Wii™ Overview

Version 1.1.0

The contents in this document are highly confidential and should be handled accordingly.

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Revision History

Version	Revision Date	Description
1.1.0	2007/07/26	Overall revisions to reflect changed and added features.
1.0.0	2007/05/31	Initial Version.

1 Introduction

This document describes the following content in relation to the Wii console for the purpose of developing and designing games for Wii.

- Characteristics
- Hardware Structure
- Communication Features

Figure 1-1 Wii Console

2 Wii Characteristics

2.1 Wii Concept

The modern video game market has witnessed a phenomenon called “erosion in gaming.” Gamers who previously played games were giving up gaming due to increased functionality and complexity of games. To resolve this, Nintendo began development of a “machine to make surrounding people smile” that anyone can enjoy regardless of age, sex, or game experience.

To realize this concept, the target machine must have the following two characteristics.

- A machine that lets each family member feel a connection where no one is viewed as an outsider
- A machine that becomes part of the daily routine, being powered up every day

To make it “fun for the entire family,” it is necessary to have a wide variety of content with simplicity and usability for everyone. In addition, to have a machine that is powered up everyday, Nintendo believes that the startup procedure itself must be extremely easy and that new information must be supplied daily through network features.

To realize these characteristics, Wii provides the following features.

- Wii Menu
- WiiConnect24
- Wii Remote
- Virtual Console
- Compatibility with Nintendo GameCube™
- A variety of interfaces

2.2 Wii Menu

The Wii Menu (Figure 2-1 Wii Menu) is the Wii console's internal menu system. This is the entryway for accessing Game Discs and the Wii Channels.

Figure 2-1 Wii Menu

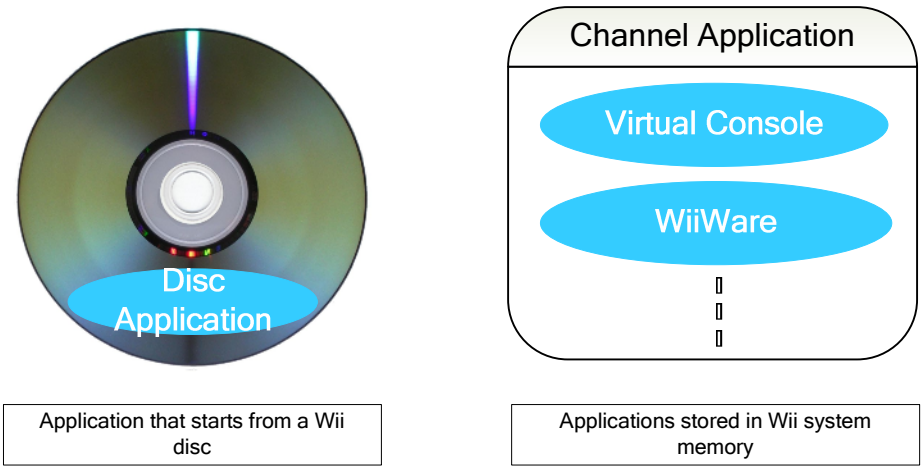
In order to create one game system that the entire family can enjoy (since every individual has interests in different content), Wii has an interface that allows content to be changed easily and simply, like changing channels on a TV set.

The individual applications arranged on the Wii Menu grid are called “Channels.” The Wii Menu can be customized by adding, deleting, or rearranging the Channels.

2.2.1 Disc Applications and Channel Applications

As shown in Figure 2-2, there are two broad kinds of applications that can be started from the Wii Menu: "disc applications" and "channel applications." WiiWare is the name for the dedicated Wii applications that can be downloaded from the Wii Shop Channel and saved to the Wii console's system memory. Applications for the Nintendo Entertainment System and other game machines that can be played on Wii are called "Virtual Console" applications.

Figure 2-2 Disc Applications and Channel Applications



Application that starts from a Wii disc

Applications stored in Wii system memory

Applications can be linked and used, in the same way that a Mii created on the Mii Channel to be used in Wii Sports.

2.2.2 Icons and Preview Screens

Wii Channels are displayed on a grid as 12 "icons" on the Wii Menu screen (Figure 2-3). When the icon for a Channel is selected, a "Channel preview screen" for that selected Wii Channel is displayed until the ”Start” button is pressed (Figure 2-4).

