



Technical Note

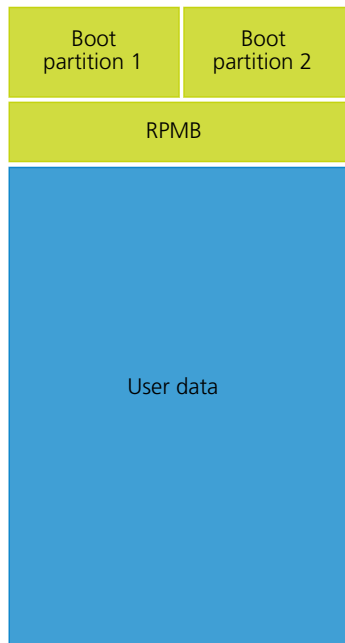
Configuring the Embedded e.MMC Device

Introduction

This technical note discusses the organization and configuration of Micron's e.MMC memory device.

The e.MMC memory device, at time zero, is organized into three areas: the user data area (to store data), two boot partitions (to boot the device), and the replay protected memory block (RPMB) (to manage data in an authenticated and replay-protected manner).

Figure 1: e.MMC Memory Organization



The device can also be configured with additional local memory partitions containing independent address spaces, starting from logical address 0x00000000. As a result, the device's memory block area can be classified as:

- Two boot partitions from which booting the device can be performed; each partition's size is a multiple of 128KB.
- One RPMB partition accessed through a trusted mechanism; size is defined as multiple of 128KB.
- Four general purpose partitions (GPPs) for storing sensitive data or other host usage models; each partition's size is a multiple of a write protect group.

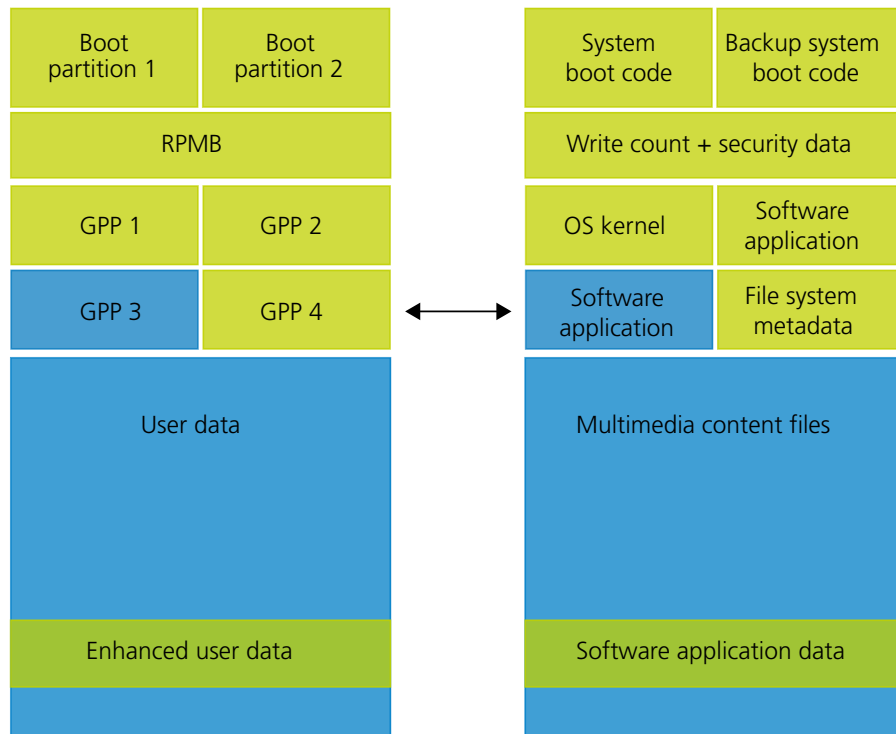


TN-FC-40: Embedded e.MMC Configuration Introduction

Some of the user data area and each GPP can be configured as enhanced with technological features that distinguish them from the default storage media. If the device supports enhanced features, the boot and RPMB partitions are enhanced by default.

