

# Simulation of Flyback Converter with Peak Current Mode Control

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**Abstract:** The most of the analogue and digital electronic systems requires a DC power supplies, many of the system would expect that these power supplies should be of high efficiency, smaller size and weight. The low cost high efficiency flyback converter is most widely used in a DC power supplies. This paper presents the analysis and simulation of a flyback converter in a peak current mode control.

**Keywords:** Flyback converter, DC power supply, peak current mode, Subharmonic oscillation.

## I. INTRODUCTION

The power converters are broadly classified as non-isolated converter and isolated converter. Non-isolated converter such as buck, boost, and buck-boost converters, can be easily built at lower cost. But they do not provide any protection to the load or to the source when subjected to the high current or voltage. Whereas isolated converters such as flyback, push-pull, forward which are derived from the basic non-isolated converters provides isolation and protection for the source as well as to the load.

To provide a stable DC supply, the regulation of DC output voltage is necessary. The output voltage is regulated using a feedback loop in the system [4]: voltage mode control and current mode control methods are available to control the output voltage. Traditionally voltage mode control technique which is a single loop control method is used in which the output voltage is regulated by directly controlling the duty cycle of the switch. The drawback of this method is poor dynamic performance and prone to input voltage variations [5]. The current mode control is a two loop systems with inner current loop and outer voltage loop, the output voltage is not directly controlled by the duty cycle but it will depend on the inductor current.

Current Mode Controls are classified as a peak current mode control and average current mode control. In average current mode control, average value of the inductor current is controlled and in peak current mode control, the peak of the inductor current is sensed and controlled. The power switch is turned on by the fixed frequency clock and turned off when the peak of the inductor current reaches the threshold level set by the outer voltage loop. Peak current mode control is a widely used method because of its inherent cycle by cycle current limiting to protect the inductor from the over current. For

the continuous current conduction mode the peak current mode control suffer from the problem of sub harmonic oscillation for the duty cycle above 50%. This problem is avoided by a slope compensation method.

This paper presents the analysis of peak current mode control for the flyback converter. Section II describes the basic principle of operation of flyback converter. Output voltage regulation by voltage mode control and current mode control is analyzed in section III. Section IV presents the MATLAB/Simulink model of flyback converter and results of the current mode controlled flyback converter.

## II. PRINCIPLE OF OPERATION OF FLYBACK CONVERTER

Flyback converter is basically derived from the non-isolated buck-boost converter; fig 1 below shows the circuit diagram of the basic flyback converter.

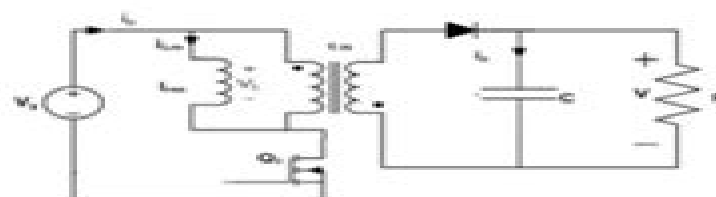


Fig 1 Flyback converter circuit

The fig 1 represents the transformer equivalent circuit model of flyback converter, where the magnetizing inductor  $L_m$  functions similar to the inductor of the buck-

