



The Black Art of Video Game Console Design

By Andre LaMothe



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&a>breaks new ground in game development by bridging the alien worlds of hardware and software together for the first time!

The Black Art of Video Game Console Design is written for the programmer and/or hobbyist interested in software game development, but also wants to understand the hardware games are implemented on. This book assumes no prior knowledge of Electrical Engineering or Computer Architecture, but takes you on a breathtaking journey from atomic semiconductor theory to the design and construction of basic video game consoles that you can build and write your own games for! Included in the book is the entire design of numerous embedded game systems including the XGameStation systems and much more.

The Black Art of Video Game Console Design with 800+ pages covers everything you need to know to design your own game console including:

- Basic atomic physics and semiconductor theory primer.
- Introduction to circuit analysis; current, voltage, and resistance.
- Analog design using discrete components.
- Digital electronics and Boolean algebra.
- Physical hardware construction and prototyping techniques.
- Combinational logic and advanced integrated circuit building blocks.
- Finite state machine design.
- Computer architecture and design.
- Understanding and using microprocessors and microcontrollers.
- Developing software for embedded systems.
- Designing video (NTSC/VGA), audio, and input device systems.
- Interfacing and communications.
- The complete design and discussion of numerous game systems including the XGameStations!

Register your book at informit.com/register and download the following additional resources (previously on bundled CD):

- PCB and circuit simulation tools.
- All necessary data sheets.
- Demos and source code.
- Complete designs to numerous embedded systems including the XGameStations.

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Introduction

Thank you for purchasing *The Black Art of Video Game Console Design*. We have worked hard to provide a unique, high-quality, and educational book that will both engage and entertain. Within these pages you will learn how to design your own game console as well as learn about the complete design of the XGameStation Micro Edition and Pico Edition. This is the world's first do-it-yourself video game console design book and will empower you to an unprecedented level of knowledge and understanding, whether you're a hobbyist, student, or both.

Installing the CD

The CD contains all the sources, schematics, tools, and content discussed in this book. There is no installer; simply work from the CD or drag the entire contents from the CD to your hard drive. Also, you may want to install one or more of the tools, especially *Labcenter's Proteus PCB Design Tools*, so you can look at the design examples from the book including the XGS Micro and Pico Edition game console designs in their native format.

Please read the README.TXT file at the root of the CD for any last minute instructions and changes. Also, each directory also has a README.TXT explaining the contents. The CD root for this content is laid out as follows:

XGSME_HW_CD	- The main directory/CD root for this content
(may	be within another directory).
Datasheets	- Contains datasheets for all chips. General_Papers
- Contains articles, papers, on SX and XGS	
programming. Schematics_Circuits	- Contains XGS schematics and
circuits. SX_Docs_Books	- Contains SX related docs and eBooks.
SX_Key_IDE	- Contains Parallax Inc.'s SX-Key Software. Tools
- Contains various tools for engineering. XGSME_Sources	-
Contains source code, demos, games. XGSME_Studio	- Contains
complete XGS ME Studio Software and	manual.
XGSME_Tutorials	- Contains tutorials on programming.

Caution - READ ONLY FLAG

This is a very important detail, so read on. When creating a CD-ROM, all the files will be written with the READ-ONLY flag enabled. This is fine in most cases unless you copy the files to your hard drive (which you will) and then edit and try to write the files back to disk. You will get a READ-ONLY protection error.

Fixing this is a snap. You simply need to clear the READ-ONLY flag on any files that you want to modify. There are 3 ways to do it. First, you can do it with Windows and simply navigate into the directory with the file you want and then select the file, press the RIGHT mouse button to get the file properties, and then clear the READ-ONLY flag and APPLY your changes. You can do this with more than one file at once by selecting a group of files.

The second way is to use the File Manager and perform a similar set of operations as in the example above. The third and best way is to use the ATTRIB command with a DOS/Command

Shell prompt. Here's how:

Assume you have copied the entire SOURCE directory on your hard drive to the location C:SOURCE. To reset all the READ-ONLY attributes in one fell swoop, you can use the ATTRIB command. Here is the syntax:

```
C:DIRECTORY> ATTRIB -r *.* /-->s
```

This instructs the command shell to clear the READ-ONLY flag "r" from all files "*.*)" and all lower sub-directories "/s".

Getting Started

Before reading this document and experimenting with hardware and low level programming, I highly recommend you at least once page through the entire book to get an idea of the breadth and depth that will be discussed. Also, it will give you an idea of any materials that you might need as you actually implement and build hardware yourself.

Viewing the Schematics

The XGameStation Micro Edition and all the other designs in this book were designed using Labcenter's Proteus schematic entry and PCB layout tools. I consider these to be the best tools for the price and performance. If you wish to view any of the schematics for the XGS ME then you will need to install Proteus on your computer; you can find a copy of the installer in the **Tools** sub-directory. However, the latest version can always be downloaded from their site directly at

<http://www.labcenter.co.uk/>

What to Expect?

