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Subj: SPC-4 SBC-3 Adding more low power options
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Overview

The existing Power Condition Mode Page Allows for two low power modes (idle and standby). This proposal increases the number of low power modes to four (adds idle2 and idle3) and adds a recovery time parameter for each of the low power modes.

Elements included in this proposal are:

a) additions to the Power Condition mode page to add two more idle modes and add a recovery time parameter for each power mode;
b) changes to START STOP command wording to clarify how to immediately enter the new idle power modes;
c) addition to the power condition model to allow REQUEST SENSE to return new ASC values for the new idle modes;
d) define 4 new ASC values; and
e) add new log parameters to count transitions to low power modes.

Rev. 1: Added details of power condition model changes for SBC and SPC; split the power condition transition log parameters into a new log page; combined two tables into one to clarify START STOP UNIT command behavior; added new options to START STOP UNIT; and editorial changes in various other places.

Rev. 2: Rearranged sections to be in section number order; Added standby2 power condition to the model, the ASC list, the mode page, the log page, and the START STOP UNIT command; Added rule to idle condition model restricting power consumption when transitioning to active; added details to standby condition model; miscellaneous editorial changes.

Rev. 3: Made changes requested at 9/10 CAP meeting.

Rev. 4: Added changes suggested by Ralph Weber.

SPC-4 changes:

5.9 Power conditions
5.9.1 Power conditions overview
The optional Power Condition mode page (see 7.4.12) allows an application client to control the power condition of a logical unit in a manner that may reduce power consumption of the SCSI target device. This control is invoked by enabling and ~~setting~~ initializing the idle condition ~~timer~~ timers and/or the standby condition ~~timer~~ timers using ~~the~~ their Power Condition mode page values. A change in the power condition of any logical unit in a SCSI target device may result in a change in the SCSI target device's power consumption. If a SCSI target device contains multiple logical units, then the SCSI target device's power consumption may not decrease until a group of the logical units have transitioned to a lower power condition. Any grouping of logical units for power condition management is outside the scope of this standard.

In addition to the Power Condition mode page, the power condition of a logical unit may be controlled by the START STOP UNIT command (see SBC-3 or RBC). If both the Power Condition mode page and the START STOP UNIT command methods are being used to control the power condition of the same logical unit, then any START STOP UNIT command's power condition

specification shall override the Power Condition mode page's power control and may disable the idle condition and standby condition timers.

There shall be no notification to the application client that a logical unit has transitioned from one power condition to another. The REQUEST SENSE command (see 6.28) indicates if a logical unit is in one of the idle or standby power conditions ~~or the standby power condition~~.

Command standards (see 3.1.18) may define for their peripheral device types additional power conditions (e.g., the stopped power condition defined by SBC-3 for direct-access block devices) and extensions to the REQUEST SENSE command for reporting power conditions.

When a device server processes a command while in a lower power condition defined in this standard (e.g., standby1), the logical unit shall transition to a higher power condition (e.g., active), if necessary, to process the command. Transport protocol standards may impose additional requirements (e.g., the SAS-2 NOTIFY (ENABLE SPINUP) primitive requirement) that shall be satisfied before completing a power condition transition to a higher power condition.

If any power condition timer is enabled, then it shall be stopped on receipt of a command. On completion of the command, all enabled timers shall be reinitialized based on their Power Condition mode page value and then started.

No power condition shall affect the supply of any power required for proper operation of a service delivery subsystem.

Logical units that contain cache memory shall write all cached data to the medium for the logical unit (e.g., as a logical unit would do in response to a SYNCHRONIZE CACHE command as described in SBC-2) prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the standby1 power condition).

The power conditions are described in table 51.

