Nintendo DS Game Card Manual

Version 1.05

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Revision History

Version	Revision Date	Description
1.05	2008/02/20	Changed the description of 8-megabit flash in section 2.2.1 Lineup.
1.04	2008/02/19	Added information about 2-gigabit ROM. Added a description about flash memory of 8 megabits or larger to section 2.2.1 Lineup. Deleted FRAM from section 2.2.1 Lineup.
1.03	2006/12/14	Revised section 2.1.2 ROM Registration Data. Added a description of the difference in manufacturer codes. Added a specific market region for China and Korea. Changed the ROM version in figures and changed the color separation from GEN to RSF.
1.02	2006/06/19	Overall document • Added information about 1gigabit ROM. In the “ROM registration data” section on pages 7 and 9, added items about reserved memory region. • Reserved region -> ARM9/ARM7 module, parameter addresses In the “ROM registration data” section on pages 7 through 9, different colors are used to indicate different methods of setting data. In the Lineup section on page 13, changed the guaranteed number or writes and the time required to write for the 4Mbit flash memory. In the Lineup section on page 13, added 8Mbit to flash memory.
1.01	2005/10/17	In the “Lineup” section on page 10, changed the EEPROM data storage period from 40 years to 10 years. In the “Lineup” section on page 10, deleted mention of a scheduled release of 512-kilobit EEPROM in the second half of 2005. It is available now. Added 4-megabit flash memory in the “Lineup” section on page 10. In the “Lineup” section on page 10, deleted mention of a scheduled release of FRAM in the second half of 2005. It is available now (consultation required regarding delivery time). Changed the number of guaranteed rewrites.
1.00	2005/07/01	Initial version.

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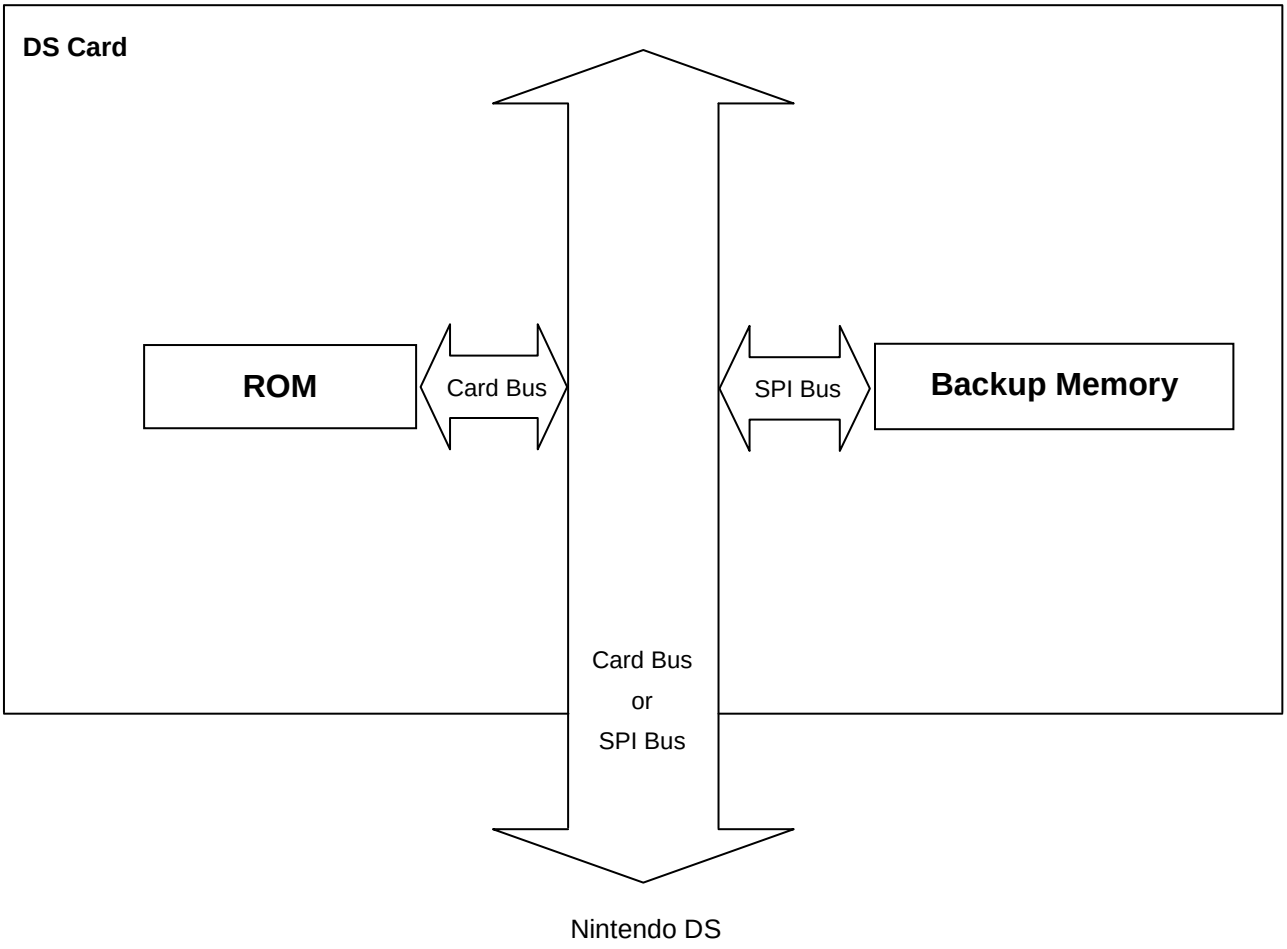
1 Introduction

