

# Development and Magnetic Analysis of Stirling Converter Assembly Linear Alternators

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Infinia Corporation is working with NASA Glenn Research Center to evolve the Infinia Technology Demonstration Converter into a lower mass, higher efficiency design. As part of the effort, the linear alternator has been re-designed and analyzed using a 3-D finite element analysis (FEA) software package. The linear alternator is the most massive component of the Stirling converter assembly and offers the highest potential for mass reduction and corresponding gains in power density. The 3-D MAXWELL software package was applied to determine the demagnetization margin for permanent magnets and to map the detailed magnetic field of the laminations to maximize the use of lamination iron, which is not provided by the empirical, in-house design code. Initial evaluation shows that substantial weight reduction can be achieved with a compact, moving-magnet linear alternator design. The improved linear alternators employ more compact copper coils and stator/mover iron and higher operation frequency to achieve significant overall weight reduction. This paper presents some of the analysis results and discusses areas for future improvement.

## Nomenclature

<i>FPSE</i>	=	Free-Piston Stirling Engine
<i>CHP</i>	=	Combined Heat and Power
<i>GRC</i>	=	Glenn Research Center
<i>SCA</i>	=	Stirling Converter Assembly
<i>FEA</i>	=	Finite Element Analysis
<i>MTI</i>	=	Mechanical Technology Incorporated
<i>CTCP</i>	=	Component Test Power Converter
<i>SBIR</i>	=	Small Business Innovative Research

## I. Introduction

Recently Infinia, supported through a NASA Glenn Research Center (GRC) task order contract, undertook a design study to reduce Stirling Converter Assembly (SCA) mass. Particular attention was paid to the converter assembly and the linear alternator, which constitutes 70% of the overall SCA mass. Several new, low-mass alternator configurations were designed and evaluated, from which a smaller, lighter, moving-magnet configuration was chosen as a promising upgrade over the Infinia legacy, moving-iron linear alternator. Other analyses of the general linear alternator design have identified significant potential mass savings through optimization of magnetic flux distribution, improved topologies, and coil/laminate usage. This paper provides some details regarding the new linear alternator designs, as well as results of analyses performed using 3-D MAXWELL.

## II. Advanced Low-Mass Alternator

Moving-iron alternators, such as those used in legacy SCA systems, contribute significantly to overall mass. Reducing the overall stator diameter will be a key focus of the new design, considering that mass and volume both scale with the square of the diameter. Figure 1 provides an illustration of the current Infinia moving-iron linear

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# Development And Magnetic Analysis Of Stirling Convertor

**Yijin Wang**



## **Development And Magnetic Analysis Of Stirling Convertor:**

*A 3-D Magnetic Analysis of a Stirling Convertor Linear Alternator Under Load* ,2001      Research & Technology 2002 ,  
**A 3-D Magnetic Analysis of a Linear Alternator For a Stirling Power System** ,2000      **Magnetocaloric Energy Conversion** Andrej Kitanovski,Jaka Tušek,Urbanc Tomc,Uroš Plaznik,Marko Ožbolt,Alojz Poredoš,2014-12-03 This book provides the latest research on a new alternative form of technology the magnetocaloric energy conversion This area of research concerns magnetic refrigeration and cooling magnetic heat pumping and magnetic power generation The book s systematic approach offers the theoretical basis of magnetocaloric energy conversion and its various sub domains and this is supported with the practical examples Besides these fundamentals the book also introduces potential solutions to engineering problems in magnetocalorics and to alternative technologies of solid state energy conversion The aim of the book is therefore to provide engineers with the most up to date information and also to facilitate the understanding design and construction of future magnetocaloric energy conversion devices The magnetocaloric energy conversion represents an alternative to compressor based refrigerators and heat pumps It is a serious alternative to power generation with low enthalpy heat sources This green technology offers an opportunity to use environmentally friendly solid refrigerants and the potentially high energy efficiency follows the trends of future energy conversion devices This book is intended for postgraduate students and researchers of refrigeration heat pumping power generation alternatives heat regenerators and advanced heat transfer mechanisms      **Aerospace America** ,2005      *A Collection of Technical Papers* Conference,Intersociety Energy Conversion Engineering,2000      **Space Technology and Applications International Forum 2007** Mohamed S. El-Genk,2007 The proceedings of STAIF 2007 feature a broad spectrum of topics on These topics span the range from basic research to the most recent technology advances and hardware development and testing The proceedings will be of particular interest to program managers practicing engineers academicians graduate students system designers and researchers interested in the fields of space technology and space science      **NASA Technical Memorandum** ,1994      **Advancing Toward Technology Breakout in Energy Conversion** ,1986      Proceedings of the 27th Intersociety Energy Conversion Engineering Conference ,1992      Research and Technology 2002 ,2003      **Research & Technology 2003** ,      Energy ,1983      **Scientific and Technical Aerospace Reports** ,1994      *Proceedings of the 27th Intersociety Energy Conversion Engineering Conference: Policy impact* ,1992      *Energy Research Abstracts* ,1986  
Bibliography of Lewis Research Center Technical Publications Announced in 1977 Lewis Research Center,1978 This compilation of abstracts describes and indexes over 780 technical reports resulting from the scientific and engineering work performed and managed by the Lewis Research Center in 1977 All the publications were announced in the 1977 issues of STAR Scientific and Technical Aerospace Reports and or IAA International Aerospace Abstracts Documents cited include research reports journal articles conference presentations patents and patent applications and theses      **Nuclear Science**

**Abstracts** ,1973 NSA is a comprehensive collection of international nuclear science and technology literature for the period 1948 through 1976 pre dating the prestigious INIS database which began in 1970 NSA existed as a printed product Volumes 1 33 initially created by DOE s predecessor the U S Atomic Energy Commission AEC NSA includes citations to scientific and technical reports from the AEC the U S Energy Research and Development Administration and its contractors plus other agencies and international organizations universities and industrial and research organizations References to books conference proceedings papers patents dissertations engineering drawings and journal articles from worldwide sources are also included Abstracts and full text are provided if available      Research Awards Index ,1977      **Oceanic Wave Energy Conversion** Omar Farrok,Md Rabiul Islam,2024-02-26 This book aims to collect the latest theoretical and technological ideas in design and construction for different kinds of oceanic wave energy converters including linear electrical generators and drive systems Advancements in new wave energy converters linear machine topologies integrated mathematical modeling application of high graded magnetic materials and high performance control strategies are of great interest With the ability to generate direct thrust without any mechanical transmission the linear electrical machines serve as the excellent choice for wave energy generators free piston engine industrial applications requiring linear motion and so on On the other hand the special characteristics of linear electrical machines such as the large air gap length force ripples end effects cogging force cut open magnetic circuit half filled end slot pose a great challenge to the engineer and scientist The challenge is not only for designing electrical machines but also for control strategies The chapters of this book have been structured with theoretical simulation and experimental results in such a way that it provides a consistent compilation of fundamental theories a compendium of current research and development activities as well as new directions to overcome critical limitations

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The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts.

The Secret History is a brilliant and thrilling novel that will keep you speculating until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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