Table 51 — Power Conditions

Power Condition	Description
active	While in the active power condition (see 3.1.5): a) A device server is capable of ~~responding to~~ processing all of its supported commands including those that cause media access ~~requests~~ without changing power condition prior to processing the command; b) A logical unit completes processing of operations in the shortest time when compared to the time required for completion while in one of the idle or standby power conditions; and c) The SCSI target device may consume more power than when the logical unit is in one of the idle power conditions (e.g., a disk drive's spindle motor may be active).
idle (i.e., idle1, idle2, and idle3)	While in one of the idle power conditions (see 3.1.54): a) ~~A device server is capable of responding to all of its supported commands including media access requests;~~ A device server is capable of processing all of its supported commands, but those that cause media access may cause a change of power condition prior to processing the command; b) A logical unit may take longer to complete processing a command than it would while in the active power condition (e.g., the device may have to activate some circuitry before processing a command); ~~and~~ c) The power consumed by the SCSI target device while in an idle power condition should be less than or equal to the power consumed when the logical unit is in the active power condition and may be greater than the

	power consumed when the logical unit is in one of the standby power conditions; d) The peak power consumption during the transition from an idle power condition to the active power condition shall be no more than the peak power consumption during the active power condition; and e) A device server may support more than one idle power condition (e.g., idle1, idle2, idle3) to provide progressively lower power consumption (i.e., power consumption for active >= idle1 >= idle2 >= idle3).
standby (i.e., standby2 and standby1)	While in one of the standby power conditions (see 3.1.155): ~~a) A device server is not capable of processing media access commands and~~ ~~b) The power consumed by the SCSI target device should be less than or equal to the power consumed when the logical unit is in the idle power condition (e.g., a disk drive's spindle motor is stopped).~~ a) A device server is not capable of processing commands that cause media access without first making a transition to the active power condition; b) transport protocol standards may impose additional requirements on command responses (e.g., for SAS-2 the response may be CHECK CONDITION status with sense key set to NOT READY and additional sense bytes set to LOGICAL UNIT NOT READY, NOTIFY (ENABLE SPINUP) REQUIRED instead of GOOD status); c) A logical unit may take longer to complete processing a command than it would while in the active power condition or one of the idle power conditions (e.g., a disk drive's spindle motor may need to be started); d) The power consumed by the SCSI target device while in a standby power condition should be less than the power consumed when the logical unit is in the active power condition or one of the idle power conditions; e) The peak power consumption during the transition from a standby power condition to the active power condition is not limited; and f) A device server may support more than one standby power condition (e.g., standby2 and standby1) to provide progressively lower power consumption (i.e., power consumption for active >= idle >= standby2 >= standby1).

5.9.2 Power condition state machine

[This clause is unchanged and is not shown here.]

6.28 REQUEST SENSE command

The REQUEST SENSE command (see table 226) requests that the device server transfer parameter data containing sense data to the application client.

[Unchanged tables and CDB description text are not shown here.]

Sense data shall be available and cleared under the conditions defined in SAM-4. If the device server has no sense data available to return, it shall:

1) Return parameter data containing sense data with the sense key set to NO SENSE and the additional sense code set to NO ADDITIONAL SENSE INFORMATION; and
2) Complete the REQUEST SENSE command with GOOD status.

If the logical unit is in the idle power condition (see 5.9), the device server shall process a REQUEST SENSE command by:

1) Returning parameter data containing sense data with the sense key set to NO SENSE and the additional sense code set to one of the following:

A) LOW POWER CONDITION ON if the reason for entry into the idle power condition is unknown;
B) IDLE1 CONDITION ACTIVATED BY TIMER if the logical unit entered the idle1 power condition due to the idle1 condition timer (see 7.4.12); ~~and~~
C) IDLE1 CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle1 power condition due to receipt of a command requiring the idle1 power condition while it was in the idle2, idle3, standby2, or standby1 power condition;
D) IDLE2 CONDITION ACTIVATED BY TIMER if the logical unit entered the idle2 power condition due to the idle2 condition timer (see SPC-4);
E) IDLE2 CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle2 power condition due to receipt of a command requiring the idle2 power condition while it was in the idle3, standby2, or standby1 power condition;
F) IDLE3 CONDITION ACTIVATED BY TIMER if the logical unit entered the idle3 power condition due to the idle3 condition timer (see SPC-4); or
G) IDLE3 CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle3 power condition due to receipt of a command requiring the idle3 power condition while it was in the standby2 or standby1 power condition;

and

2) Complete the REQUEST SENSE command with GOOD status.