The figure below shows an example of partition configuration and its file system view. The left side shows how the device appears after all four general purpose partitions are created and a section of the user area has been enhanced and configured as single-level cell (SLC). The right side shows the same partitions, including labels that identify the type of data that can be kept in each partition on the fully configured device.

Figure 2: Example Partition Organization and Corresponding File System View





Partitioning and Enhancing the Device

Partitioning the device sets aside portions of the user data area for specific data use. Up to four general purpose partitions (GPPs) can be configured on the device, all with various sizes. The size of each GPP is a multiple of the high capacity write protect group size, specific to the device. Each partition's size attributes are one-time programmable (they can be programmed only once in the device lifecycle). The overall capacity of the device is not changed unless partitions or the user data area is enhanced.

GPP and enhanced user data area configuration can affect previously stored data (data will be destroyed) and the device's initialization time. In particular, the initialization time after the first power cycle subsequent to configuration can exceed the maximum initialization time defined by device specifications because the internal controller could execute operations to set up the configurations stated by the host.

Note the following when issuing commands to GPPs:

- Command classes 0, 2, 4, 5, 6 are admitted.
- Write protection can be set individually for each write protect group in each partition; therefore, write protection types can be set differently in each write protect group.

Partitioning the user data area has several advantages; including, it can create areas with specialized security for sensitive data and it can isolate data from other areas on the device. Partitions can also be configured in various sizes, enabling configuration that is unique to each system.

Enhanced mode is a common method for improving performance and reliability. The boot and RPMB partitions are enhanced (pSLC) by default. GPPs and the user data area can be configured as all enhanced. The user data area can also be part MLC and pSLC, but only one part of the user data area can be enhanced. After a partition is enhanced, the enhancement cannot be reversed. When a portion of data in the user data area is enhanced, that area occupies twice its original size.

Configuring General Purpose Partitions and Enhanced User Data Area

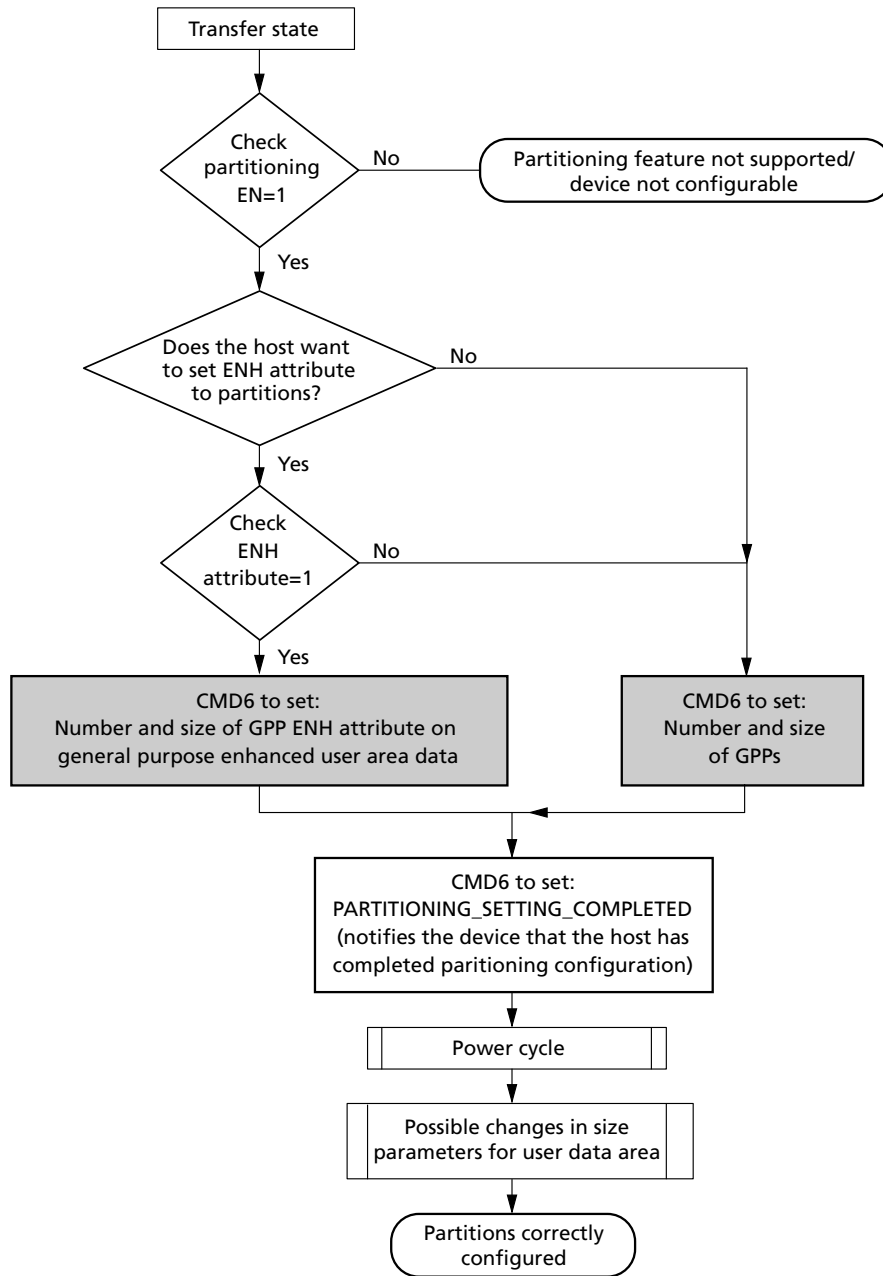
The device configures itself after a power cycle according to the partition parameters in the extended CSD (ECSD) register. Any valid commands issued after the PARTITION_SETTING_COMPLETED bit is set, but before a power cycle takes place, are executed normally. Any previous incomplete partitioning configuration sequence before this bit is set is cancelled upon a power cycle.