Figure 1-1 shows the Nintendo DS proprietary Game Card (DS Card).

Figure 1-1 DS Card Block Diagram



2 Composition

The DS Card consists of the read-only memory (ROM) and the backup memory.

2.1 ROM

2.1.1 Types of ROM

There are two types of ROM: the mask ROM and the one-time PROM. The `makerom` settings file (ROM specification file) specifies the kind of ROM image that will be created. In addition,

- `makerom` in NITRO SDK Version 2.1 and earlier always creates mask ROM.
- Only the mask ROM can be selected for a 64-megabit capacity ROM.
- Support for the mask ROM is not planned for ROMs whose capacity is 1 gigabit or larger.

Features of the two types of ROM are shown in Table 2-1.

Table 2-1 Features of ROM

	Mask ROM	One-Time PROM
Transfer Rate	5.99 MB/sec	1.52 MB/sec
Capacity	64 megabits 128 megabits 256 megabits 512 megabits	128 megabits 256 megabits 512 megabits 1 gigabit 2 gigabits
Page Size	512 bytes (= 4 kilobits)	
Feature	Fast transfer rate	Short delivery times for repeat deliveries

Notes on transfer rate:

- These theoretical values exclude overhead.
  Although the transfer rate depends on the program, the difference between transfer times in the program will not be as large as the difference between the transfer rates shown in Table 2-1.
- If one-time PROM is specified for the RSF, the production could use the one-time PROM as well as the mask ROM. However, the transfer rate will always be that of the one-time PROM.

For the capacity limit of 1- and 2-gigabit ROMs:

- The last 20 megabits of a 1-gigabit (1024-megabit) ROM cannot be used. Be sure to fill this region with `0xff`. Access to this region is prohibited.
- The last 40 megabits of a 2-gigabit (2048-megabit) ROM cannot be used. Be sure to fill this region with `0xff`. Access to this region is prohibited.

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2.1.2 ROM Registration Data

The ROM used in DS Game Cards must include information about the game software written on the DS Card ROM. This information is called ROM registration data and is generated using `makerom`. For more information about the ROM specification file (RSF), see the reference for `makerom`. Figure 2-1 provides details about ROM registration data.

