

HPA State Diagram and Descriptions

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This document contains three major sections: HPA feature set description changes, new HPA state diagram, and HPA state transition descriptions.

The following section is modified based on ACS revision 3f text.

4.10 Host Protected Area (HPA) feature set

4.10.1 HPA overview

A reserved area for data storage outside the normal operating system file system is required for several specialized applications. Systems may wish to store configuration data or save memory to the device in a location that the operating systems cannot change. The optional Host Protected Area feature set allows a portion of the device to be reserved for such an area when the device is initially configured. Commands in the HPA feature set are prohibited from use in devices that implement the PACKET feature set. A device that implements the Host Protected Area feature set shall implement the following minimum set of commands:

- a) READ NATIVE MAX ADDRESS
- b) SET MAX ADDRESS

A device that implements the Host Protected Area feature set and supports the 48-bit Address feature set shall implement the following additional set of commands:

- a) READ NATIVE MAX ADDRESS EXT
- b) SET MAX ADDRESS EXT

Devices supporting this feature set shall set IDENTIFY DEVICE data word 82 bit 10 to one.

4.10.2 HPA security extensions

In addition, a device supporting the Host Protected Area feature set may optionally include the HPA security extensions. The Host Protected Area security commands use a single command code and are differentiated from one another by the value placed in the Feature field.

- a) SET MAX SET PASSWORD
- b) SET MAX LOCK
- c) SET MAX FREEZE LOCK
- d) SET MAX UNLOCK

Devices supporting these extensions shall set IDENTIFY DEVICE data word 82 bit 10 or IDENTIFY PACKET DEVICE data word 82 bit 10 to one, and shall set IDENTIFY DEVICE DATA word 83 bit 8 or IDENTIFY PACKET DEVICE data word 83 bit 8 to one.

Upon successfully execution of the power-on reset, the HPA security extension is disabled and the IDENTIFY DEVICE data word 86 bit 8 or IDENTIFY PACKET DEVICE data word 86 bit 8 is cleared to zero. There is no valid HPA password after power-on and the IDENTIFY DEVICE data word 86 bit 8 or IDENTIFY PACKET DEVICE data word 86 bit 8 is cleared to zero.

When a SET MAX SET PASSWORD command is executed successfully the HPA security extension is enabled. In addition the IDENTIFY DEVICE data word 86 bit 8 or IDENTIFY PACKET DEVICE data word 86 bit 8 shall be set to one.

4.10.3 28-bit and 48-bit HPA commands interactions

The READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command allows the host to determine the maximum native address space of the device even when a protected area has been allocated. The SET MAX ADDRESS or SET MAX ADDRESS EXT command allows the host to redefine the maximum LBA of the user accessible address space. That is, when the SET MAX ADDRESS or SET MAX ADDRESS EXT command is issued with a maximum address less than the native maximum address, the device reduces the user accessible address space to the maximum specified by the command, providing a protected area above that maximum address. The SET MAX ADDRESS or SET MAX ADDRESS EXT command shall be immediately preceded by a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command. After the SET MAX ADDRESS or SET MAX ADDRESS EXT command has been issued, the device shall report only the reduced user address space in IDENTIFY DEVICE data words (61:61) and IDENTIFY DEVICE data words (103:100). Any read or write command to an address above the maximum address specified by the SET MAX ADDRESS or SET MAX ADDRESS EXT command shall cause command completion with the IDNF bit set to one and ERR set to one, or command aborted. A Volatility bit in the Count field allows the host to specify if the maximum address set is preserved after a power-on reset or a hardware reset. During processing a power-on reset or hardware reset, the device sets the maximum address to the last non-volatile address setting regardless of subsequent volatile SET MAX ADDRESS or SET MAX ADDRESS EXT commands. If the SET MAX ADDRESS or SET MAX ADDRESS EXT command is issued with a value that exceeds the native maximum address command aborted shall be returned.

The SRST does not affect the HPA feature set. Receiving of SRST does not change the maximum LBA address or the HPA state which the device is in.

When the device is in unlock or unfrozen states multiple SET MAX SET PASSWORD commands can be executed. The device only keeps the password set by the last SET MAX SET PASSWORD command; previous received password is overwritten by the last password. There is no limit for the number of times the password can be set.

Typical use of these commands would be:

After a power-on reset or a hardware reset is processed:

- 1) BIOS receives control after the reset;
- 2) BIOS issues a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command to find the max capacity of the device;
- 3) BIOS issues a SET MAX ADDRESS or SET MAX ADDRESS EXT command to the values returned by READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT;
- 4) BIOS reads configuration data from the highest area on the disk;
- 5) BIOS issues a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command followed by a SET MAX ADDRESS or SET MAX ADDRESS EXT command to reset the device to the size of the file system.

On save to disk

- 1) BIOS receives control prior to shut down;
- 2) BIOS issues a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command to find

the max capacity of the device;

3) BIOS issues a volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command to the values returned by READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT;

4) Memory is copied to the reserved area;

5) Shut down completes;

6) During processing a power-on reset or hardware reset, the device sets the maximum address to the last non-volatile address setting regardless of subsequent volatile SET MAX ADDRESS or SET MAX ADDRESS EXT commands.

These commands are intended for use only by system BIOS or other low-level boot time process. Using these commands outside BIOS controlled boot or shutdown may result in damage to file systems on the device.

Devices should return command aborted if a subsequent non-volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command is received after a power-on or hardware reset.

The SET MAX SET PASSWORD command allows the host to define the password to be used during the current power cycle. The password does not persist after a power-on reset has been processed but does persist after a hardware reset or a software reset has been processed. This password is not related to the password used for the Security Mode Feature set. When the password is set the device is in the Set_Max_Unlocked mode.

The SET MAX LOCK command provides a method for the host to disable the SET MAX commands (except SET MAX UNLOCK) until after the device has processed the next power-on reset or command completion of a SET MAX UNLOCK command. When the SET MAX LOCK command is completed the device is in the Set_Max_Locked mode.

The SET MAX UNLOCK command changes the device from the Set_Max_Locked mode to the Set_Max_Unlocked mode.

The SET MAX FREEZE LOCK command provides a method for the host to disable the SET MAX commands (including SET MAX UNLOCK) until after the device has processed the next power-on reset. When the SET MAX FREEZE LOCK command is completed the device is in the Set_Max_Frozen mode.