Figure 2-3 Channel Icons

Figure 2-4 Channel Preview Screen

You can dynamically alter the images and sounds used for Channel icons and previews by, for example, using data downloaded from WiiConnect24 (described below) and by referencing Save data from games. For example, the weather shown on the Forecast Channel's icon and the temperature and chance of rain displayed on the channel's preview screen can be changed depending the day's weather forecast.

However, updates for icons and previews are considerably restricted for disc applications.

2.2.3 Wii Options

Wii Options consist of Data Management that manages save data and available memory and Wii Settings used to adjust the settings for the Wii console.

From Wii Settings, basic settings such as time, screen, sound, Sensor Bar, memory initialization, and Internet connection settings can be performed. By allowing connection to the Internet, a variety of entertainment styles can be attained from individual gameplay to world-wide entertainment that includes network competition between distant users complete with ranking display of score data. In addition, expandability is provided by downloading system updates in order to use features that were not available at the time of purchase.

By implementing the Wii Parental Controls, parents and guardians who are concerned about the scope of their children's Wii usage can safely set restrictions.

2.2.4 Wii Message Board

The Wii Message Board, accessible from the Wii Menu, has a wide variety of uses. For example, in addition to receiving notice of new games, the Wii Message Board can be used to exchange regular text messages and communicate game score updates. There is also a feature called Today's Accomplishments, designed with excessive gameplay in mind. This feature can be used to manage a history of sent messages and keep a daily track of what games were played on the Wii and for how long.

These features allow new information and the status of family members and friends using Wii to be easily communicated and work as triggers for using Wii daily.

Figure 2-5 Wii Message Board

The Wii Message Board has a feature that enables specific Channel applications to be started from messages. One way of using this feature would be as a trigger to start up games and applications. An example would be, to jump to WiiWare to view scores from a message that talked about a desire to see the newest high score for a game.

2.2.5 Linking Disc Applications and Channel Applications

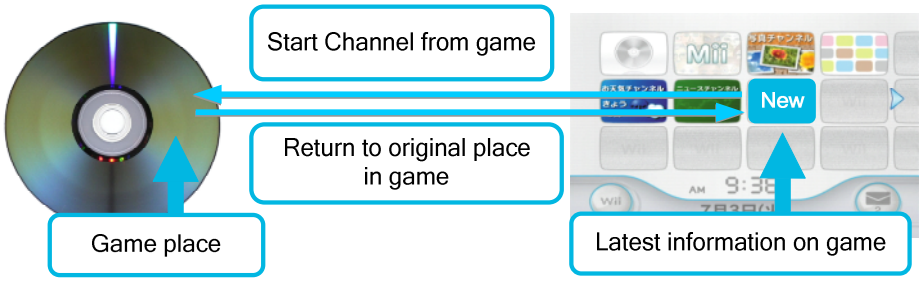
To make disc applications even more fun, the discs can include Channel applications. Channel applications have these features:

- When Wii starts up, the latest information can be shown instantly using the Channel icons and the Channel preview screens
- Channel applications can operate even when the disc is not inserted in the disc slot
- New information can be obtained using WiiConnect24

Using Channel applications to get the latest information when the Wii starts up, you can steer the user to start up disc applications.

You can also go back and forth between disc applications and channel applications, starting up a Channel application from a disc application and later returning to that disc application.

Figure 2-6 Linking Disc Application and Channel Application

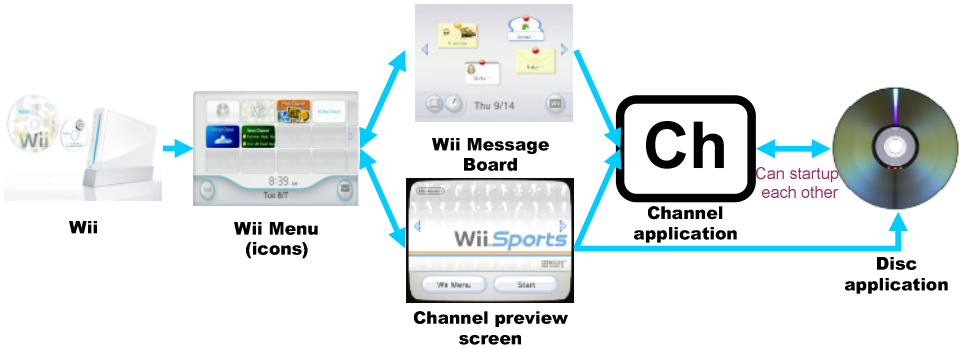


Note: This kind of mutual booting between disc applications and Channel applications only works for applications from the same company.

