TCG Storage Opal Family Feature Set: Shadow MBR for Multiple Namespaces

Version 1.00
Revision 1.21
October 7, 2020

Contact: admin@trustedcomputinggroup.org

PUBLISHED
DISCLAIMERS, NOTICES, AND LICENSE TERMS

THIS SPECIFICATION IS PROVIDED “AS IS” WITH NO WARRANTIES WHATSOEVER, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NONINFRINGEMENT, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION OR SAMPLE.

Without limitation, TCG disclaims all liability, including liability for infringement of any proprietary rights, relating to use of information in this specification and to the implementation of this specification, and TCG disclaims all liability for cost of procurement of substitute goods or services, lost profits, loss of use, loss of data or any incidental, consequential, direct, indirect, or special damages, whether under contract, tort, warranty or otherwise, arising in any way out of use or reliance upon this specification or any information herein.

This document is copyrighted by Trusted Computing Group (TCG), and no license, express or implied, is granted herein other than as follows: You may not copy or reproduce the document or distribute it to others without written permission from TCG, except that you may freely do so for the purposes of (a) examining or implementing TCG specifications or (b) developing, testing, or promoting information technology standards and best practices, so long as you distribute the document with these disclaimers, notices, and license terms.

Contact the Trusted Computing Group at www.trustedcomputinggroup.org for information on specification licensing through membership agreements.

Any marks and brands contained herein are the property of their respective owners.
CONTENTS

DISCLAIMERS, NOTICES, AND LICENSE TERMS ................................................................................................. 1

1 Introduction ..................................................................................................................................................... 4
   1.1 Document Purpose and Scope .................................................................................................................. 4
   1.2 Intended Audience .................................................................................................................................... 4
   1.3 Document References .............................................................................................................................. 4
   1.4 Key Words .................................................................................................................................................. 4
   1.5 Conventions ................................................................................................................................................ 5
       1.5.1 Informative Text ............................................................................................................................... 5
       1.5.2 Precedence ............................................................................................................................................ 5
       1.5.3 Lists ...................................................................................................................................................... 5
       1.5.4 Table Legend ....................................................................................................................................... 5
       1.5.5 Fonts .................................................................................................................................................... 5
   1.6 Document Precedence .............................................................................................................................. 6
   1.7 Dependencies on Other Feature Sets ......................................................................................................... 7
   1.8 Interactions with Other Feature Sets ......................................................................................................... 7
   1.9 Terminology ................................................................................................................................................. 7

2 Overview .......................................................................................................................................................... 8
   2.1 Overview ..................................................................................................................................................... 8

3 Feature Set Requirements ............................................................................................................................... 9
   3.1 Level 0 Discovery .......................................................................................................................................... 9
       3.1.1 Shadow MBR for Multiple Namespaces Feature Descriptor (Feature Code = 0x0407) (M) ............... 9

4 SSC Specific Functionality ............................................................................................................................... 10
   4.1 Tables ......................................................................................................................................................... 10
       4.1.1 Modified Tables .................................................................................................................................. 10
       4.1.2 Modified Method ............................................................................................................................... 11

5 Interaction with the Namespace Management Command and the Format NVM command ....................... 12

6 Modifications to Core Specification .............................................................................................................. 13
1 Introduction

1.1 Document Purpose and Scope

The Storage Workgroup specifications provide a comprehensive architecture for putting Storage Devices under policy control as determined by the trusted platform host, the capabilities of the Storage Device to conform with the policies of the trusted platform, and the lifecycle state of the Storage Device as a Trusted Peripheral.

1.2 Intended Audience

This specification defines the Shadow MBR for Multiple Namespaces feature set for the Opal Family Security Subsystem Classes (SSCs). Any Storage Device that claims Opal Family SSCs Shadow MBR for Multiple Namespaces feature set compatibility SHALL conform to this specification.

The intended audience for this specification is both trusted Storage Device manufacturers and developers that want to use these Storage Devices in their systems.


1.3 Document References

[1] Internet Engineering Task Force (IETF), "Key words for use in RFCs to Indicate Requirement Levels" (RFC 2119)

1.4 Key Words

Key words are used to signify SSC requirements.