4.10.4 IDENTIFY DEVICE data

When the host issues a SETMAX ADDRESS or SETMAX ADDRESS EXT, several IDENTIFY DEVICE data words may be affected. The following guidelines are used for setting IDENTIFY DEVICE data:

a) if the 48 bit address feature set is not supported then words 61:60 shall contain the total number of user addressable sectors and words 103:100 shall be reserved;

b) if the 48 bit address feature set is supported and the total number of user addressable sectors is less than or equal to 0FFF_FFFFh then Words 61:60 and 103:100 shall contain the total number of user addressable sectors;

c) if the 48 bit address feature set is supported and the total number of user addressable sectors is greater than 0FFF_FFFFh then words 61:60 shall contain 0FFF_FFFFh and words 103:100 shall contain the total number of user addressable sectors.

4.10.5 BIOS determination of SET MAX security extension status

When the device is locked IDENTIFY DEVICE data word 86 bit 8 or IDENTIFY PACKET DEVICE data word 86 bit 8 shall be set to one

4.10.6 BIOS locking SET MAX

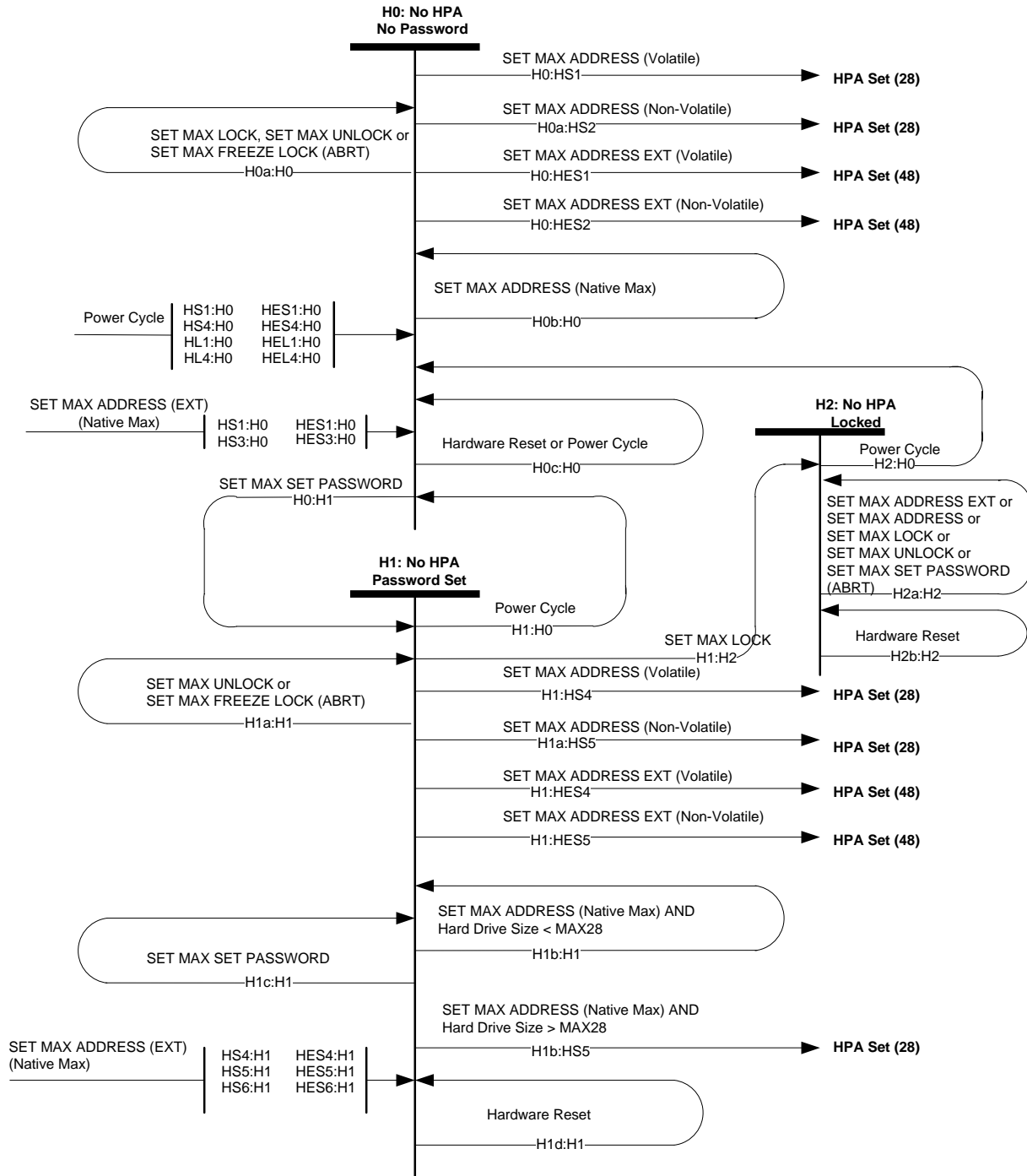
To allow for multiple BIOSs to gain access to the protected area the host BIOS should only lock the protected area immediately prior to booting the operating system.

Figure 5 is the SET MAX state diagram.