Figure 2-1 ROM Registration Data

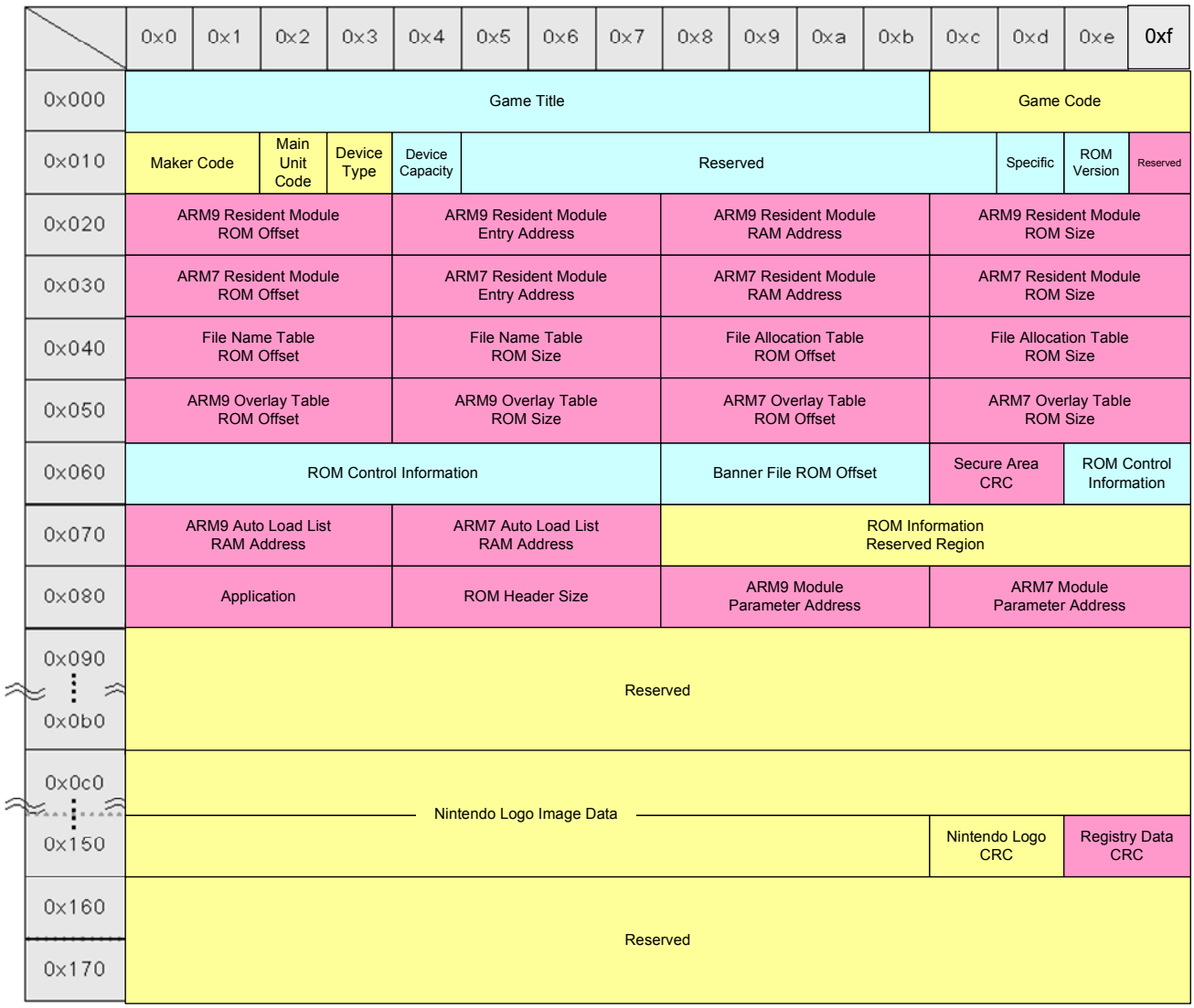

Table 2-2 shows the methods for setting ROM registration data.