2.2.6 The Flow of Application Startup

Figure 2-7 shows the flow for the startup of applications after Wii boots.

Figure 2-7 Application Startup Flow



2.3 WiiConnect24

WiiConnect24 is a feature that is provided with the purpose of becoming embedded in every day life and having the Wii Power Button turned on each day. Using the Internet, the user is provided new information daily.

Even when it seems as though the power is off, some portions of the Wii console operate automatically with low power consumption and data can be automatically exchanged 24 hours a day in mail format between Wii, mobile telephones, and PCs. Game makers can distribute messages to users. Notification that a message was received by the Wii Message Board is made via slot illumination.

In addition, because the exchange using the network for WiiConnect24 occurs on the Wii console, the application does not need to be aware of instructions to the network device.

For a detailed description of WiiConnect 24 see *WiiConnect24 Overview*.

2.4 Wii Remote

Wii uses the Wii Remote, a controller that has a novel operation method unavailable until now.

Figure 2-8 Wii Remote Operations

Users can intuitively operate Wii with this one-handed controller mounted with a Pointer and a Motion Sensor. Wii Remote operations can present a variety of entertainment possibilities limited only by the developers' imagination.

In addition to the one-handed Wii Remote, external extension controllers such as the Nunchuk can be connected to the Wii Remote. With these, the game developer can select a controller for operation based on the game type.

Not limited to the traditional button functions, operation through motions such as swinging, tilting, or pointing the Wii Remote is possible. Make sure you effectively use any new Wii Remote operability as you plan and design your application.

2.5 Virtual Console

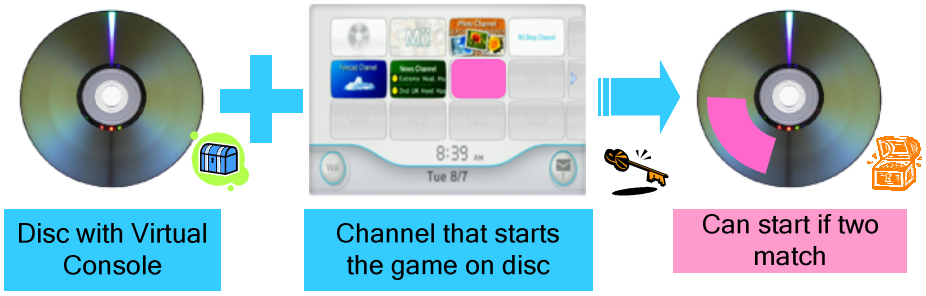
The Wii Shop Channel offers a download service using the network to obtain Wii-specific applications as well as games for other game machines that play on the Virtual Console.

Figure 2-9 Virtual Console

Virtual Console provides an easy way to offer great games of the past and is expected to be of interest even to players who have graduated from those games.

If the program for a Virtual Console game is particularly large, it can be provided as shown in Figure 2-10, with the large content placed on a disc and the game started from the Channel.

Figure 2-10 Virtual Console Can Start if Disc and Channel Pair Up



Please contact support@noa.com if you plan to use this service.

2.6 Compatibility with Ninrtendo GameCube

Wii can play not only Wii Game Discs but also all discs that are made for the Nintendo GameCube.

2.7 A Variety of Interfaces

Wii comes standard with internal wireless LAN. For users who only have a wired environment, the optional Wii LAN adapter (Ethernet) connects to the USB connector. The USB connector can also be used to extend functionality with peripheral devices. In addition, Wii comes standard with an SD Card slot that accepts standard SD Cards so that they can be used to transport data or for backup.

3 Wii Hardware Structure

This section describes the hardware structure related to the Wii console and the Wii Remote.