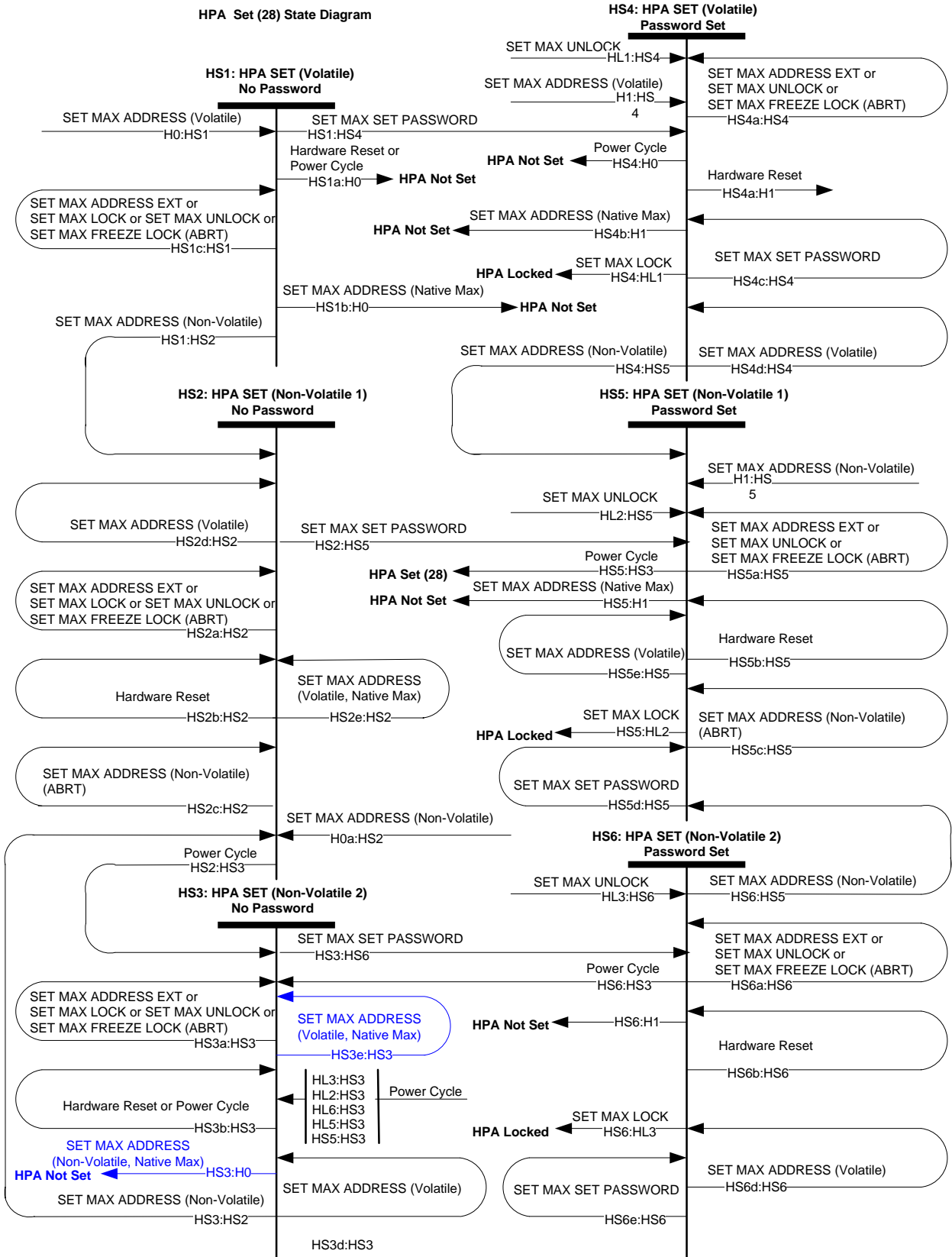
HPA Commands State Diagram

1. HPA Not Set State Diagram

HPA Not Set State Diagram

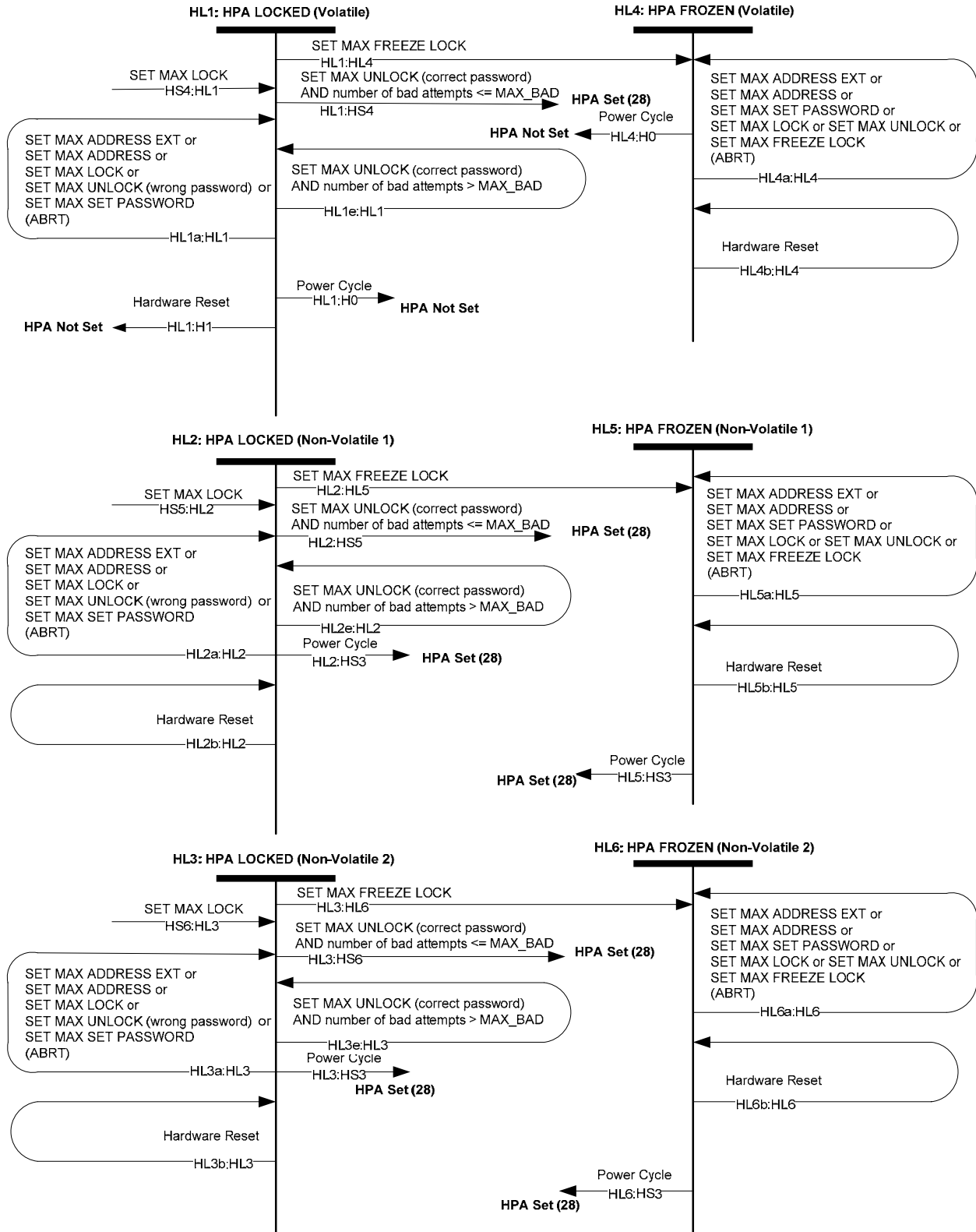


2. HPA Set (28) State Diagram

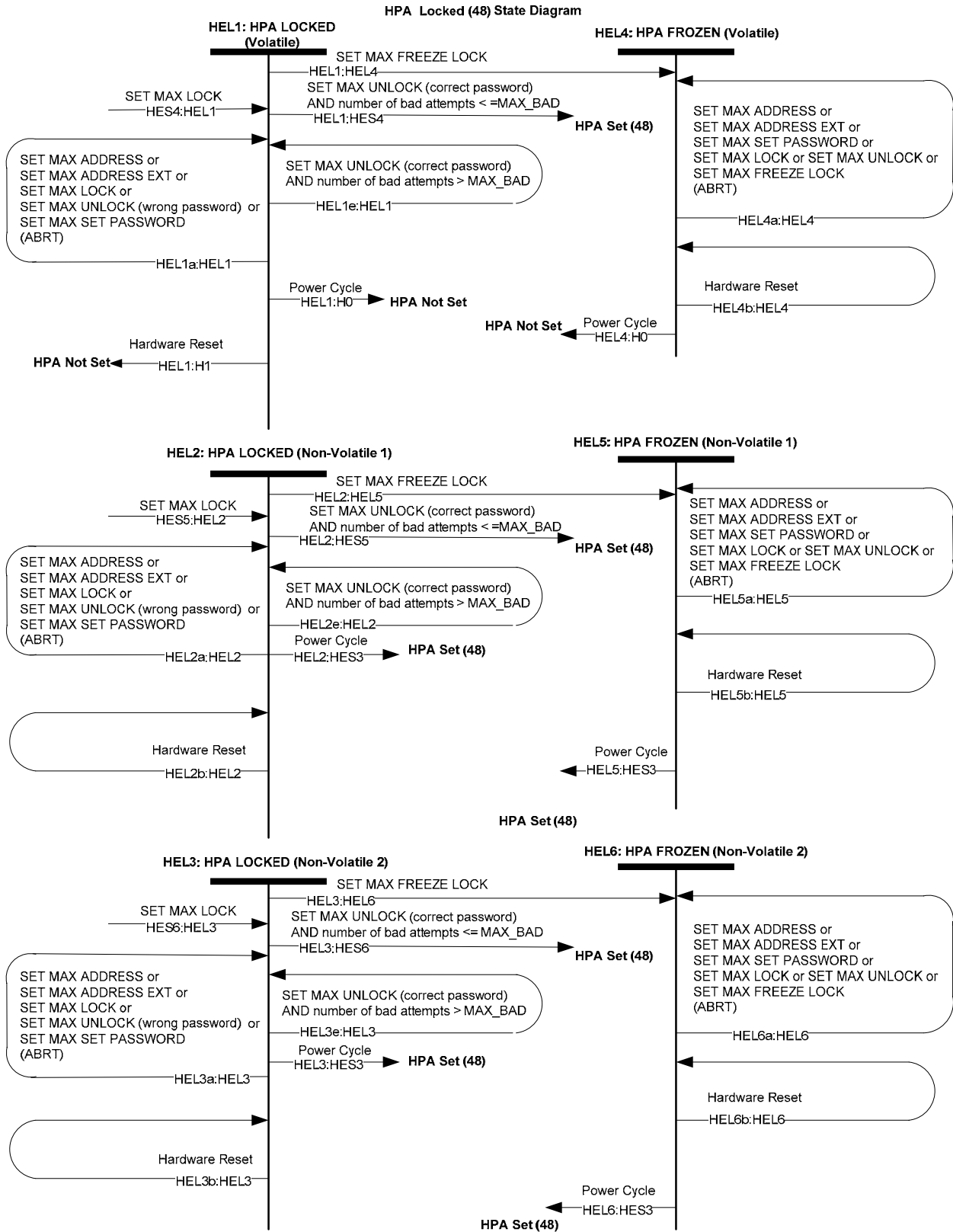


4. HPA Locked (28) State Diagram

HPA Locked (28) State Diagram



5. HPA Locked (48) State Diagram



General Information of the HPA State Diagram

Volatile state means no non-volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command has been issued after a volatile one.

Non-Volatile 1 state means a non-volatile SET MAX ADDRESS or SET MAX ADDRESS command was issued after power cycle.

Non-Volatile 2 state means no non-volatile SET MAX ADDRESS or SET MAX ADDRESS command was issued after power cycle.

MAX_BAD: Maximum number of failed password attempts is defined by the MAX_BAD (5 attempts)

After device power-on the password is cleared and HPA is not locked. States can be entered at power-on are H0, HS3, and HES3. If the device does not have Non-Volatile address setting, the device powers on at H0 state. If the device already has the Non-Volatile address setting and the address is less than the Native Max address, the device powers on at HS3 for non-extended mode or HES3 for extended mode.

In the state diagram if SET MAX ADDRESS volatile and non-volatile does not indicate “native max” it shall be less than native max.

HPA Not Set State Diagram

H0: No HPA/No Password: This state shall be entered when the device is powered on. In this state the device has not established the HPA and the password has not been set.

Transition H0:H1: When the device has completed a SET MAX SET PASSWORD command without error, the device shall make a transition to H1 state.

Transition H0:HS1: When the device has completed a SET MAX ADDRESS command without error in a volatile state (non-volatile bit set to 0), this command shall be executed and the device shall make a transition to the HS1 state.

Transition H0:HES1: When the device has completed a SET MAX ADDRESS EXT command without error in a volatile state (non-volatile bit set to 0), this command shall be executed and the device shall make a transition to the HES1 state.