Table 2-2 Methods for Setting ROM Registration Data

Type	Registration Data
FIX	Uses values set in the ROM header template as they are.
RSF	Descriptions in the ROM specification file are updated in `makerom`. Without specification, this works the same way as FIX.
GEN	Values generated by `makerom` are written.

The following list provides details about registration data.

- Game Title <12 bytes> (RSF)
  Name of the software title. It is registered using ASCII codes that range from `0x20` to `0x5f`.
  Use `0x20` for spaces and `0x00` for unused portions.
- Game Code <4 bytes> (FIX)
  Registers the 4-digit code that is set for each game title.
- Maker Code <2 bytes> (FIX)
  Registers the 2-digit licensee code assigned by Nintendo.
- Main Unit Code <1 byte> (FIX)
  Registers the identifying code of the main unit for which the software is made.
  Currently, this is fixed at `0x00`.
- Device Type <1 byte> (FIX)
  Registers the type of device mounted in the Game Card.
- Device Capacity <1 byte> (RSF)
  Registers ROM capacity.

Table 2-3 shows set values with corresponding ROM capacities.

Table 2-3 Device Capacity Set Values and Corresponding ROM Capacities

Set Value	ROM Capacity	Set Value	ROM Capacity
0x00	1 megabits	0x08	256 megabits
0x01	2 megabits	0x09	512 megabits
0x02	4 megabits	0x0a	1 gigabits
0x03	8 megabits	0x0b	2 gigabits
0x04	16 megabits	0x0c	4 gigabits
0x05	32 megabits	0x0d	8 gigabits
0x06	64 megabits	0x0e	16 gigabits
0x07	128 megabits	0x0f	32 gigabits

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- Specific region <1 byte> (RSF)
  This flag indicates support for consoles intended for specific regions shown in Table 2-4.

Table 2-4 Supported Region Codes

Supported Region	Code
China	0x80
Korea	0x40
Other	0x00

- ROM Version <1 byte> (RSF)
  Registers the ROM version number.
- ARM9/ARM7 Static Module ROM Offset <4 bytes> (GEN)
  Stores the ROM transfer source address of each processor's static module.
- ARM9/ARM7 Static Module Entry Address <4 bytes> (GEN)
  Stores the execution start address of each processor's static module.
- ARM9/ARM7 Static Module RAM Address <4 bytes> (GEN)
  Stores the RAM transfer destination address of each processor's static module.
- ARM9/ARM7 Static Module ROM Size <4 bytes> (GEN)
  Stores the size of each processor's static module.
- File Name Table/File Allocation Table ROM Offset <4 bytes> (GEN)
  Stores the ROM address of each file-related table.
- File Name Table/File Allocation Table ROM Size <4 bytes> (GEN)
  Stores the size of each file-related table.
- ARM9/ARM7 Overlay Table ROM Offset <4 bytes> (GEN)
  Stores ROM addresses of the overlay tables used for each processor.
- ARM9/ARM7 Overlay Table ROM Size <4 bytes> (GEN)
  Stores sizes of the overlay tables used for each processor.
- ROM Control Information <10 bytes> (RSF)
  Stores parameters that control the ROM. When the debugger is used, some parameters are overwritten after being loaded.
  Address: `0x060` - `0x067` and `0x06e` - `0x06f`.
- Banner File ROM Offset <4 bytes> (RSF)
  Stores ROM offset to the banner file that summarizes the identifying image information for the application. This banner file is shown on the menu when the DS is started; in the absence of a banner file, this is zero. Banner files are created using `makebanner` and integrated into the application ROM image using `makerom`.