The Key Words “SHALL”, “SHALL NOT”, “SHOULD,” and “MAY” are used in this document. These words are a subset of the RFC 2119 key words used by TCG, and have been chosen since they map to key words used in T10/T13 specifications. These key words are to be interpreted as described in [1].

In addition to the above key words, the following are also used in this document to describe the requirements of particular features, including tables, methods, and usages thereof.

- **Mandatory (M):** When a feature is Mandatory, the feature SHALL be implemented. A Compliance test SHALL validate that the feature is operational.
- **Optional (O):** When a feature is Optional, the feature MAY be implemented. If implemented, a Compliance test SHALL validate that the feature is operational.
- **Excluded (X):** When a feature is Excluded, the feature SHALL NOT be implemented. A Compliance test SHALL validate that the feature is not operational.
• **Not Required (N)** When a feature is Not Required, the feature MAY be implemented. No Compliance test is required.

1.5 Conventions

1.5.1 Informative Text

Informative text is used to provide background and context. Informative text does not define requirements. Informative text is formatted as follows:

```
Begin Informative Text
Hello World!
End Informative Text
```

1.5.2 Precedence

The order of precedence to resolve conflicts between text, tables, or figures is text, then tables, then figures.

1.5.3 Lists

If the item in a list is not a complete sentence, the first word in the item is not capitalized. If the item in a list is a complete sentence, the first word in the item is capitalized.

Each item in a list ends with a semicolon, except the last item, which ends in a period. The next to the last entry in the list ends with a semicolon followed by an “and” or an “or” (i.e., “…; and”, or “…; or”). The “and” is used if all the items in the list are required. The “or” is used if only one or more items in the list are required.

Lists sequenced by letters show no ordering among the listed items. The leftmost level uses lower case letters and the next level uses capital letters. The following list shows no ordering among the named items:

- a) oak;
- b) maple; and
- c) soft wood:
  - A) pine; or
  - B) cedar.

List sequenced by numbers show an ordering relationship among the listed items. All levels use Arabic numerals. The following list shows an ordered relationship among the named items:

1) hydrogen;
2) helium; and
3) lithium:
   1) lithium-6; and
   2) lithium-7.

1.5.4 Table Legend

The following legend defines SP table cell coloring coding, with the RGB values for the shading of each cell indicated in parentheses. This color coding is informative only. The table cell content is normative.
### Table 1 SP Table Legend

<table>
<thead>
<tr>
<th>Table Cell Legend</th>
<th>R-W</th>
<th>Value</th>
<th>Access Control</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arial-Narrow</td>
<td>Read-only</td>
<td>Configurable Namespace Locking Feature Set specified</td>
<td>Fixed</td>
<td>- Cell content is Read-Only.</td>
</tr>
<tr>
<td>(230, 230, 230)</td>
<td></td>
<td></td>
<td></td>
<td>- Access control is fixed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Value is specified by the Configurable Namespace Locking Feature Set</td>
</tr>
<tr>
<td>Arial Narrow bold-under</td>
<td>Read-only</td>
<td>VU</td>
<td>Fixed</td>
<td>- Cell content is Read-Only.</td>
</tr>
<tr>
<td>(230, 230, 230)</td>
<td></td>
<td></td>
<td></td>
<td>- Access Control is fixed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Values are Vendor Unique (VU). A minimum or maximum value may be specified.</td>
</tr>
<tr>
<td>Arial-Narrow</td>
<td>Not Defined</td>
<td>(N)</td>
<td>Not Defined</td>
<td>- Cell content is (N).</td>
</tr>
<tr>
<td>(0, 0, 0)</td>
<td></td>
<td></td>
<td></td>
<td>- Access control is not defined.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Any text in table cell is informative only.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- A <code>Get</code> MAY omit this column from the method response.</td>
</tr>
<tr>
<td>Arial Narrow bold-under</td>
<td>Write</td>
<td>Preconfigured, user personalizable</td>
<td>Preconfigured, user personalizable</td>
<td>- Cell content is writable.</td>
</tr>
<tr>
<td>(179, 179, 179)</td>
<td></td>
<td></td>
<td></td>
<td>- Access control is personalizable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- <code>Get</code> Access Control is not described by this color coding</td>
</tr>
<tr>
<td>Arial Narrow</td>
<td>Write</td>
<td>Preconfigured, user personalizable</td>
<td>Fixed</td>
<td>- Cell content is writable.</td>
</tr>
<tr>
<td>(179, 179, 179)</td>
<td></td>
<td></td>
<td></td>
<td>- Access control is fixed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- <code>Get</code> Access Control is not described by this color coding</td>
</tr>
</tbody>
</table>