# Designing Flyback Converters Using Peak Current Mode

**Colonel Wm. T. McLyman**



## **Designing Flyback Converters Using Peak Current Mode:**

Pulsewidth Modulated DC-to-DC Power Conversion Byungcho Choi, 2021-10-04 ORGANIC REACTIONS CYCLIZATION REACTIONS OF NITROGEN CENTERED RADICALS Stuart W McCombie B atrice Quiclet Sire and Samir Z Zard TRANSITION METAL CATALYZED AMINOXYGENATION OF ALKENES Sherry R Chemler Dake Chen Shuklendu D Karyakarte Jonathan M Shikora and Tomasz Wdowik      *Pulse Width Modulated DC-DC Converters* Keng Chih Wu, 2012-12-06 For the first time in power electronics this comprehensive treatment of switch mode DC DC converter designs addresses many analytical closed form equations such as duty cycle prediction output regulation output ripple control loop gain and steady state time domain waveform Each of these equations are given various topologists and configurations including forward flyback and boost converters Pulse Width Modulated DC DC Converters begins with a detailed approach to the quiescent operating locus of a power plant under open loop The reader is then led through other supporting circuits once again in the quiescent condition These exercises result in the close loop formulations of the subject system providing designers with the ability to study the sensitivities of a system against disturbances With the quiescent conditions well established the book then guides the reader further into the territories of system stability where small signal behaviors are explored Finally some important large signal time domain studies cap the treatment Some distinctive features of this book include detailed coverage of dynamic close loop converter simulations using only personal computer and modern mathematical software Steady state time domain analysis based on the concept of continuity of states Voltage mode and current mode control techniques and their differences of merits A detailed description on setting up different equations for DC DC converters simulation using only PC      *Transformer and Inductor Design Handbook, Third Edition* Colonel Wm. T. McLyman, 2004-03-31 Extensively revised and expanded to present the state of the art in the field of magnetic design this third edition presents a practical approach to transformer and inductor design and covers extensively essential topics such as the area product  $A_p$  and core geometry  $K_g$  The book provides complete information on magnetic materials and core characteristics using step by step design examples and presents all the key components for the design of lightweight high frequency aerospace transformers or low frequency commercial transformers Written by a specialist with more than 47 years of experience in the field this volume covers magnetic design theory with all of the relevant formulas      **Practical Switching Power Supply Design** Martin C. Brown, 2012-12-02 Take the black magic out of switching power supplies with Practical Switching Power Supply Design This is a comprehensive hands on guide to the theory behind and design of PWM and resonant switching supplies You ll find information on switching supply operation and selecting an appropriate topology for your application There s extensive coverage of buck boost flyback push pull half bridge and full bridge regulator circuits Special attention is given to semiconductors used in switching supplies RFI EMI reduction grounding testing and safety standards are also detailed Numerous design examples and equations are given and discussed Even if your primary expertise

is in logic or microprocessor engineering you ll be able to design a power supply that s right for your application with this essential guide and reference Gives special attention to resonant switching power supplies a state of the art trend in switching power supply design Approaches switching power supplies in an organized way beginning with the advantages of switching supplies and thier basic operating principles Explores various configurations of pulse width modulated PWM switching supplies and gives readers ideas for the direction of their designs Especially useful for practicing design engineers whose primary specialty is not in analog or power engineering fields

**Control and Nonlinear Dynamics on Energy Conversion Systems** Herbert Ho-Ching Iu, Abdelali El Aroudi, 2019-07-01 The ever increasing need for higher efficiency smaller size and lower cost make the analysis understanding and design of energy conversion systems extremely important interesting and even imperative One of the most neglected features in the study of such systems is the effect of the inherent nonlinearities on the stability of the system Due to these nonlinearities these devices may exhibit undesirable and complex dynamics which are the focus of many researchers Even though a lot of research has taken place in this area during the last 20 years it is still an active research topic for mainstream power engineers This research has demonstrated that these systems can become unstable with a direct result in increased losses extra subharmonics and even uncontrollability unobservability The detailed study of these systems can help in the design of smaller lighter and less expensive converters that are particularly important in emerging areas of research like electric vehicles smart grids renewable energy sources and others The aim of this Special Issue is to cover control and nonlinear aspects of instabilities in different energy conversion systems theoretical analysis modelling and practical solutions for such emerging applications In this Special Issue we present novel research works in different areas of the control and nonlinear dynamics of energy conversion systems

**Practical Lighting Design with LEDs** Ron Lenk, Carol Lenk, 2017-03-10 The essential how to guide to designing and building LED systems revised and updated The second edition of Practical Lighting Design with LEDs has been revised and updated to provide the most current information for developing light emitting diodes products The authors noted authorities in the field offer a review of the most relevant topics including optical performance materials thermal design and modeling and measurement Comprehensive in scope the text covers all the information needed to design LEDs into end products The user friendly text also contains numerous drawings and schematics that show how things such as measurements are actually made and show how circuits actually work Designed to be practical the text includes myriad notes and illustrative examples that give pointers and how to guides on many of the book s topics In addition the book s equations are used only for practical calculations and are kept at the level of high school algebra This thoroughly expanded second edition offers New chapters on the design of an LED flashlight USB light automotive taillight and LED light bulbs A practical and user friendly guide with dozens of new illustrations The nitty gritty day to day engineering and systems used to design and build complete LED systems An essential resource on the cutting edge technology of Light Emitting Diodes Practical Lighting Design with LEDs