If the logical unit is in the standby power condition, the device server shall process a REQUEST SENSE command by:

1) Return parameter data containing sense data with the sense key set to NO SENSE and the additional sense code set to one of the following:
   A) LOW POWER CONDITION ON if the reason for entry into the standby power condition is unknown; ~~and~~
   B) STANDBY2 CONDITION ACTIVATED BY TIMER if the logical unit entered the standby2 power condition due to the standby2 condition timer (see SPC-4);
   C) STANDBY2 CONDITION ACTIVATED BY COMMAND if the logical unit entered the standby2 power condition due to receipt of a command requiring the standby2 power condition while it was in the standby1 power condition; or
   D) STANDBY1 CONDITION ACTIVATED BY TIMER if the logical unit entered the standby power condition due to the standby1 condition timer (see 7.4.12);

and

2) Complete the REQUEST SENSE command with GOOD status.

Upon completion of the REQUEST SENSE command, the logical unit shall return to the same power condition that was active before the REQUEST SENSE command was received. A REQUEST SENSE command shall not reset any power condition timers.

The device server shall return CHECK CONDITION status for a REQUEST SENSE command only to report exception conditions specific to the REQUEST SENSE command itself. Examples of conditions that cause a REQUEST SENSE command to return a CHECK CONDITION status are:

[Remainder of clause 6.28 is unchanged.]

Sense code changes for Table 40 and Table D.1:

Sense	ASCQ	Description
2Ch	05h DT LPWRO A BK	ILLEGAL POWER CONDITION REQUEST
5Eh	00h DT LPWRO A BK	LOW POWER CONDITION ON
5Eh	01h DT LPWRO A K	IDLE1 CONDITION ACTIVATED BY TIMER
5Eh	02h DT LPWRO A K	STANDBY1 CONDITION ACTIVATED BY TIMER
5Eh	03h DT LPWRO A BK	IDLE1 CONDITION ACTIVATED BY COMMAND
5Eh	04h DT LPWRO A BK	STANDBY1 CONDITION ACTIVATED BY COMMAND
5Eh	05h DT LPWRO A K	IDLE2 CONDITION ACTIVATED BY TIMER
5Eh	06h DT LPWRO A K	IDLE2 CONDITION ACTIVATED BY COMMAND
5Eh	07h DT LPWRO A K	IDLE3 CONDITION ACTIVATED BY TIMER
5Eh	08h DT LPWRO A K	IDLE3 CONDITION ACTIVATED BY COMMAND
5Eh	09h DT LPWRO A K	STANDBY2 CONDITION ACTIVATED BY TIMER
5Eh	0Ah DT LPWRO A K	STANDBY2 CONDITION ACTIVATED BY COMMAND

7.4.12 Power Condition mode page

The Power Condition mode page provides an application client with methods to control the power condition of a logical unit (see 5.9). These methods include:

a) Specifying that the logical unit transition to a power condition without delay; and
b) ~~Activating~~ enabling and ~~setting~~ initializing any of ~~idle condition and standby~~ the power condition timers to specify that the logical unit wait for a period of inactivity before transitioning to a specified power condition.

The mode page policy (see 6.9) for this mode page shall be shared.

~~When a device server receives a command while in a power condition based on a setting in the Power Condition mode page, the logical unit shall transition to the power condition that allows the command to be processed. If either the idle condition timer or the standby power condition timer has been set, then they shall be reset on receipt of the command. On completion of the command, the timer(s) shall be started.~~

Logical units that contain cache memory shall write all cached data to the medium for the logical unit (e.g., as a logical unit does in response to a SYNCHRONIZE CACHE command as described in SBC-~~2~~3) prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the standby power condition).

The logical unit shall use the values in the Power Condition mode page to control its power condition after a power on or a hard reset until a START STOP UNIT command setting a power condition is received.

Table 319 defines the Power Condition mode page.