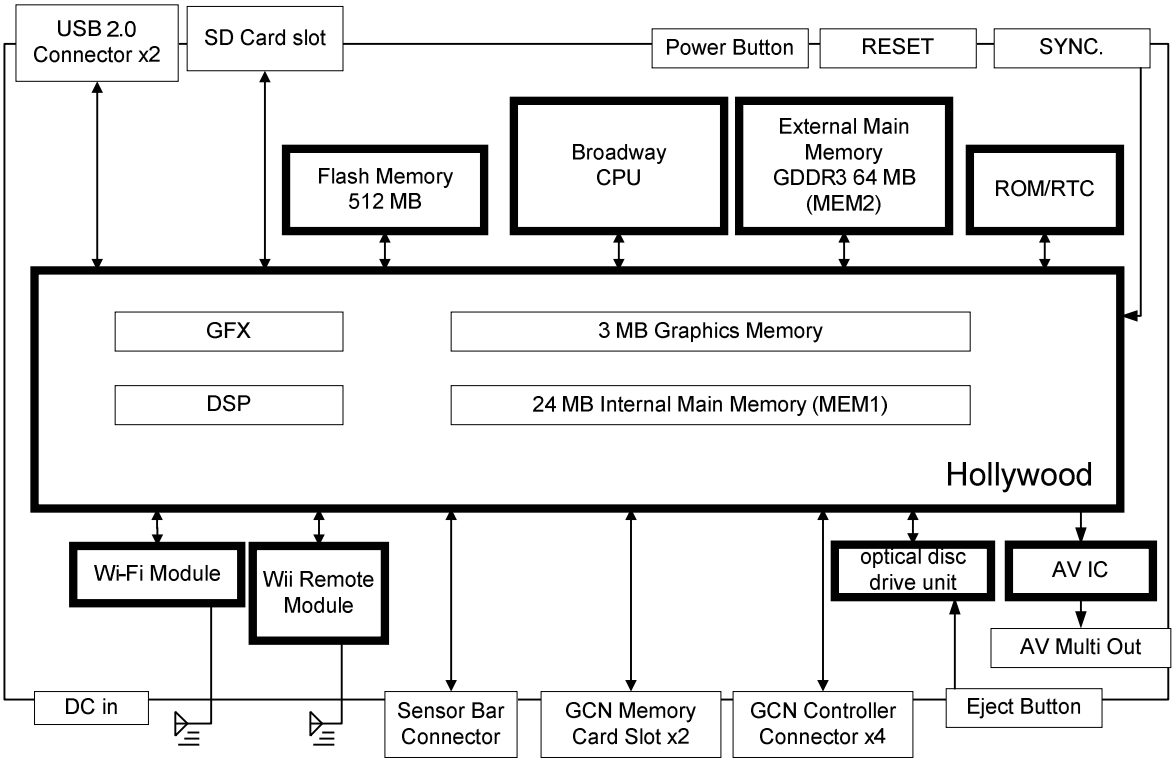
3.1 Hardware Block Diagram

The core of the Wii hardware is the Broadway CPU and the Hollywood large-scale integration (LSI) chip. The Hollywood chip includes a graphic processing unit (including 3 MB graphics RAM), 24 MB internal main memory, and audio digital sound processor (DSP.)

For main memory, in addition to the above-mentioned Hollywood internal main memory (MEM1) of 24 MB, 64 MB of GDDR3 memory (MEM2) are also implemented as external main memory. In other words, the total main memory capacity is 88 MB.

The Wii hardware block diagram is shown in Figure 3-1.

Figure 3-1 Wii Hardware Block Diagram



3.2 Broadway

The Broadway CPU is the main processor for the Wii console. Broadway functionality and specifications are as follows.

- Operates at 729 MHz
- 32 Kbyte 8-way set associative L1 instruction cache
- 32 Kbyte 8-way set associative L1 data cache (A data scratch pad of 16 Kbyte can be set)
- 256 Kbyte 2-way set associative L2 cache
- 32-bit version PowerPC architecture
- Big endian

3.3 Hollywood

The Hollywood system LSI is composed of a graphics processing unit, internal main memory (MEM1) and others. The internal memory has 3 MB graphics memory and 24 MB main memory. However, the size that can be expanded (size of an application that can be run) when the boot program loads an application is currently 7 MB.

Hollywood has the following components.

- Graphics Processing Unit (GPU)
- Audio DSP
- I/O Bridge
- 24 MB Internal Main Memory (MEM1)
  - Programs can be loaded
  - Low Latency
- 3 MB of graphics memory

3.4 External Main Memory (Mem2)

Wii implements 64MB of GDDR3 (MEM2) as external main memory. However, because about 10 MB are currently used as the system region, the region that can be used by applications is approximately 54 MB. In addition, programs can be placed in MEM2, but access speed is slower than MEM1.

