches among different manufacturers websites Includes free downloads Filter Solutions from Nuhertz Technologies enables the design of Elliptic Function low pass filters up to the tenth order ELI 1 0 allows the design of odd order elliptic function LC low pass filters up to a complexity of 15 nulls transmission zeros or the 31st order Fltrform an EXCEL spreadsheet arranged by chapter that contains all the significant formulas to simplify some of the calculations

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Electromagnetic Compatibility in Medical Equipment William D. Kimmel,Daryl Gerke,2018-02-06 Co published with the IEEE Press this book is a practical hands on guide to EMC issues for medical device designers and installers It addresses electromagnetic interference and covers the basics of EMC design physics and installation minimizing theory and concentrating upon the correct way to ground and shield Covering EMC from the inside out the book provides the basics of electronics discusses and evaluates problems and common causes and explores effective remedial techniques at three levels circuit box and interconnect It contains appendices that provide important reference material such as constants and conversion factors

Grounds for Grounding Elya B. Joffe,Kai-Sang Lock,2011-09-20 GROUNDS FOR GROUNDING The first book to cover grounding from the circuit to system and across the entire spectrum of applications Grounds for Grounding provides a complete and thorough approach to the subject of designing electrical and electronic circuits and systems blending theory and practice to demonstrate how a few basic rules can be applied across a broad range of applications The authors begin with the basic concepts of Electromagnetic Compatibility EMC that are essential for understanding grounding theory and its applications such as ground loop which is one of the most misunderstood concepts in EMC Next they provide an introduction to grounding including safety grounding grounding for control of electromagnetic interference and grounding related case studies Subsequent chapter coverage includes Fundamentals of grounding design Bonding principles Grounding for power distribution and lightning protection systems Grounding in wiring circuits and cable

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