helps engineers and managers meet the demand for the surge in usage for products using light emitting diodes with a practical guide that takes them through the relevant fields of light electronic and thermal design *Power Electronic Converters* Teuvo Suntio, Tuomas Messo, Joonas Puukko, 2017-09-12 Ein Referenzwerk mit Erläuterungen zum Verhalten von elektronischen Leistungswandlern fehlte bislang Dieses Fachbuch bietet Informationen die in vergleichbaren Publikationen zur Leistungselektronik nicht enthalten sind In einer übersichtlichen Struktur werden in vier Abschnitten die folgenden Themen behandelt Der erste Abschnitt beschäftigt sich mit der Dynamik und Steuerung herkömmlicher Leistungswandler Dynamik und Steuerung von Gleichspannungswandlern in Anwendungen mit erneuerbaren Energien sind Gegenstand des zweiten Abschnitts der auch eine Einführung in die Quellen und das Design von stromgespeisten Leistungswandlern nach dem Prinzip der Dualitätstransformation Der dritte Abschnitt beschreibt die Dynamik und Steuerung von dreiphasigen Gleichrichtern in spannungsgespeisten Anwendungen Im letzten Abschnitt geht es um die Dynamik und Steuerung von dreiphasigen VS Umrichtern bei Anwendungen mit erneuerbaren Energien Dieses zukunftsorientierte Fachbuch mit fundierten Informationen aus erster Hand ist das Referenzwerk der Wahl für Forscher und Ingenieure die ein zugehöriges Nachschlagewerk zu Design und Steuerung von elektronischen Leistungswandlern benötigen *Power Electronics Handbook* Muhammad H. Rashid, 2023-09-27 Power Electronics Handbook Fifth Edition delivers an expert guide to power electronics and their applications The book examines the foundations of power electronics power semiconductor devices and power converters before reviewing a constellation of modern applications Comprehensively updated throughout this new edition features new sections addressing current practices for renewable energy storage transmission integration and operation as well as smart grid security intelligent energy artificial intelligence and machine learning applications applied to power electronics and autonomous and electric vehicles This handbook is aimed at practitioners and researchers undertaking projects requiring specialist design analysis installation commissioning and maintenance services Provides a fully comprehensive work addressing each aspect of power electronics in painstaking depth Delivers a methodical technical presentation in over 1500 pages Includes 50 contributions prepared by leading experts Offers practical support and guidance with detailed examples and applications for lab and field experimentation Includes new technical sections on smart grid security and intelligent energy artificial intelligence and machine learning applications applied to power electronics and autonomous and electric vehicles Features new chapter level templates and a narrative progression to facilitate understanding *Electrical Generation and Distribution Systems and Power Quality Disturbances* Gregorio Romero, Luisa Martinez, 2011-11-21 The utilization of renewable energy sources such as wind energy or solar energy among others is currently of greater interest Nevertheless since their availability is arbitrary and unstable this can lead to frequency variation to grid instability and to a total or partial loss of load power supply being not appropriate sources to be directly connected to the main utility grid Additionally the presence of a static converter as output interface of the generating plants introduces

voltage and current harmonics into the electrical system that negatively affect system power quality By integrating distributed power generation systems closed to the loads in the electric grid we can eliminate the need to transfer energy over long distances through the electric grid In this book the reader will be introduced to different power generation and distribution systems with an analysis of some types of existing disturbances and a study of different industrial applications such as battery charges

**Origin of Power Converters** Tsai-Fu Wu, Yu-Kai Chen, 2020-04-14 A comprehensive guide to approaches to decoding synthesizing and modeling pulse width modulation PWM converters Origin of Power Converters explores the original converter and provides a systematic examination of the development and modeling of power converters based on decoding and synthesizing approaches The authors noted experts on the topic present an introduction to the origins of the converter and detail the fundamentals related to power the converter s evolution They cover a range of converter synthesis approaches synthesis of multi stage multi level converters extension of hard switching converters to soft switching ones and determination of switch voltage stresses in the converters In later chapters this comprehensive resource reviews conventional two port network theory and the state space averaged SSA modeling approach from which systematic modeling approaches are based on the graft switch technique In addition the book reviews the converter layer scheme and some fundamental circuit theories This important book Contains a review of several typical transfer codes such as step down step up step up down and step up down Describes the syntheses of pulse width modulation PWM converters such as voltage fed z source current fed z source quasi z source switched capacitor and switched inductor converters Presents two application examples based on previously proposed modeling approaches Written for academic researchers graduate students and seniors in power electronics Origin of Power Converters provides a comprehensive understanding of the evolution of the converter and its applications