Transition H0:HES2: When the device has completed a SET MAX ADDRESS EXT command without error in a non-volatile state (non-volatile bit set to 1), this command shall be executed and the device shall make a transition to the HES2 state.

Transition H0a:HS2: When the device has completed a SET MAX ADDRESS command without error in a non-volatile state (non-volatile bit set to 1), this command shall be executed and the device shall make a transition to the HS2 state.

Transition H0a:H0: When the device has completed a SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition H0b:H0: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall remain in the same state.

Transition H0c:H0: When the device processes a hardware ~~is~~-reset or a power-~~on reset-eyeled~~, the device shall remain in the same state.

H1: No HPA/Password Set: When the device has completed a SET MAX SET PASSWORD is received in the H0 state, the device transitions to the H1 state. In this state the device has not established the HPA and the password has been set.

Transition H1:H0: When device processes at~~the system is~~ power-on reset-eyeled, the device shall make a transition to the H0 state.

Transition H1:HS4: When the device has completed a SET MAX ADDRESS command without error in a volatile state, the device shall make a transition to the HS4 state.

Transition H1:HES4: When the device has completed a SET MAX ADDRESS EXT command without error in the volatile state, the device shall make a transition to the HES4 state.

Transition H1:HES5: When the SET MAX ADDRESS EXT command without error in the non-volatile state, the device shall make a transition to the HES5 state.

Transition H1a:H1: When the device has completed a SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition H1a:HS5: When the device has completed a SET MAX ADDRESS command without error in a non-volatile state, the device shall make a transition to the HS5: HPA SET (Non-Volatile 1) Password Set state.

Transition H1b:H1: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall remain in the same state.