- Secure Region CRC <2 bytes> (GEN)
  Stores CRC-16 for the ROM secure region.
  Calculations with this algorithm use `0xffff` as the initial value.
- ARM9/ARM7 Auto Load List RAM Address <4 bytes> (GEN)
  Stores, at startup, the address of the list used to transfer a portion of the static module to an execution address mapped in another region.
- ROM Information Reserved Region <8 bytes> (FIX)
  This region is reserved for storage of ROM-related information and must be set to `0x00`.
- Application End ROM Offset <4 bytes> (GEN)
  Stores the end ROM offset of the region used by the application inside the ROM image.
- ROM Header Size <4 bytes> (GEN)
  Normally stores the size of the ROM header template. In single-card play, it stores the size of the ROM header template included in the executable image on the child device.
- ARM9/ARM7 module parameter address <4 bytes> (GEN)
  Stores the address for ARM9/ARM7 auto-load parameters.
- Nintendo Logo Image Data <156 bytes> (FIX)
  Stores the image data used to display the logo when the main unit starts. The contents are verified before the application starts.
- Nintendo Logo CRC <2 bytes> (FIX)
  CRC-16 for the Nintendo Logo Image Data. It is a fixed value obtained using the algorithm with an initial value of `0xffff`.
- ROM Registration Data CRC <2 bytes> (GEN)
  Stores CRC-16 for the area up to the Nintendo Logo CRC. Calculations with this algorithm use the initial value of `0xffff`.
- Reserved Region (FIX)
  Must be set to `0x00`.

2.1.3 Memory Map

The memory map is the same for mask ROM and one-time PROM devices.

FiguresFigure 2-2 and Figure 2-3 provide examples of the memory map for a 64-megabit and a 1-gigabit DS card. For cards whose capacity is other than 64 megabits, the address value of the game region's upper limit depends on the card's ROM capacity.

The game region capacity is expressed as follows:

Game Region Capacity = ROM total capacity – 32 KB

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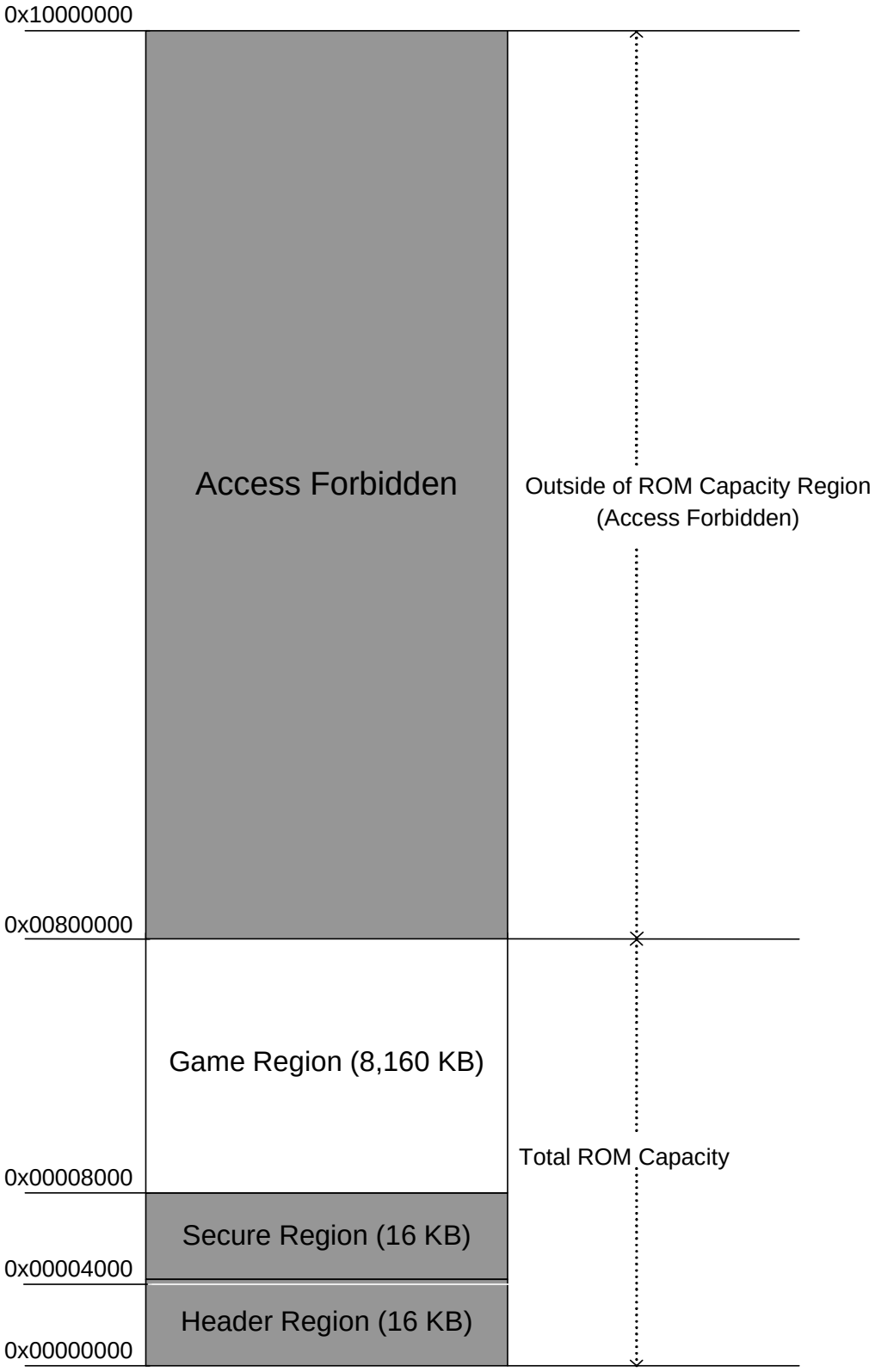