**Fundamentals of Power Electronics** Erickson, 2013-06-29 In many university curricula the power electronics field has evolved beyond the status of comprising one or two special topics courses Often there are several courses dealing with the power electronics field covering the topics of converters motor drives and power devices with possibly additional advanced courses in these areas as well There may also be more traditional power area courses in energy conversion machines and power systems In the breadth vs depth tradeoff it no longer makes sense for one textbook to attempt to cover all of these courses indeed each course should ideally employ a dedicated textbook This text is intended for use in introductory power electronics courses on converters taught at the senior or first year graduate level There is sufficient material for a one year course or at a faster pace with some material omitted for two quarters or one semester The first class on converters has been called a way of enticing control and electronics students into the power area via the back door The power electronics field is quite broad and includes fundamentals in the areas of Converter circuits and electronics Control systems Magnetics Power applications Design oriented analysis This wide variety of areas is one of the things which makes the field so interesting and appealing to newcomers This breadth also makes teaching the field a challenging

undertaking because one cannot assume that all students enrolled in the class have solid prerequisite knowledge in so many areas

*Demystifying Switching Power Supplies* Raymond A. Mack, 2011-03-14 This book is a crash course in the fundamental theory concepts and terminology of switching power supplies. It is designed to quickly prepare engineers to make key decisions about power supplies for their projects. Intended for readers who need to quickly understand the key points of switching power supplies, this book covers the 20% of the topic that engineers use 80% of the time. Unlike existing switching power supply books that deal strictly with design issues, this book also recognizes the growing importance of off the shelf commercial switching power supplies, giving readers the background necessary to select the right commercial supply. This book covers the core essentials of power supply theory and design while keeping mathematics to the absolute minimum necessary. Special attention is given to the selection of appropriate components such as inductors and transformers to ensure safe and reliable operation. Engineers whose main design responsibilities are in other areas will better understand the strengths and weaknesses of switching power supplies and whether such supplies are appropriate for their projects. They will be able to give more meaningful design requirements and specifications to those who design switching power supplies. Discusses both AC line supplies and DC DC inverters. Covers the main switching power supply designs including flyback, forward, conversion bridge, buck, boost, and boost buck topologies. Design examples include a 220 volt offline switching power supply and a 110 volt uninterruptible supply.

*Power Electronics, A First Course* Ned Mohan, Siddharth Raju, 2023-01-12

**POWER ELECTRONICS A FIRST COURSE** Enables students to understand power electronics systems as one course in an integrated electric energy systems curriculum. *Power Electronics A First Course* provides instruction on fundamental concepts related to power electronics to undergraduate electrical engineering students, beginning with an introductory chapter and moving on to discussing topics such as switching power poles, switch mode dc/dc converters, and feedback controllers. The authors also cover diode rectifiers, power factor correction (PFC) circuits, and switch mode dc power supplies. Later chapters touch on soft switching in dc/dc power converters, voltage and current requirements imposed by various power applications, dc and low frequency sinusoidal ac voltages, thyristor converters, and the utility applications of harnessing energy from renewable sources. *Power Electronics A First Course* is the only textbook that is integrated with hardware experiments and simulation results. The simulation files are available on a website associated with this textbook. The hardware experiments will be available through a University of Minnesota startup at a low cost. In *Power Electronics A First Course*, readers can expect to find detailed information on the availability of various power semiconductor devices that are essential in power electronic systems, plus their switching characteristics and various tradeoffs. Common foundational unit of various converters and their operation, plus fundamental concepts for feedback control, illustrated by means of regulated dc/dc converters. Basic concepts associated with magnetic circuits to develop an understanding of inductors and transformers needed in power electronics. Problems associated with hard switching and some of the practical circuits where this problem

can be minimized with soft switching Power Electronics A First Course is an ideal textbook for Junior Senior Undergraduate students in Electrical and Computer Engineering ECE It is also valuable to students outside of ECE such as those in more general engineering fields Basic understanding of electrical engineering concepts and control systems is a prerequisite