Partition configuration parameters are stored in one-time programmable fields in the ECSD register. The host can read them by issuing a CMD8 even though the PARTITION_SETTING_COMPLETED has not yet been set; however, the partitioning will take place only after the following power cycle. It is recommended to avoid changes on these parameters after reading them because they are one-time programmable fields.



TN-FC-40: Embedded e.MMC Configuration Configuring General Purpose Partitions and Enhanced User Data Area

Figure 3: e.MMC Configuration





To configure the GPPs and enhanced user data area:

1. ERASE_GROUP_DEF[175]

Set bit 0 to 0x1 in the ECSD, CDM6 arg 0x03AF0100. If the partition parameters are sent to a device by CMD6 before setting ERASE_GROUP_DEF bit, the slave shows SWITCH_ERROR.

- **ERASE_GROUP_DEF[175]:**
 - CMD6(175,0x01);

2. PARTITION GPP attributes

Set the size of each partition to be created: GP_SIZE_MULT_GPX[154:143]

- **GP_SIZE_MULT_GP0[145-143]:**
 - CMD6(143,0x[ADDR1]);
 - CMD6(144,0x[ADDR2]);
 - CMD6(145,0x[ADDR3])
- **GP_SIZE_MULT_GP1[148:146]:**
 - CMD6(146,0x[ADDR1]);
 - CMD6(147,0x[ADDR2]);
 - CMD6(148,0x[ADDR3])
- **GP_SIZE_MULT_GP2[151:149]:**
 - CMD6(149,0x[ADDR1]);
 - CMD6(150,0x[ADDR2])
 - CMD6(151,0x[ADDR3])
- **GP_SIZE_MULT_GP3[154:152]:**
 - CMD6(152,0x[ADDR1]);
 - CMD6(153,0x[ADDR2]);
 - CMD6(154,0x[ADDR3])

The size of General_Purpose_Partition_X is:

$$(ADDR3 \times 2^{16} + ADDR2 \times 2^8 + ADDR1 \times 2^0) \times HC_WP_GRP_SIZE \times HC_ERASE_GRP_SIZE \times 512\text{kBytes}$$

where HC_WP_GRP_SIZE = ECSD[221] and HC_ERASE_GRP_SIZE = ECSD[224]

3. Set enhanced user area properties

Set start address of the enhanced user area (expressed in bytes for densities up to 2GB, in sector units for densities greater than 2GB). The device will ignore the LSBs below the write group size and will align the enhanced user data area start address to the write protect group the address (in bytes or sectors) belongs to.