Transition H1c:H1: When the device has completed a SET MAX PASSWORD command without error, the device shall remain in the same state.

Transition H1d:H1: If the hardware is reset, the device shall remain in the same state.

H2: No HPA/Locked: When the device has completed a SET MAX LOCK command without error in the H1 state, the device transitions to the H2 state. In this state the device is locked and only the power cycle transits the state to H0.

Transition H2:H0: When ~~device processes at the system is~~ power-~~on reset-eyeled~~, the device shall make a transition to the H0 state.

Transition H2a:H2: When the SET MAX ADDRESS EXT, SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK or SET MAX SET PASSWORD command without error, the device will abort the command and the device will remain in the same state.

Transition H2b:H2: If the hardware is reset, the device shall remain in the same state.

HPA Set (28) State Diagram

HS1: HPA SET (Volatile)/No Password: This state shall be entered when the device completes SET MAX ADDRESS (Volatile) command. In this state the volatile HPA address is established and the password is not set.

Transition HS1:HS2: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device shall make a transition to HS2 state.

Transition HS1:HS4: When the device has completed a SET MAX SET PASSWORD command without error, the device transitions to the HS4 state.

Transition HS1a:H0: When the ~~device processes a~~ hardware ~~is~~-reset or if ~~device processes at the system is~~ power-~~on reset-eyeled~~, the device shall make a transition to the H0 state.

Transition HS1b:H0: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall make a transition to H0 state.

Transition HS1c:HS1: When the device has completed a SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the command and the device will remain in the same state.

HS2: HPA SET (Non-Volatile 1)/No Password: This state shall be entered when the device completes SET MAX ADDRESS (Non-Volatile) command. In this state the non-volatile HPA address is established and the password is not set.

Transition H0:HS2: When the device has completed a SET MAX ADDRESS command without error in the non-volatile state, the device shall make a transition to HS2 state.

Transition HS2:H0: When SET MAX ADDRESS (Volatile, Native Max) command without error, the device shall make a transition to H0 state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

Transition HS2:HS5: When the device has completed a SET MAX PASSWORD command without error, the device shall make a transition to HS5 state.

Transition HS2a:HS2: When the device has completed a SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HS2b:HS2: If the hardware is reset, the device shall remain in the same state.

Transition HS2c:HS2: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device will abort the commands and the device shall remain in the same state.

Transition HS2d:HS2: When the device has completed a SET MAX ADDRESS command without error in volatile state, the device shall make a transition to HS2 state.

Transition HS2e:HS2: When the device has completed a SET MAX ADDRESS command without error in non-volatile state with the address equals to the Native Max address, the device shall make a transition to HS2 state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

Transition HS2:HS3: When ~~device processes a the system is~~ power ~~on reset eyeled~~, the device shall make transition to HS3 state.

HS3: HPA SET (Non-Volatile 2)/No Password: Device shall enter this state when the device ~~processes a~~ ~~is-power-on reset-eyeled~~ from HS2, HS5 or HS6 states. In this state the non-volatile HPA address is established and the password is not set.

Transition HS3:H0: When the device has completed a SET MAX ADDRESS (Volatile, Native Max) command without error, the device will transition to H0 state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

Transition HS3:HS2: When the device has completed a SET MAX ADDRESS command without error in a non-volatile state, the device shall transition to HS2 state.

Transition HS3:HS6: When the device has completed a SET MAX SET PASSWORD command without error, the device shall make a transition to HS6 state.

Transition HS3a:HS3: When the device has completed a SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HS3b:HS3: When the ~~device processes a~~ hardware ~~is~~-reset or when ~~device processes at the system is~~ power-~~on reset-eyeled~~, the device shall transition to HS3 state.

Transition HS3d:HS3: When the device has completed a SET MAX ADDRESS command without error in a volatile state, the device shall transition to HS3 state.

Transition HS3e:HS3: When the device has completed a SET MAX ADDRESS (Non-Volatile, Native Max) command without error, the device will transition to HS3 state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

HS4: HPA SET (Volatile)/Password Set: When the device has completed a SET MAX ADDRESS (Volatile), SET MAX UNLOCK, or SET MAX SET PASSWORD command without error, the device shall enter this state. In this state the volatile HPA address is established and the password is set.

Transition H1:HS4: When the device has completed a SET MAX ADDRESS command without error, the device shall transition to HS4 state.

Transition HL1:HS4: When the device has completed a SET MAX UNLOCK command without error, the device shall transition to HS4 state.

Transition HS4:HL1: When the device has completed a SET MAX LOCK command without error, the device shall transition to HL1 state.

Transition HS4:H0: When ~~device processes at the system is~~ power-~~on reset-eyeled~~, the device shall transition to H0 state.

Transition HS4:HS5: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device shall transition to HS5 state.

Transition HS4a:H1: When the hardware is reset, the device shall transition to H1 state.

Transition HS4a:HS4: When the device has completed a SET MAX ADDRESS EXT, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HS4b:H1: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall transition to H1 state.

Transition HS4c:HS4: When the device has completed a SET MAX SET PASSWORD command without error, the device shall transition to HS4 state.

Transition HS4d:HS4: When the device has completed a SET MAX ADDRESS command without error in volatile state, the device shall transition to HS4 state.

HS5: HPA SET (Non-Volatile 1)/Password Set: This state shall be entered when the device completes SET MAX ADDRESS (Volatile) command. In this state the non-volatile HPA address is established and the password is set.

Transition H1:HS5: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device shall transition to HS5 state.

Transition HL2:HS5: When the device has completed a SET MAX UNLOCK command without error, the device shall transition to HS5 state.

Transition HS5:H1: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall transition to H1 state.

Transition HS5:HL2: When the device has completed a SET MAX LOCK command without error, the device shall transition to HL2 state.

Transition HS5:HS3: When ~~device processes at the system is~~ power-on reset-cycled, the device shall transition to HS3 state.

Transition HS5d:HS5: When the device has completed a SET MAX PASSWORD command without error, the device shall remain in the same state.

Transition HS5e:HS5: When the device has completed a SET MAX ADDRESS command without error in volatile state, the device shall remain in the same state.

Transition HS5a:HS5: When the device has completed a SET MAX ADDRESS EXT, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HS5b:HS5: When the hardware is reset, the device shall transition to the HS5 state.

Transition HS5c:HS5: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device aborts the command and the device shall remain in the same state.

HS6: HPA SET (Non-Volatile 2)/Password Set: When the device has completed a SET MAX UNLOCK command without error in the HL3 state or when the device has completed a SET MAX SET PASSWORD is received in HS3 state, the device enters this state. In this state the non-volatile HPA address is established and the password is set.