3.5 Memory Map

The memory map as seen from the CPU (software) is shown in Table 3-1.

Table 3-1 Memory Map as Seen from the CPU (Software)

Logical Address	Hardware	Capacity	Cached/Uncached
0x80000000 - 0x817FFFFF	Internal Main Memory (MEM1)	24 MB	Cached
0x90000000 - 0x93FFFFFF	GDDR Memory (MEM2: shared by both commercial versions and development devices)	64 MB	Cached
0x94000000 - 0x97FFFFFF	GDDR Memory (MEM2: addition to development devices)	64 MB	Cached
0xC0000000 - 0xC17FFFFF	Internal Main Memory (MEM1)	24 MB	Uncached
0xD0000000 - 0xD3FFFFFF	GDDR Memory (MEM2: shared by both commercial versions and development devices)	64 MB	Uncached
0xD4000000 - 0xD7FFFFFF	GDDR Memory (MEM2: addition to development devices)	64 MB	Uncached
0xE0000000 - 0xE0003FFF	(Locked Cache) See Note below	(16 KB)	

Note: Only when the locked cache feature is used.

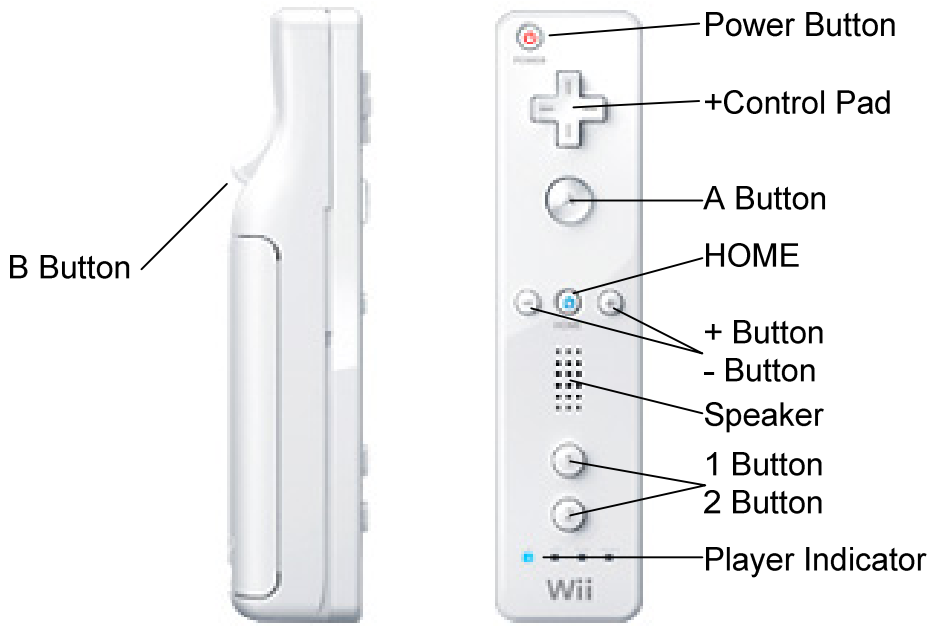
3.6 I/O Interface

3.6.1 Wii Remote

The Wii Remote has the following features.

- Pointer
- Motion Sensor (x, y, and z axis)
- Power Button that can turn the Wii console power on or off
- HOME (button for accessing HOME Menu)
- Buttons that can be used for application operations
  (+Control Pad, A Button, B Button, 1 Button, 2 Button, + Button, and - Button)
- Wireless (Bluetooth) connectivity
- Player Indicators
- Rumble Feature
- Speaker
- Internal memory (16 KB)
- Batteries (2 AA batteries)
- An external extension connector to connect extension controllers
- Playable distance within 5 meters of the Sensor Bar
- A Wii Remote wrist strap (to prevent the Wii Remote from accidentally being thrown during gameplay)

Figure 3-2 Wii Remote



3.6.1.1 Pointer

With the Pointer, the orientation and distance to the TV screen relative to the Wii Remote can be calculated. By detecting the Sensor Bar located at the top or bottom of the screen, the Wii Remote direction can be calculated.

3.6.1.2 Motion Sensor

With the Motion Sensor on the Wii Remote, changes in the orientation and movement of the Wii Remote in relation to the floor can be detected in the x, y, and z axis.