- **ENH_START_ADDR[139:136]:**
 - CMD6(139,0x[ENH_START_ADDR_3]);
 - CMD6(138,0x[ENH_START_ADDR_2]);
 - CMD6(137,0x[ENH_START_ADDR_1]);
 - CMD6(136,0x[ENH_START_ADDR_0])

Set the size of the user area to be enhanced.



TN-FC-40: Embedded e.MMC Configuration Configuring General Purpose Partitions and Enhanced User Data Area

- **ENH_SIZE_MULT[142:140]:**
 - CMD6(142, 0x ENH_SIZE_MULT_2);
 - CMD6(141, 0x ENH_SIZE_MULT_1);
 - CMD6(140, 0x ENH_SIZE_MULT_0)

The size of the enhanced user data area size is:

$$(ENH_SIZE_MULT_2 \times 2^{16} + ENH_SIZE_MULT_1 \times 2^8 + ENH_SIZE_MULT_0 \times 2^0) \times HC_WP_GRP_SIZE \times HC_ERASE_GRP_SIZE \times 512KB$$

MAX_ENH_SIZE_MULT = ECSD[159:157] register defines the maximum amount of memory area that can have the enhanced attribute.

$$\text{Max Enhanced Area} = (\text{MAX_ENH_SIZE_MULT_2} \times 2^{16} + \text{MAX_ENH_SIZE_MULT_1} \times 2^8 + \text{MAX_ENH_SIZE_MULT_0} \times 2^0) \times \text{HC_WP_GRP_SIZE} \times \text{HC_ERASE_GRP_SIZE} \times 512 \text{ KB}$$

The following is valid for both the enhanced and general purpose partitions:

$$\sum \text{Enhanced general partition size}(i) + \text{enhanced user data area} \leq \text{max enhanced area}$$

For 100% pSLC configuration command sequence, see Configuring Fully Enhanced User Data Area.

4. Set enhanced area partitions

Host can now set enhanced attribute for the GPP(s) and user data in **PARTITIONS_ATTRIBUTE[156]** bit [4:0].

- **PARTITIONS_ATTRIBUTE[156]:**
 - CMD6(156,0xENH);
 - ENH bits are:
 - [7:5] Reserved
 - [4] 0x1: Set Enhanced attribute in general purpose partition 4
 - [3] 0x1: Set enhanced attribute in general purpose partition 3
 - [2] 0x1: Set enhanced attribute in general purpose partition 2
 - [1] 0x1: Set enhanced attribute in general purpose partition 1
 - [0] 0x1: Set enhanced attribute in user data area

5. Complete partitioning

Set bit 0 in **PARTITION_SETTING_COMPLETED[155]** to notify the device that the partitioning configuration completed successfully.

- CMD6(155,0x01);

A CMD13 is issued by the host to make sure all parameters are set correctly. If any of the partitioning parameters are incorrect, a SWITCH_ERROR is raised by the device. Because the device will not know the total size of the configured partitions and the user area until **PARTITIONING_SETTING_COMPLETED** bit is set, the device may show SWITCH_ERROR when the host sets the **PARTITIONING_SETTING_COMPLETED** bit, if the total size of the configured partitions and user data area does not fit in the available space of the device. In this case, all the settings will be cleared after the next power cycle. The host will need to set the proper values in each of the partition configuration register bytes again.



By setting this bit, the host protects the partitioning sequence against unexpected power loss. If a sudden power loss occurs when the partitioning process has been only partially executed, at the next power-up, the device can detect and invalidate (if this bit is not set) the previous incomplete partitioning process. The host can repeat and complete the process again.