Transition HL3:HS6: When the device has completed a SET MAX UNLOCK command without error, the device transitions to HS6 state.

Transition HS6:HS5: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device transitions to HS5 state.

Transition HS6:H1: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall transition to H1 state.

Transition HS6:HL3: When the device has completed a SET MAX LOCK command without error, the device shall transition to HL3 state.

Transition HS6a:HS6: When the device has completed a SET MAX ADDRESS EXT, SET MAX UNLOCK, or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HS6:HS3: When ~~device processes at the system is~~ power-on reset eyeled, the device shall transition to HS3 state.

Transition HS6b:HS6: When the device completes a hardware reset, the device shall remain in the same state.

Transition HS6d:HS6: When the device has completed a SET MAX ADDRESS command without error in the volatile state, the device shall remain in the same state.

Transition HS6e:HS6: When the device has completed a SET MAX SET PASSWORD command without error, the device shall remain in the same state.

HPA Set (48) State Diagram

HES1: HPA SET (Volatile)/No Password: This state shall be entered when the device completes SET MAX ADDRESS EXT (Volatile) command. In this state the volatile HPA address is established and the password is not set.

Transition HES1:HES2: When the device has completed a SET MAX ADDRESS EXT command without error in non-volatile state, the device shall make a transition to HES2 state.

Transition HES1:HES4: When the device has completed a SET MAX SET PASSWORD command without error, the device transitions to the HES4 state.

Transition HES1a:H0: When the device processes a hardware is-reset or if device processes at the system is power-on reset-eyeled, the device shall make a transition to the H0 state.

Transition HES1b:H0: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall make a transition to H0 state.

Transition HES1c:HES1: When the device has completed a SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the command and the device will remain in the same state.

HES2: HPA SET (Non-Volatile 1)/No Password: This state shall be entered when the device completes SET MAX ADDRESS EXT (Non-Volatile) command. In this state the non-volatile HPA address is established and the password is not set.

Transition HES2:H0: When SET MAX ADDRESS (Non-Volatile, Native Max) command without error, the device shall make a transition to H0 state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

HES3: When device processes at the system is power-on reset-eyeled, the device shall make transition to HES3 state.

Transition HES2:HES5: When the device has completed a SET MAX PASSWORD command without error, the device shall make a transition to HES5 state.

Transition HES2a:HES2: When the device has completed a SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HES2b:HES2: If the hardware is reset, the device shall remain in the same state.

Transition HES2c:HES2: When the device has completed a SET MAX ADDRESS EXT command without error in non-volatile state, the device will abort the commands and the device shall remain in the same state.

Transition HES2d:HES2: When the device has completed a SET MAX ADDRESS command without error in volatile state, the device shall remain in the same state.

Transition HES2e:HES2: When the device has completed a SET MAX ADDRESS EXT command without error in volatile state with the address equals to the Native Max address, the device shall make a transition to HES2: HPA SET (Non-Volatile 1) No Password state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

HES3: HPA SET (Non-Volatile 2)/No Password: Device shall enter this state when the device ~~processes a~~ ~~is-power-on reset-eyeled~~ from HES2, HES5 or HES6 states. In this state the non-volatile HPA address is established and the password is not set.

Transition HES3:H0: When the device has completed a SET MAX ADDRESS (Volatile, Native Max) command without error, the device will transition to H0 state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

Transition HES3:HES2: When the device has completed a SET MAX ADDRESS EXT (Non-Volatile) command without error in a non-volatile state, the device shall transition to HES2 state.

Transition HES3:HES6: When the device has completed a SET MAX SET PASSWORD command without error, the device shall make a transition to HES6 state.

Transition HES3a:HES3: When the device has completed a SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HES3b:HES3: When the ~~device processes a~~ hardware ~~is~~-reset or when ~~device processes at the system is~~ power-~~on reset-eyeled~~, the device shall remain in the same state.

Transition HES3d:HES3: When the device has completed a SET MAX ADDRESS EXT (Volatile) command without error in a volatile state, the device shall remain in the same state.

Transition HES3e:HES3: When the device has completed a SET MAX ADDRESS EXT (Non-Volatile, Native Max) command without error, the device will transition to HS3 state. The Host Protected Area has been established bit in IDENTIFY command word 85 bit 10 is cleared at this state transition.

HES4: HPA SET (Volatile)/Password Set: When the device has completed a SET MAX ADDRESS EXT-(Volatile), SET MAX UNLOCK, or SET MAX SET PASSWORD command without error, the device shall enter this state. In this state the volatile HPA address is established and the password is set.

Transition HES4:H0: When ~~device processes at the system is~~ power-on reset-cycled, the device shall transition to H0: No HPA No Password state.

Transition HES4:HES5: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device shall transition to HES5 state.

Transition HEL1:HES4: When the device has completed a SET MAX UNLOCK command without error, the device shall transition to HES4 state.

Transition HES4:HEL1: When the device has completed a SET MAX LOCK command without error, the device shall transition to HEL1 state.

Transition HES4a:H1: When the hardware is reset, the device shall transition to H1 state.

Transition HES4a:HES4: When the device has completed a SET MAX ADDRESS, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HES4b:H1: When the device has completed a SET MAX ADDRESS (Native Max) command without error, the device shall transition to H1 state.

Transition HES4c:HES4: When the device has completed a SET MAX SET PASSWORD command without error, the device shall remain in the same state.

Transition HES4d:HES4: When the device has completed a SET MAX ADDRESS command without error in volatile state, the device shall remain in the same state.

HES5: HPA SET (Non-Volatile 1)/Password Set: When the device has completed a SET MAX ADDRESS EXT (Non-Volatile) or SET PASSWORD command without error, the device shall enter this state. In this state the non-volatile HPA address is established and the password is set.

Transition H1:HES5: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device shall transition to HES5 state.

Transition HES5:H1: When the device has completed a SET MAX ADDRESS EXT (Native Max) command without error, the device shall transition to H1 state.

Transition HES5:HEL2: When the device has completed a SET MAX LOCK command without error, the device shall transition to HEL2 state.

Transition HES5:HES3: When ~~device processes the system is~~ power-~~on reset-eyeled~~, the device shall transition to HES3 state.

Transition HES5a:HES5: When the device has completed a SET MAX ADDRESS EXT, SET MAX UNLOCK or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HES5b:HES5: When the hardware is reset, the device shall remain in the same state.

Transition HES5c:HES5: When the device has completed a SET MAX ADDRESS command without error in non-volatile state, the device aborts the command and the device shall remain in the same state.