When developing an application, avoid the following conditions:

- Recognizing only aggressive swinging or responding only to the controller movements when it is swung about vigorously
- Requiring actions such as continually hitting an object.
- Requiring the player to swing the controller by holding only the Wii Remote wrist strap or requiring actions that put an excessive burden on the wrist strap, such as twisting or pulling the wrist strap.

3.6.1.3 Buttons

The Wii Remote is equipped with buttons to be used for game operations (+Control Pad, A Button, B Button, 1 Button, 2 Button, + Button, and - Button), HOME, and the Power Button (which can turn the Wii console power on or off).

Note: HOME is used to display the HOME Menu. Do not use it for application operations.

3.6.1.4 Bluetooth

The Wii Remote uses the 2.4 GHz Bluetooth wireless communication standard to communicate with the Wii console. Multiple controllers communicate using time-division multiplexing. If there are 2.4 GHz wireless devices other than Wii nearby, controller response may be sluggish. However, Wii specifications make it difficult to interfere with the wireless LAN of the Wii console itself.

3.6.1.5 Player Indicator

The number assigned to the Wii Remote that the user is operating is indicated with one of the four Player LEDs mounted on the Wii Remote in order from 1 to 4.

3.6.1.6 Power Supply

The Wii Remote uses two AA alkaline dry cell batteries for power.

3.6.1.7 Extension Connectors

The Wii Remote has an external extension connector to add external extension controllers such as new input devices. Currently, the Nunchuk and the Classic Controller are available as extension controllers.

Extension controllers are connected with cables to the Wii Remote. Avoid application specifications that have motions that require the Wii Remote and extension controller to be separated by a distance greater than the length of the extension controller's cable.

Figure 3-3 Nunchuk

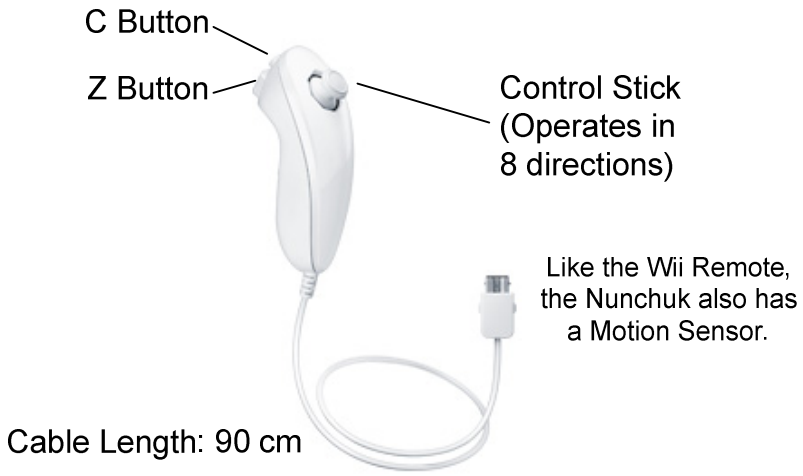
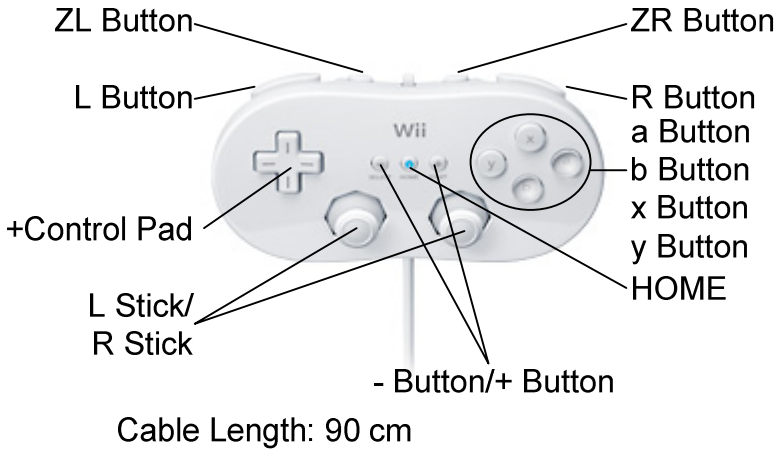


Figure 3-4 Classic Controller



3.6.1.8 Wii Remote Memory

The Wii Remote has 16 KB of internal memory. Applications can use about 4 KB (including the file system) of this memory capacity. However, only one file is shared for all files to use (it is always overwritten.)