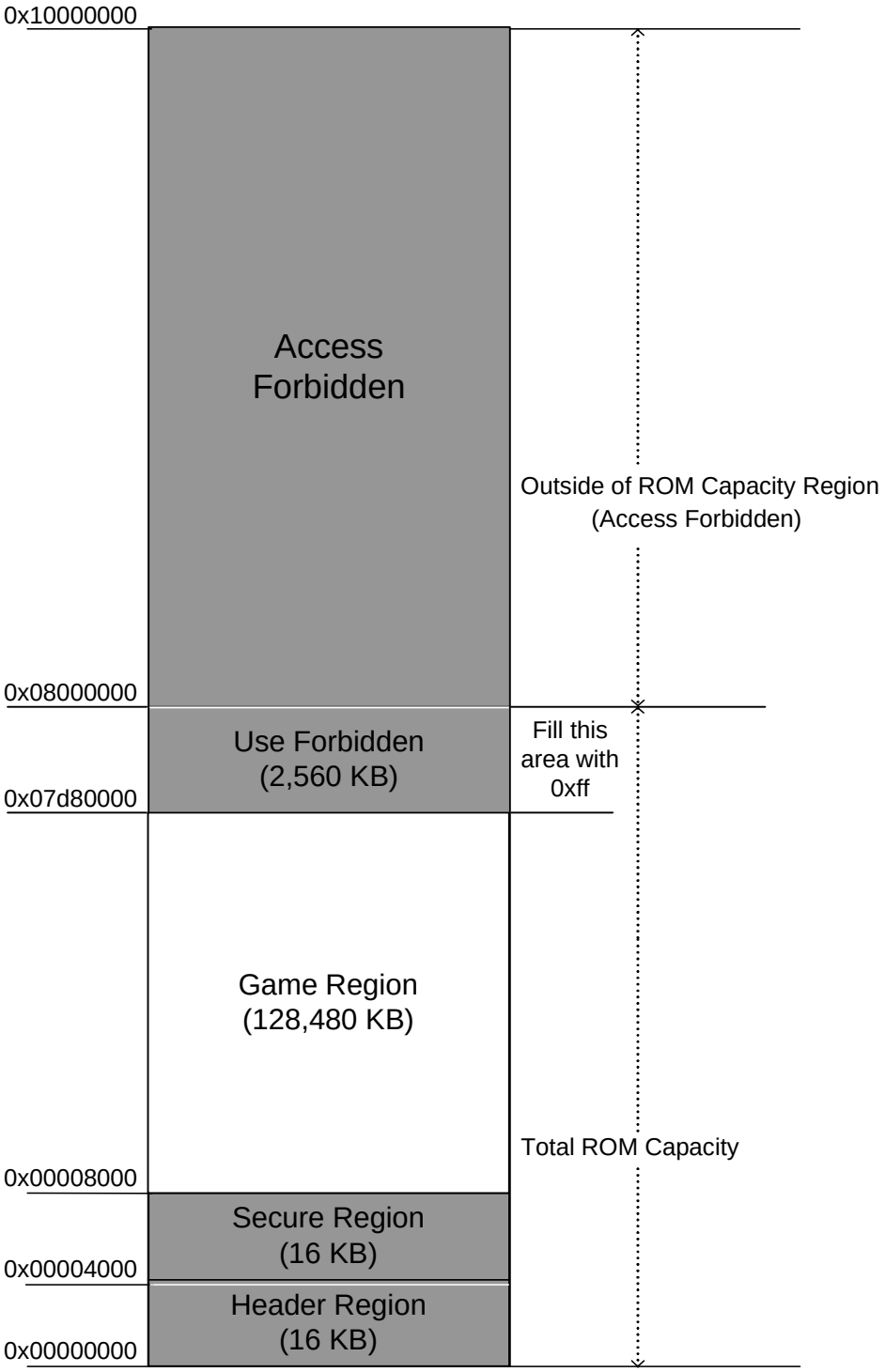
Figure 2-2 Memory Map of the DS Card ROM Region: 64-Megabit Card