Transition HES5d:HES5: When the device has completed a SET MAX PASSWORD command without error, the device shall remain in the same state.

Transition HES5e:HES5: When the device has completed a SET MAX ADDRESS command without error in volatile state, the device shall remain in the same state.

HES6: HPA SET (Non-Volatile 2)/Password Set: When the device has completed a SET MAX UNLOCK command without error in the HEL3 state or when the device has completed a SET MAX SET PASSWORD is received in HES3 state, the device enters this state. In this state the non-volatile HPA address is established and the password is set.

Transition HES6:HES5: When the device has completed a SET MAX ADDRESS EXT command without error in non-volatile state, the device transitions to HES5 state.

Transition HES6:H1: When the device has completed a SET MAX ADDRESS EXT (Native Max) command without error, the device shall transition to H1 state.

Transition HES6:HEL3: When the device has completed a SET MAX LOCK command without error, the device shall transition to HEL3 state.

Transition HES6:HES3: When ~~device processes the system is~~ power-~~on reset-eyeled~~, the device shall transition to HES3 state.

Transition HES6a:HES6: When the device has completed a SET MAX ADDRESS EXT, SET MAX UNLOCK, or SET MAX FREEZE LOCK command without error, the device will abort the commands and the device shall remain in the same state.

Transition HES6b:HES6: When the hardware is reset, the device shall remain in the same state.

Transition HES6d:HES6: When the device has completed a SET MAX ADDRESS EXT command without error in the volatile state, the device shall remain in the same state.

Transition HES6e:HES6: When the device has completed a SET MAX SET PASSWORD command without error, the device shall remain in the same state.

HPA Locked (28) State Diagram

HL1: HPA LOCKED (Volatile): This state shall be entered when the device completes SET MAX LOCK (Volatile) command in HS4 state. In this state the volatile HPA address is established, the drive is locked from HPA commands except the SET MAX UNLOCK command with a proper password or the SET MAX FREEZE LOCK command.

Transition HL1:H0: When ~~device processes at the system is~~ power ~~on reset eyeled~~, the device shall transition to H0 state.

Transition HL1:HL4: When the device has completed a SET MAX FREEZE LOCK command without error, the device shall transition to HL4 state.

Transition HL1:HS4: When the SET MAX UNLOCK (correct password) command without error and the number of bad attempts is less or equal than MAX_BAD, the device shall transition to HS4 state.

Transition HL1a:HL1: When the SET MAX ADDRESS EXT, SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD command without error, the device will abort the command and the device will remain in the same state.

Transition HL1b:HL1: When the hardware is reset, the device shall remain in the same state.

Transition HL1e:HL1: When the device has completed a SET MAX UNLOCK (correct password) and the number of bad attempts is greater than MAX_BAD, the device shall abort the command and remain in the same state.

HL2: HPA LOCKED (Non-volatile 1): This state shall be entered when the device completes SET MAX LOCK (Non-Volatile) command in HS5 state. In this state the non-volatile HPA address is established, the drive is locked from HPA commands except the SET MAX UNLOCK command with a proper password or the SET MAX FREEZE LOCK command.

Transition HL2:HL5: When the device has completed a SET MAX FREEZE LOCK command without error, the device shall transition to HL5 state.

Transition HL2:HS3: When ~~device processes at the system is~~ power ~~on reset eyeled~~, the device shall transition to HS3 state.

Transition HL2:HS5: When the device has completed a SET MAX UNLOCK (correct password) command without error and the number of bad attempts is less or equal than MAX_BAD, the device shall transition to HS5 state.

Transition HL2a:HL2: When the device has completed a SET MAX ADDRESS EXT, SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD command without error, the device shall abort the command and the device shall remain in the same state.

Transition HL2b:HL2: When the hardware is reset, the device shall transition to HL2 state.

Transition HL2e:HL2: When the device has completed a SET MAX UNLOCK (correct password) command without error and the number of bad attempts is greater than MAX_BAD, the device shall remain in the same state.

HL3: HPA LOCKED (Non-volatile 2): This state shall be entered when the device completes SET MAX LOCK (Non-Volatile) command in HS6 state. In this state the non-volatile HPA address is established, the drive is locked from HPA commands except the SET MAX UNLOCK command with a proper password or the SET MAX FREEZE LOCK command.

Transition HL3:HL6: When the device has completed a SET MAX FREEZE LOCK command without error, the device shall transition to HL6 state.

Transition HL3:HS3: When the device ~~processes a~~ power-on reset-eyeled, the device shall transition to HS3 state.

Transition HL3:HS6: When the device has completed a SET MAX UNLOCK command without error with the correct password and the number of bad attempts is less or equal than MAX_BAD, the device shall transition to HS6 state.

Transition HL3a:HL3: When the device has completed a SET MAX ADDRESS EXT, SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD command without error, the device shall abort the command and the device shall remain in the same state.

Transition HL3b:HL3: When the device completes ~~a hardware reset~~Hardware-Reset, the device shall remain in the same state.

Transition HL3e:HL3: When the device has completed a SET MAX UNLOCK (correct password) command is given and the number of bad attempts is greater than MAX_BAD, the device shall remain in the same state.

HL4: HPA FROZEN (Volatile): This state shall be entered when the device completes SET MAX FREEZE LOCK command in HL1 state. In this state the volatile HPA address is established, the drive is locked from all HPA commands. Only power cycle can make the device to change to other state.

Transition HL4:H0: When ~~device processes at the system is~~ power-on reset-cycled, the device shall transition to H0 state.

Transition HL4a:HL4: When the device has completed a SET MAX ADDRESS EXT, SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK, SET MAX FREEZE LOCK or SET MAX SET PASSWORD command without error, the device shall abort the command and the device shall remain in the same state.

Transition HL4b:HL4: When the hardware is reset, the device shall remain in the same state.

HL5: HPA FROZEN (Non-Volatile 1): This state shall be entered when the device completes SET MAX FREEZE LOCK command in HL2 state. In this state the non-volatile HPA address is established, the drive is locked from all HPA commands. Only power cycle can make the device to change to other state.

Transition HL5a:HL5: When the device has completed a SET MAX ADDRESS EXT, SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK, SET MAX FREEZE LOCK or SET MAX SET PASSWORD command without error, the device shall abort the commands and the device shall remain in the same state.

Transition HL5b:HL5: When the device completes a hardware reset, the device shall remain in the same state.

Transition HL5:HS3: When ~~device processes at the system is~~ power-on reset-cycled, the device shall transition to HS3 state.

HL6: HPA FROZEN (Non-Volatile 2): This state shall be entered when the device completes SET MAX FREEZE LOCK command in HL3 state. In this state the non-volatile HPA address is established, the drive is locked from all HPA commands. Only power cycle can make the device to change to other state.