**Power-Switching Converters** Simon Ang,Alejandro Oliva,Gary Griffiths,Richard Harrison,2010-12-20 Significantly expanded and updated with extensive revisions new material and a new chapter on emerging applications of switching converters Power Switching Converters Third Edition offers the same trusted accessible and comprehensive information as its bestselling predecessors Similar to the two previous editions this book can be used for a **EDN, Electrical Design News** ,2003 **Power Converters with Digital Filter Feedback Control** Keng C. Wu,2016-01-22 Power Converter with Digital Filter Feedback Control presents a logical sequence that leads to the identification extraction formulation conversion and implementation for the control function needed in electrical power equipment systems This book builds a bridge for moving a power converter with conventional analog feedback to one with modern digital filter control and enlists the state space averaging technique to identify the core control function in analytical close form in s domain Laplace It is a useful reference for all professionals and electrical engineers engaged in electrical power equipment systems design integration and management Offers logical sequences to identification extraction formulation conversion and implementation for the control function needed Contains step by step instructions on how to take existing analog designed power processors and move them to the digital realm Presents ways to extract gain functions for many power converters power processing stages and their supporting circuitry **Modeling and Control of Power Electronics Converter System for Power Quality Improvements** Sanjeet Kumar Dwivedi,Shailendra Jain,Krishna Kumar Gupta,Pradyumn Chaturvedi,2018-08-17 Modeling and Control of Power Electronics Converter Systems for Power Quality Improvements provides grounded theory for the modeling analysis and control of different converter topologies that improve the power quality of mains Intended for researchers and practitioners working in the field topics include modeling equations and the state of research to improve power quality converters By presenting control methods for different converter topologies and aspects related to multi level inverters and specific analysis related to the AC interface of drives the book helps users by putting a particular emphasis on different control algorithms that enhance knowledge and research work Present In depth coverage of modeling and control methods for different converter topology Includes a particular emphasis on different control algorithms to give readers an easier understanding Provides a results and discussion chapter and MATLAB simulation to support worked examples and real life application scenarios **Power Sources and Supplies: World Class Designs** Marty Brown,2011-04-08 Newnes has worked with Marty Brown a leader in the field of power design to select the very best design specific material from the Newnes portfolio Marty selected material for its timelessness its relevance to current power supply design needs and its real world approach to design issues Special attention is given to switching power supplies and their design issues including



component selection minimization of EMI toroid selection and breadboarding of designs Emphasis is also placed on design strategies for power supplies including case histories and design examples This is a book that belongs on the workbench of every power supply designer Marty Brown author and power supply design consultant has personally selected all content for its relevance and usefulness Covers best design practices for switching power supplies and power converters Emphasis is on pragmatic solutions to commonly encountered design problems and tasks

**Power Electronics Circuit Analysis with PSIM®** Farzin Asadi, Kei Eguchi, 2021-09-20 Power electronics systems are nonlinear variable structure systems They involve passive components such as resistors capacitors and inductors semiconductor switches such as thyristors and MOSFETs and circuits for control The analysis and design of such systems presents significant challenges Fortunately increased availability of powerful computer and simulation programs makes the analysis design process much easier PSIM is an electronic circuit simulation software package designed specifically for use in power electronics and motor drive simulations but can be used to simulate any electronic circuit With fast simulation speed and user friendly interface PSIM provides a powerful simulation environment to meet the user simulation and development needs This book shows how to simulate the power electronics circuits in PSIM environment The prerequisite for this book is a first course on power electronics This book is composed of eight chapters Chapter 1 is an introduction to PSIM Chapter 2 shows the fundamentals of circuit simulation with PSIM Chapter 3 introduces the Simview™ Simview is PSIM's waveform display and post processing program Chapter 4 introduces the most commonly used components of PSIM Chapter 5 shows how PSIM can be used for analysis of power electronics circuits 45 examples are studied in this chapter Chapter 6 shows how you can simulate motors and mechanical loads in PSIM Chapter 7 introduces the SimCoupler™ Simcoupler fuses PSIM with Simulink by providing an interface for co simulation Chapter 8 introduces the SmartCtrl SmartCtrl is a controller design software specifically geared towards power electronics applications <https://powersimtech.com> 2021 10 01 book release power electronics circuit analysis with psim

**Design and Control of Power Converters 2019** Manuel Arias, 2021-07-02 In this book 20 papers focused on different fields of power electronics are gathered Approximately half of the papers are focused on different control issues and techniques ranging from the computer aided design of digital compensators to more specific approaches such as fuzzy or sliding control techniques The rest of the papers are focused on the design of novel topologies The fields in which these controls and topologies are applied are varied MMCs photovoltaic systems supercapacitors and traction systems LEDs wireless power transfer etc

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