1.5.5 Fonts
Names of methods and SP tables are in Courier New font (e.g., the `Set` method, the `Locking` table). This convention does not apply to method and table names appearing in headings or captions.

1.6 Document Precedence
In the event of conflicting information in this specification and other documents, the precedence for requirements is:

1. This specification;
2. TCG Storage Architecture Core Specification [2];
3. TCG Storage Interface Interactions Specification [3];
4. TCG Storage Security Subsystem Class: [4] [5] [6], [7], [8], [9], [10]; and
5. NVM Express 1.3 [11]

1.7 Dependencies on Other Feature Sets
This document has no dependencies on other feature sets.

1.8 Interactions with Other Feature Sets
This document has no interactions with other feature sets.

1.9 Terminology
This document does not define any new terms.
2 Overview

2.1 Overview

When MBR shadowing (see [2]) is supported by the TPer and there is more than one namespace exists in the NVM subsystem, there are two use cases:

   a) it is shared by all namespaces and controllers within the NVM subsystem; and

   b) it is applied to one namespace and controller within the NVM subsystem only.

SIIS (see [3]) covers the first use case. The purpose of this feature set is to cover the second use case and to allow the host to specify to which namespace MBR Shadow is applicable.
3 Feature Set Requirements
This section defines the Mandatory (M) and Optional (O) requirements for the Shadow MBR for Multiple Namespaces feature set, when it is implemented in an Opal-compliant device.

3.1 Level 0 Discovery
A Storage Device implementing the Shadow MBR for Multiple Namespaces feature set SHALL:

a) return the Namespace Feature Descriptor as defined in section 3.1.1; and
b) support the Level 0 Discovery response requirements defined in [4], [5], [6], [7], [8], [9] or [10].

3.1.1 Shadow MBR for Multiple Namespaces Feature Descriptor (Feature Code = 0x0407) (M)
This feature descriptor SHALL be returned when the Storage Device supports the Shadow MBR for Multiple Namespaces feature set. The contents of the feature descriptor are defined in Table 2.

<table>
<thead>
<tr>
<th>Byte</th>
<th>Bit</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(MSB)</td>
<td>Feature Code (0x0407)</td>
<td>(LSB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Version</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Length</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Reserved</td>
<td>ANS_C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-15</td>
<td></td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.1.1.1 Feature Code
0x0407

3.1.1.2 Version
This field indicates 0x1 or any version that supports the features described in this specification.

3.1.1.3 Length
This field indicates the number of bytes in the descriptor following byte 3. The value SHALL be set to 0x0C.

3.1.1.4 ANS_C
The All Namespace Capable (ANS_C) field is set to one to indicate that the Storage Device supports a value of 0xFFFF_FFFF for the NamespaceID column value of the MBRControl table. The ANS_C field is set to zero to indicate that the Storage Device does not support a column value of 0xFFFF_FFFF for the Namespace ID column value of the MBRControl table.
4 SSC Specific Functionality
This section specifies the additional SSC-specific functionality (not contained in [4], [5], [6], [7], [8], [9] or [10]).

4.1 Tables
This section defines new tables and modifications to existing tables required for this feature set.

4.1.1 Modified Tables
This feature set modifies the following tables:

a) MBRControl.
b) ACE.