For 1-gigabit cards, the address value of the game area's upper limit is distinct from ROMs of other capacities. Game region capacity is expressed as follows:

Game Region Capacity = ROM total capacity – 32 KB – 2560 KB

Figure 2-3 Memory Map of the DS Card ROM Region: 1-Gigabit Card



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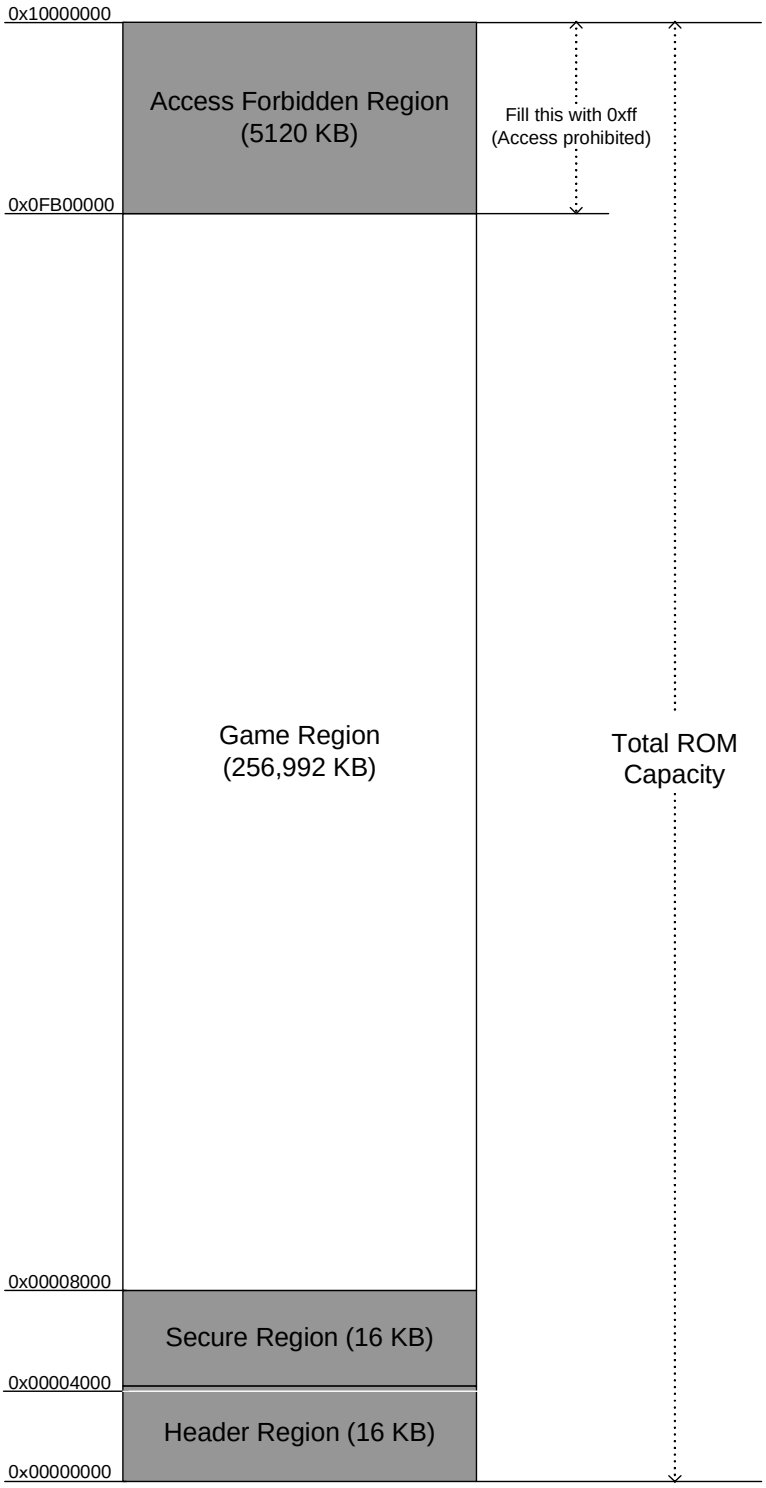
Again, for 2-gigabit cards, the address value of the game area's upper limit is distinct from ROMs of other capacities. Game region capacity is expressed as follows:

Game Region Capacity = ROM total capacity – 32 KB – 5120 KB

Figure 2-4 Memory Map of the DS Card ROM Region: 2-Gigabit Card



2.2 Backup Memory

2.2.1 Lineup

Table 2-5 presents the lineup of backup memory devices.

Table 2-5 Lineup of Backup Memory Devices

Type of Memory	Capacity	Page Size	Number of Guaranteed Rewrites	Required Time for Rewrite (1 byte - 1 page)	Data Storage Period
EEPROM	4 kilobits	16 bytes	1 million	5 ms	10 years
	64 kilobits	32 bytes			
	512 kilobits	128 bytes			
Flash Memory[4]	2 megabits	256 bytes	100,000 (10,000)[1]	25 ms[2] 300 ms[3]	20 years
	4 megabits		100,000	25 ms	
	8 megabits				

[1] 10,000 represents the guaranteed number of rewrites that require 25 ms each.
[2] Represents the guaranteed time for devices that have fewer than 10,000 total rewrites.
[3] Represents the guaranteed time for devices that have more than 10,000 but fewer than 100,000 total rewrites.
[4] If high-capacity (8-, 16-, 32-, or 64-megabit) flash memory is required, please contact support@noa.com.

The following points apply to rewrite units:

- EEPROM internally maintains a one-page buffer, and rewrites are executed in chunks that range from 1 byte to one page in size.
- Flash memory internally maintains a one-page buffer, and rewrites are executed in units of one page (for flash memory whose capacity ranges from 2 to 16 megabits).

Additional notes:

- For 32- and 64-megabit flash memory, data is erased in blocks (writing is possible in chunks as small as 1 byte).
  - 32-megabit flash: 4 KB / block
  - 64-megabit flash: 64 KB / block

  Do not write programs that depend on erasure time. Because erasure time will be affected by individual variation among memory devices, this way of programming could lead to malfunction or the programs running out of control.

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