By using the memory region available to applications, it is possible to provide a service where simple data can be loaded from a disc application to the Wii Remote so that it can be loaded into another user's Wii environment via the Wii Remote.

3.6.2 USB Connector

The Wii console has the following USB features.

- USB 2.0 Host functionality
- Two USB 2.0 standard ports (USB connectors)
- Support for three transfer speeds: Low-speed with a maximum of 1.5 Mbps, Full-Speed with a maximum of 12 Mbps, and High-Speed with a maximum of 480 Mbps
- The wired Wii LAN adapter (Ethernet) can be connected
- Can connect to some USB keyboards (The Nintendo homepage (http://www.nintendo.com/) will provide information about compatible USB keyboards.)

3.6.3 Nintendo GameCube Controller Sockets

The Wii console has four Nintendo GameCube Controller Sockets. The Nintendo GameCube Controller (or an equivalent licensed product), Nintendo GameCube WaveBird™ Wireless Controller, Nintendo GameCube DK Bongos, and Nintendo GameCube Mat Controller can be connected to these ports.

In this way, controllers for the Nintendo GameCube can be used. But when developing applications for Wii, do not support these controllers if they are not required for the game.

3.6.4 Nintendo GameCube Memory Card Slots

The Wii console has two Nintendo GameCube Memory Card slots. They can be used to read out Nintendo GameCube data to a Wii application for the application's use. However, they cannot be used to save Wii application game data.

The following Nintendo Products (including legally licensed products) are supported.

- Nintendo GameCube Memory Card 59
- Nintendo GameCube Memory Card 251
- Nintendo GameCube Memory Card 1019 (not sold in Japan)

3.6.5 Optical Disc Drive and Optical Discs

3.6.5.1 Optical Disc Drive

The optical disc drive is a read-only drive and supports the following.

- Automatically distinguishes inserted discs as Wii Game Discs (single-sided 12 cm) or Nintendo GameCube Game Discs (single-sided 8 cm)
- Supports single-layer and double-layer Wii discs
- Supports Wii Game Disc transfer speeds of:
  - Innermost track 32 MB sequential read: about 2.2 MB/s
  - Outermost track 32 MB sequential read: about 4.6 MB/s
- Disc eject with the Eject Button

3.6.5.2 Optical Discs

The following optical discs are supported.

- Wii Game Disc (12 cm, single-sided, single-layer: 4.70 GB/single-sided, double-layer: 8.51 GB
- Nintendo GameCube Game Disc (8 cm, single-sided, single-layer: 1.46 GB)

Note: Some of the capacity of the Wii Game Disc is used for the system. As a result, single-layer discs have around 4 GB available for use by applications, and double-layer discs have around 7.5 GB available.

3.6.6 Recording Media

The following are the Wii recording media:

- Wii system memory
- SD Memory Card

3.6.6.1 Wii System Memory (Internal Flash Memory)

Game save data is saved to Wii system memory (NAND formatted flash memory) internal to the Wii console. In addition, it can also be used to store system files, font data, internal Wii console applications, and Virtual Console contents.

The specifications for Wii system memory are as follows. Separate documents are available to provide details.

- Read speed: About 7.5 MB/s
- Write speed: About 3.1 MB/s

Note: These speeds represent favorable-case scenarios. Performance may decline for various reasons, including the firmware being used, the memory for reading and writing (MEM1 and MEM2), the size of data being accessed, the memory buffer alignment, and the status of various chips and buses.

- Memory capacity that can be used by the application and usage:
  - Maximum capacity for save data: 16 MB
  - Temporary region capacity: 40 MB

The Wii system memory file system has the following characteristics.

- Hierarchical file system (HFS)
- Three permission levels (owner, group, everyone)
  - Permissions can be set to allow access to only a specific game title (owner), to multiple game titles from the same company (group), or to unlimited game titles (everyone)
- Copy and move to SD Memory Cards (prohibited attribute available)
  - The Wii Menu can be used to move data or channels in the Wii system memory to an SD Memory Card

3.6.6.2 SD Memory Card

The Wii has one SD Card slot, and game save data stored in Wii system memory can be moved to commercially available SD Cards. The maximum capacity for SD Cards supported by Wii is 2 GB.

3.6.7 AV

3.6.7.1 Audio Interface

The audio interface (AI) has the following characteristics.