This book is for anyone who wants to learn the electronics and engineering behind video game console design. For many years I have looked for any single text that covers how to design game consoles and there simply is nothing available. Sure, there are hundreds of books on "game programming," but nothing on the hardware. And of course there are thousands of books on electronics, electrical engineering, and so forth, but no one has ever collected the information together to show how to make the special application of game console hardware. I think that many people are getting a little bored with software and a revival of hardware along with retro technology used as a teaching platform is a great way to get into electronics. So expect to have a lot of fun and learn a lot of cool things about the **details** of how things work. I promise to present it with the least amount of pain as possible, but there is no getting around—"hard stuff is hard"! Also, this book uses very simple math; high school algebra is all you need, so no calculus!

Who Are You?

With that in mind, this book assumes absolutely no knowledge of electronics whatsoever; however, a knowledge of programming in C/C++, BASIC, ASM, Java, or similar language(s) is required. This book will not teach programming; I assume you are familiar with the concept of programming and have done enough of it to get around fairly easily. You might be a programmer who wants to learn about video game hardware,

or an electrical engineer who is interested in developing embedded systems with video and audio, or a game developer who wants to have some idea of how an Xbox works. All of you will find something in here.

General Outline of Book

The book starts off with "what's an electron" and ends up with developing a number of embedded game systems. While on this journey we touch upon everything from analog electronics, digital design, and computer architecture, to graphics hardware, memory management, and construction techniques to actually build things. Below is an outline of the chapters.

Section I—Fundamentals of Electronics and Electrical Engineering

- **Chapter 1—Introduction to Electronics, Electrons, and Light Speed** This chapter is a general overview of atomic theory and electronic devices, and introduces a number of electrical engineering concepts such as voltage, current, and resistance.**Chapter 2—Basic Analog Circuit Analysis** This chapter introduces basic circuit analysis techniques for DC steady state circuits and explains the use of very powerful Ohm's and Kirchhoff's circuit analysis laws.**Chapter 3—Analog Design with Discrete Components** This is the first design chapter where devices such as resistors, capacitors, inductors, and much more are used to create electrical networks that perform various functions.

Section II—Digital Electronics and Fabrication

- **Chapter 4—Entering the Digital Realm** This chapter covers basic digital concepts, Boolean logic, truth tables, and timing diagrams, and introduces various families of digital logic that are used in modern day digital design.**Chapter 5—Hardware Construction Techniques** The chapter briefly takes a detour from theory and discusses how actual electronic projects and circuits are constructed. Soldering, wire wrapping, breadboards, power supplies, and CAD tools will all be discussed. Also, best practices will be covered, so your projects will actually work!**Chapter 6—Combinational Logic and SSI/MSI Blocks** This chapter covers the more mathematical side to digital electronics and explains how functional descriptions are turned into working digital circuits. Additionally, popular small-scale and medium-scale integrated circuits are covered to help you speed your designs up by using chips that simplify them.**Chapter 7—Changing Your Mind with Flip Flops State Machines and Sequential Logic** This chapter discusses flip flops and memory, which are very complex subjects unto themselves. State machines, sequential logic, and other complex circuitry will be explained.

Section III—Computer Architecture and Embedded Game Console Design

- **Chapter 8—Computer Architecture Fundamentals: Microprocessors, Microcontrollers, Microprogramming, and Marble Madness** This chapter takes things to the next level with microprocessors and microcontrollers, and shows how to use the high-level building blocks in embedded system design, and how they interface to the real world. This chapter focuses on the internals of microprocessors and microcontrollers as well.**Chapter 9—Designing Microprocessor and Microcontroller Based Game Systems** This hardcore design chapter has numerous design examples based on microcontrollers and microprocessors, and shows how to select a particular processor and make it work in a desired system to perform a specific task(s).**Chapter 10—Developing Software for Embedded Game Console Systems and the XGS** This chapter discusses basic methodologies and software engineering techniques that are commonly used for small memory footprint, constrained resource based embedded systems.

Section IV—Detailed Design/Analysis Examples: The XGameStation Micro and Pico Editions

- **Chapter 11—The XGS Micro Edition System Design and Programming** This chapter takes everything learned in the book and shows the reader the complete design, programming, and use of the XGS Micro Edition commercial educational game console. Every single aspect of the system's design is discussed and complete technical specifications, circuit designs, and firmware are shown.**Chapter 12—The XGS Pico Edition System Design, Programming, and Assembly** This chapter discusses the XGS Pico Edition's design, programming, and actual assembly and construction from standard parts. If you have a kit version of this book then you have the entire XGS Pico Edition kit and are ready to go. Otherwise, the chapter shows you the parts list and gives you a number of vendors from which you can purchase the parts if you want to build the system yourself.

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