4.1.1.1 MBRControl
This feature set modifies the MBRControl table by adding the following columns, in addition to those defined in [2]:

<table>
<thead>
<tr>
<th>Column Number</th>
<th>Column Name</th>
<th>IsUnique</th>
<th>Column Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x04</td>
<td>NamespaceID</td>
<td></td>
<td>bytes_4</td>
</tr>
</tbody>
</table>

4.1.1.1.1 NamespaceID (M)
This column value identifies the namespace to which the MBR Shadow is applied. The initial NamespaceID column value SHALL be either 0x0000_0000 or the Namespace Identifier of the existing namespace. Support for the value of 0xFFFF_FFFF in the Namespace ID column is Optional. If the Storage Device reports a value of one in the ANS_C field of the Shadow MBR for Multiple Namespaces Feature Descriptor (see Section 3.1.1), then the initial value of the NamespaceID column MAY also be set to 0xFFFF_FFFF.

If this column value is equal to 0xFFFF_FFFF, then the MBR and the MBRControl tables in the Locking SP are shared by all namespaces and controllers within the NVM subsystem as defined in Section 5.6.1.4.6 in [3]. If this column value is equal to the value of the Namespace Identifier of an existing namespace, the MBR and the MBRControl tables in the Locking SP are applied to that namespace only.

4.1.1.2 ACE
This feature set modifies ACE table in the Locking SP as follows:

<table>
<thead>
<tr>
<th>Table Association</th>
<th>Informative Column</th>
<th>Column Name</th>
<th>CommonName</th>
<th>BooleanExp</th>
<th>Columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBRControl</td>
<td>UID</td>
<td>Name</td>
<td></td>
<td>BooleanExp</td>
<td>Columns</td>
</tr>
</tbody>
</table>
4.1.2 Modified Method

4.1.2.1 Set

If the Set method is invoked on the NamespaceID column of the MBRControl table and its value is equal to the Namespace Identifier of the non-existing namespace except when the value of the Namespace Identifier is 0x0000_0000, then the Set method SHALL fail with a status of INVALID_PARAMETER.

If the Set method is invoked on the NamespaceID column of the MBRControl table and the value of the Enabled column of the MBRControl table is TRUE, then the Set method SHALL fail with a status of INVALID_PARAMETER.

If the Storage Device reports a value of zero in the ANS_C field of the Shadow MBR for the Multiple Namespaces Feature Descriptor (see Section 3.1.1), and the Set method is invoked on the NamespaceID column of the MBRControl table and its value is 0xFFFF_FFFF, then the Set method SHALL fail with a status of INVALID_PARAMETER.

If the NamespaceID column value of the MBRControl table is 0x0000_0000, and the Set method is invoked on Enable column of the MBRControl table and its value is TRUE, then the Set method SHALL fail with a status of INVALID_PARAMETER.

If the Set method is invoked with the Enabled column value set to TRUE on the MBRControlObj and the LBA Format of the namespace corresponding to the value of NamespaceID column of MBRControl table is incompatible with the content of MBR table, then the Set method MAY fail with a status of INCOMPATIBLE_MBR_FORMAT.
5 Interaction with the Namespace Management Command and the Format NVM command

SIIS (see [3]) specifies that the MBR and the MBRControl tables in the Locking SP are shared by all namespaces and controllers within the NVM subsystem. It also defines the interactions with the Namespace Management Command and the Format NVM command.

This feature set modifies interactions with the Namespace Management command and the Format NVM command as follows:

If:
   a) the Select (SEL) field of a Namespace Management command is Delete; and
   b) the Namespace Identifier (NSID) field of that command is equal to the value of the NamespaceID column of the MBRControl table,
then that command SHALL fail with a status of Operation Denied.

If:
   a) the Enabled column value of the MBRControlObj is TRUE; and
   b) a Format NVM command specifies an LBA Format (see [11]) of the namespace corresponding to the value of the NamespaceID column of the MBRControl table that is different from the original LBA Format of that namespace,
then that command SHALL fail with a status of Invalid Security State.

If:
   a) the NamespaceID column value of the MBRControlObj is 0xFFFF_FFFF;
   b) the Enabled column value of the MBRControlObj is TRUE; and
   c) the Select (SEL) field of a Namespace Management command is Create and specifies an LBA Format (see [11]) which is different from any existing namespace,
then the Namespace Management command SHALL fail with a status of Operation Denied.
6 Modifications to Core Specification

The Core Specification defines the Storage Device response for attempts by the host to read or write user data (see [2]). This feature set overwrites the response for attempts by the host to read or write user data as follows:

If the value of the NamespaceID column in the MBRControl table is not equal to 0xFFFFFFFF, then the device response for all cases when the host attempts to read user data is specified in Table 5.