Transition HL6:HS3: When ~~device processes at the system is~~ power-on reset-cycled, the device shall transition to HS3 state.

Transition HL6a:HL6: When the device has completed a SET MAX ADDRESS EXT, SET MAX ADDRESS, SET MAX LOCK, SET MAX UNLOCK, SET MAX FREEZE LOCK or SET MAX SET PASSWORD command without error, the device shall abort the commands and the device shall remain in the same state.

Transition HL6b:HL6: When the hardware is reset, the device shall remain in the same state.

HPA Locked (48) State Diagram

HEL1: HPA LOCKED (Volatile): This state shall be entered when the device completes SET MAX LOCK command in HES4 state. In this state the volatile HPA address is established, the drive is locked from HPA commands except the SET MAX UNLOCK command with a proper password or the SET MAX FREEZE LOCK command.

Transition HEL1:H0: When ~~device processes at the system is~~ power ~~on reset eyeled~~, the device shall transition to H0 state.

Transition HEL1:HEL4: When the device has completed a SET MAX FREEZE LOCK command without error, the device shall transition to HEL4 state.

Transition HEL1:HES4: When the SET MAX UNLOCK (correct password) command without error and the number of bad attempts is less or equal than MAX_BAD; the device shall transition to HES4 state.

Transition HEL1a:HEL1: When the SET MAX ADDRESS, SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD command without error, the device will abort the command and the device will remain in the same state.

Transition HEL1b:HEL1: When the hardware is reset, the device shall remain in the same state.

Transition HEL1e:HEL1: When the device has completed a SET MAX UNLOCK (correct password) and the number of bad attempts is greater than MAX_BAD, the device shall remain in the same state.

HEL2: HPA LOCKED (Non-volatile 1): This state shall be entered when the device completes SET MAX LOCK (Non-Volatile) command in HES5 state. In this state the non-volatile HPA address is established, the drive is locked from HPA commands except the SET MAX UNLOCK command with a proper password or the SET MAX FREEZE LOCK command.

Transition HES5:HEL2: When the device has completed a SET MAX LOCK command without error, the device shall transition to HEL2 state.

Transition HEL2:HEL5: When the device has completed a SET MAX FREEZE LOCK command without error, the device shall transition to HEL5 state.

Transition HEL2:HES3: When ~~device processes at the system is~~ power ~~on reset eyeled~~, the device shall transition to HES3 state.

Transition HEL2:HES5: When the device has completed a SET MAX UNLOCK (correct password) command without error and the number of bad attempts is less or equal than MAX_BAD, the device shall transition to HES5 state.

Transition HEL2a:HEL2: When the device has completed a SET MAX ADDRESS, SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD command without error, the device shall abort the command and the device shall remain in the same state.

Transition HEL2b:HEL2: When the hardware is reset, the device shall transition to HEL2 state.

Transition HEL2e:HEL2: When the device has completed a SET MAX UNLOCK (correct password) command without error and the number of bad attempts is greater than MAX_BAD, the device shall remain in the same state.

HEL3: HPA LOCKED (Non-volatile 2): This state shall be entered when the device completes SET MAX LOCK (Non-Volatile) command in HES6 state. In this state the non-volatile HPA address is established, the drive is locked from HPA commands except the SET MAX UNLOCK command with a proper password or the SET MAX FREEZE LOCK command.

Transition HEL3:HEL6: When the device has completed a SET MAX FREEZE LOCK command without error, the device shall transition to HEL6 state.

Transition HEL3:HES3: When ~~device processes at the system is~~ power-on reset-eyed, the device shall transition to HES3 state.

Transition HEL3:HES6: When the device has completed a SET MAX UNLOCK command without error with the correct password and the number of bad attempts is less or equal than MAX_BAD, the device shall transition to HES6 state.

Transition HEL3a:HEL3: When the device has completed a SET MAX ADDRESS, SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD command without error, the device shall abort the command and the device shall remain in the same state.

Transition HEL3b:HEL3: When the device completes a Hardware ~~reset~~Reset, the device shall remain in the same state.

Transition HEL3e:HEL3: When the device has completed a SET MAX UNLOCK (correct password) command is given and the number of bad attempts is greater than MAX_BAD, the device shall remain in the same state.

HEL4: HPA FROZEN (Volatile): This state shall be entered when the device completes SET MAX FREEZE LOCK command in HEL1 state. In this state the volatile HPA address is established, the drive is locked from all HPA commands. Only power cycle can make the device to change to other state.

Transition HEL4:H0: When ~~device processes at the system is~~ power-on reset-eyeled, the device shall transition to H0 state.

Transition HEL4a:HEL4: When the device has completed a SET MAX ADDRESS, SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK, SET MAX FREEZE LOCK or SET MAX SET PASSWORD command without error, the device shall abort the command and the device shall remain in the same state.

Transition HEL4b:HEL4: When the hardware is reset, the device shall remain in the same state.

HEL5: HPA FROZEN (Non-Volatile 1): This state shall be entered when the device completes SET MAX FREEZE LOCK command in HEL2 state. In this state the non-volatile HPA address is established, the drive is locked from all HPA commands. Only power cycle can make the device to change to other state.

Transition HEL5a:HEL5: When the device has completed a SET MAX ADDRESS, SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK, SET MAX FREEZE LOCK or SET MAX SET PASSWORD command without error, the device shall abort the commands and the device shall remain in the same state.

Transition HEL5b:HEL5: When the hardware is reset, the device shall remain in the same state.

Transition HEL5:HES3: When ~~device processes at the system is~~ power-on reset-eyeled, the device shall transition to HES3 state.

Transition HES6:HEL3: When the device has completed a SET MAX LOCK command without error, the device shall transition to HEL3 state.

HEL6: HPA FROZEN (Non-Volatile 2): This state shall be entered when the device completes SET MAX FREEZE LOCK command in HEL3 state. In this state the non-volatile HPA address is established, the drive is locked from all HPA commands. Only power cycle can make the device to change to other state.

Transition HEL6:HES3: When ~~device processes at the system is~~ power-on reset-eyeled, the device shall transition to HES3 state.

Transition HEL6a:HEL6: When the device has completed a SET MAX ADDRESS, SET MAX ADDRESS EXT, SET MAX LOCK, SET MAX UNLOCK, SET MAX FREEZE LOCK or SET MAX SET PASSWORD command without error, the device shall abort the commands and the device shall remain in the same state.

Transition HEL6b:HEL6: When the hardware is reset, the device shall remain in the same state.