- Transfer audio data expanded on internal main memory or external main memory to the external digital/analog converter (DAC)

Note: The external DAC sampling rate is 48 KHz with 16-bit resolution.

- Hardware sampling rate converter to convert the 32 KHz audio data generated by DSP to 48 KHz
- Optical digital output not supported

Note: The Audio Library (AX) only supports 32 KHz audio data output.

3.6.7.2 Video Interface

The video interface (VI) provides output for TV screens. The video interface outputs a customized digital signal with a YUV422 color format. The digital signal is first converted to a specific analog video signal using the video encoder described later before being output to the AV Multi Out connector.

3.6.7.3 Video Mode

The following video modes are supported.

Table 3-2 Video Modes

Video Format	Screen Size	Resolution	Mode
NTSC-M, PAL-M, 60Hz Mode	640x480	640x480	Interlace
		640x480	Interlace (field rendering)
		640x240	Non-interlace
		640x480	Progressive
PAL-B/D/G	640x528	640x528	Interlace
		640x528	Interlace (field rendering)
		640x264	Non-interlace
		640x480	PAL Progressive

Wii supports “16:9 (Widescreen)” screen display settings. It is expected that widescreen TV ownership will increase, so we recommend supporting widescreen in consideration of games’ visual quality.

3.6.7.4 AV Cable

The Wii AV cable is newly designed especially for the Wii.

The composite signal Wii AV cable can be used anywhere in the world. In addition, the following Wii-specific AV cables can be used.

- Wii S-Video Stereo AV cable
- Wii RGB cable (sold only in Europe)
- Wii Component Video cable
- Wii D-Terminal cable (sold only in Japan)

3.6.8 Graphics

3.6.8.1 Geometry Processing Control

The following features can be defined and set for geometry processing.

- Local light
- Model view matrix and projection matrix
- Backface culling and view frustum clipping
- View port
- Texture coordinate mapping and projection mapping
- Reflection mapping
- Bump mapping

3.6.8.2 Texture Application

The following operations are possible for application of textures.

- Defining a texture object (bitmap position, wrap or mirror coefficient, filter type)
- Loading a texture look up table (TLUT)
- Setting a TMEM texture cache for the graphics processor (GP)
- Setting multi-texture combine operations (TEV)

3.6.8.3 Other Pixel Operations

Many pixel operations, such as those below, are supported.

- Anti-aliasing
- Z-buffer control
- Blending
- Fog

4 Communication Features

Wii can communicate with an IEEE 802.11b/g standard wireless LAN. In addition, communication is possible with a wired LAN using the optional Wii LAN adapter (Ethernet) that connects to the USB connector.

4.1 Wireless LAN

The Wii wireless LAN characteristics are as follows.

- Adheres to the IEEE 802.11b/g standard
- Can connect to the Internet using either a commercial wireless access router or the Nintendo Wi-Fi USB Connector (plugged into a PC using Windows XP or later)
- Can communicate with the Nintendo DS MP (*Multi Poll*) communication protocol
- Supports Nintendo Wi-Fi Connection

The features in Table 4-1 are supported to allow the user to easily set Internet security connection from the Wii Menu.

Table 4-1 Method for Setting Security Features

Method	Support/Maker
AOSS	Buffalo
Easy Wireless Start	NEC
Manual Setting	All Others

4.1.1 Communication with the Nintendo DS

The Wii and the Nintendo DS can communicate via the MP communication protocol, a Nintendo proprietary wireless communication standard.

When the Wii and the Nintendo DS are communicating, the Wii operates as the parent device. It cannot operate as the child device.

4.1.2 Nintendo Wi-Fi Connection

Nintendo Wi-Fi Connection is a wireless Internet service offered by Nintendo to allow anyone in the world to play games simply and safely using the Internet.

The service allows anyone from anywhere to enjoy games together and for distant players to gather in a single place in a game where they can communicate and play head-to-head games as long as a network environment exists.

Only use this service after considering designs that offer players security. Separate documents are available from Nintendo that provide more details.

4.1.3 WiiConnect24

WiiConnect24 is provided so that new information can be provided daily through a 24-hour-a-day Internet connection. There are two major features: sending and receiving messages and downloading.

The Wii message send and receive feature is used to send event information notifications and to exchange messages between users. The downloading feature is designed to be used as a way for users to obtain information on their interests, similar to the Forecast Channel or the News Channel.