If the value of the NamespaceID column in the MBRControl table is not equal to 0xFFFFFFFF, then the device response for all cases when the host attempts to write user data is specified in Table 6.

### Table 5 Interface Read Command Access

<table>
<thead>
<tr>
<th>MBRCtrlEnable</th>
<th>MBRCtrlDone</th>
<th>LBA belonging to Namespace equal to value of NamespaceID column in MBRControl table</th>
<th>Starting LBA within MBR</th>
<th>Ending LBA within MBR</th>
<th>ReadLockEnabled for Requested LBA range</th>
<th>ReadLocked for Requested LBA Range</th>
<th>Required Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>Return Data from MBR table</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
<td>True</td>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>Transfer no data to the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>N/A</td>
<td>Return user data</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
<td>True</td>
<td>False</td>
<td>True</td>
<td>False</td>
<td>Return all zeroes.</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
<td>True</td>
<td>False</td>
<td>True</td>
<td>Mixed (when crossing range boundaries)</td>
<td>Transfer no data to the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>N/A</td>
<td>True</td>
<td>False</td>
<td>Return user data</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>False</td>
<td>Transfer no data to the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>False</td>
<td>N/A</td>
<td>Return user data</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>False</td>
<td>Transfer no data to the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>Mixed (when crossing range boundaries)</td>
<td>Transfer no data to the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>False</td>
<td>N/A</td>
<td>Return user data</td>
</tr>
<tr>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>False</td>
<td>N/A</td>
<td>Return user data</td>
</tr>
<tr>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>False</td>
<td>N/A</td>
<td>Return user data</td>
</tr>
</tbody>
</table>
### Table 6 Interface Write Command Access

<table>
<thead>
<tr>
<th>MBRControl Enable</th>
<th>MBRControl Done</th>
<th>LBA belonging to Namespace equal to the value of NamespaceID column in MBRControl table</th>
<th>Starting LBA Within MBR</th>
<th>Ending LBA within MBR</th>
<th>ReadLockEnabled for Requested LBA range</th>
<th>WriteLockEnabled for Requested LBA range</th>
<th>Required Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Transfer no data from the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>False</td>
<td>N/A</td>
<td>Write user data</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>False</td>
<td>Transfer no data to the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>True</td>
<td>Transfer no data to the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>True</td>
<td>Transfer no data from the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>True</td>
<td>False</td>
<td>True</td>
<td>Transfer no data from the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>False</td>
<td>True</td>
<td>False</td>
<td>False</td>
<td>True</td>
<td>True</td>
<td>Transfer no data from the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>MBRControl Enable</td>
<td>MBRControl Done</td>
<td>LBA belonging to Namespace equal to the value of NamespaceID column in MBRControlTable</td>
<td>Starting LBA Within MBR</td>
<td>Ending LBA within MBR</td>
<td>WriteLockEnabled for Requested LBA range</td>
<td>WriteLocked for Requested LBA Range</td>
<td>Required Behavior</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------</td>
<td>---------------------------------</td>
<td>------------------------</td>
<td>-----------------------</td>
<td>----------------------------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>False</td>
<td>N/A</td>
<td>False</td>
<td>Write user data</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>Transfer no data from the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>True</td>
<td>True</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>Mixed (when crossing range boundaries)</td>
<td>True</td>
<td>Transfer no data from the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>False</td>
<td>N/A</td>
<td>False</td>
<td>Write user data</td>
</tr>
<tr>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>False</td>
<td>True</td>
<td>Transfer no data from the host and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
<tr>
<td>False</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>True</td>
<td>Mixed (when crossing range boundaries)</td>
<td>True</td>
<td>Transfer no data and terminate the command with a &quot;Data Protection Error&quot; (see [3])</td>
</tr>
</tbody>
</table>