The device will configure itself according to the partition parameters in the Extended CSD only after a power cycle (or RST_n assertion).

Configuring the Boot Partition

The same procedure used for JEDEC partitioning is used to change the boot partition size.

The following steps must be done at the same time as any other configuration procedure (partitioning and enhancing) before setting PARTITION_SETTING_COMPLETE [155].

- Set ECSD[127:125] for boot partition size
 - CMD6(127, 0xBOOT_SIZE_MULT_2);
 - CMD6(126, 0xBOOT_SIZE_MULT_1);
 - CMD6(125, 0xBOOT_SIZE_MULT_0);

The procedure changes the boot size from 128KB to 128MB. The setting is one-time programmable (after it is set, it cannot be changed).

Partitioning, enhancing, and boot partition configuration must be done in the same procedure flow.

If the new boot size is less than 32MB, it is reported on BOOT_SIZE_MULT[226] using the following equation:

$$\text{boot partition size} = 128\text{KB} \times \text{BOOT_SIZE_MULT}$$

Increasing the boot partition size reduces the user area data.

See Configuring Double Boot Partition Size for an example command sequence for configuring the boot partition.

Configuring Fully Enhanced User Data Area

This section outlines the steps for configuring the e.MMC device's user data area as fully enhanced.

1. Read ECSD.
 - CMD8 arg(0x00000000)
 - Read ECSD[160] check bit [0] and bit [1] to verify the device supports enhanced mode.
 - Read ECSD[159:157] get MAX_ENH_SIZE_MULT
2. Set capacity mode to HIGH.
 - CMD6 arg(0x03AF0100)
 - Write ECSD[175] ERASE_GROUP_DEF=0x01 (high density erase group definition)



TN-FC-40: Embedded e.MMC Configuration Configuring Double Boot Partition Size

3. Set enhanced user data area.
 - CMD6 arg(0x03880000)
 - Write ECSD[136] ENH_START_ADDR_0=0x00
 - CMD6 arg(0x03890000)
 - Write ECSD[137] ENH_START_ADDR_0=0x00
 - CMD6 arg(0x038A0000)
 - Write ECSD[138] ENH_START_ADDR_0=0x00
 - CMD6 arg(0x038B0000)
 - Write ECSD[139] ENH_START_ADDR_0=0x00
 - CMD6 arg(0x038C ECSD[157])
 - Write ECSD[140] ENH_SIZE_MULT_0=ECSD[157]
 - CMD6 arg(0x038D ECSD[158])
 - Write ECSD[141] ENH_SIZE_MULT_0=ECSD[158]
 - CMD6 arg(0x038E ECSD[159])
 - Write ECSD[142] ENH_SIZE_MULT_0=ECSD[159]
4. Set enhanced attribute.
 - CMD6 arg(0x039C0100)
 - Write ECSD[156] ENH_USR=0x01
5. Complete configuration.
 - CMD6 arg(0x039B0100)
 - Write ECSD[155] PARTITION_SETTING_COMPLETED=0x01
6. Power cycle (or RST_N).

Configuring Double Boot Partition Size

1. Read ECSD.
 - CMD8 arg(0x00000000)
 - Read ECSD[226] get BOOT_SIZE_MULT.
 - Suppose BOOT_SIZE_MULT = 0x40 (8MB)
 - New boot size should be 0x80 (16MB)

Set ECSD register for GPP and enhanced user data area.
2. Set ECSD[127:125] for boot partition size.
 - CMD6(125,0x80);
 - CMD6(126,0x00);
 - Not necessary
 - CMD6(127,0x00);
 - Not necessary

Complete the partitioning sequence.



Revision History

Rev. B – 11/17

- Corrected typos in numbers in step 2 of Configuring Double Boot Partition Size section

Rev. A – 7/15

- Initial release

8000 S. Federal Way, P.O. Box 6, Boise, ID 83707-0006, Tel: 208-368-4000
www.micron.com/products/support Sales inquiries: 800-932-4992
Micron and the Micron logo are trademarks of Micron Technology, Inc.
All other trademarks are the property of their respective owners.