Table 319 -- Power Condition Mode Page

Bit / Byte	7	6	5	4	3	2	1	0
0	PS	SPF(0b)	Page Code (1Ah)					
1	Page Length							
2	Reserved							
3	Reserved			STANDBY2	IDLE3	IDLE2	IDLE1	STANDBY1
4	IDLE1 CONDITION TIMER							
5								
6								
7								
8	STANDBY1 CONDITION TIMER							
9								
10								
11								
12	IDLE2 CONDITION TIMER							
13								
14								
15								
16	IDLE3 CONDITION TIMER							
17								
18								
19								
20	STANDBY2 CONDITION TIMER							
21								
22								
23								
24	IDLE1 CONDITION RECOVERY TIME							
25								
26	STANDBY1 CONDITION RECOVERY TIME							
27								
28	IDLE2 CONDITION RECOVERY TIME							
29								
30	IDLE3 CONDITION RECOVERY TIME							
31								
32	STANDBY2 CONDITION RECOVERY TIME							
33								
34	RESERVED							
39								

The PS bit, SPF bit, PAGE CODE field, and PAGE LENGTH field are described in 7.4.5.

The IDLE1, IDLE2, IDLE3, STANDBY2, and STANDBY1 bits specify which timers are ~~active~~ enabled.

If the IDLE1 bit is set to one ~~and the STANDBY bit is set to zero,~~ then the idle1 condition timer is ~~active~~ enabled and the device server shall transition to the idle1 power condition when the time specified by the IDLE1 CONDITION TIMER ~~is zero~~ field has expired and the logical unit is in a power condition higher than idle1.

If the IDLE1 bit is set to zero, then the device server shall ignore the idle1 condition timer.

If the STANDBY1 bit is set to one ~~and the IDLE bit is set to zero,~~ then the standby1 condition timer is ~~active~~ enabled and the device server shall transition to the standby1 power condition when the time specified by the STANDBY1 CONDITION TIMER ~~is zero~~ field has expired and the logical unit is in a power condition higher than standby1.

If the STANDBY1 bit is set to zero, then the device server shall ignore the standby1 condition timer.

If the IDLE2 bit is set to one then the idle2 condition timer is enabled and the device server shall transition to the idle2 power condition when the time specified by the IDLE2 CONDITION TIMER field has expired and the logical unit is in a power condition higher than idle2.

If the IDLE2 bit is set to zero, then the device server shall ignore the idle2 condition timer.

If the IDLE3 bit is set to one then the idle3 condition timer is enabled and the device server shall transition to the idle3 power condition when the time specified by the IDLE3 CONDITION TIMER field has expired and the logical unit is in a power condition higher than idle3.

If the IDLE3 bit is set to zero, then the device server shall ignore the idle3 condition timer.

If the STANDBY2 bit is set to one then the standby2 condition timer is enabled and the device server shall transition to the standby2 power condition when the time specified by the STANDBY2 CONDITION TIMER field has expired and the logical unit is in a power condition higher than standby2.

If the STANDBY2 bit is set to zero, then the device server shall ignore the standby2 condition timer.

If ~~both~~ more than one of the IDLE1, IDLE2, IDLE3, STANDBY2, and STANDBY1 bits are set to one, then ~~both~~ all of the enabled timers are active and run concurrently. When each timer expires, the device server should transition to the power condition associated with that timer. Timer expirations shall only cause the device server to transition from higher power conditions to lower power conditions (e.g., if the standby1 timer expires before the idle2 timer, the device server shall remain in the standby1 condition when the idle2 timer expires). ~~the idle condition timer is zero the device server shall transition to the idle power condition. When the standby condition timer is zero the device server shall transition to the standby power condition. If the standby condition timer is zero before the idle condition timer is zero, then the logical unit shall transition to the standby power condition.~~

The value in the IDLE1 CONDITION TIMER field specifies the inactivity time in 100 millisecond increments that the logical unit shall wait before transitioning to the idle1 power condition when the IDLE1 bit is set to one. The idle1 condition timer is expired when:

a) The IDLE1 CONDITION TIMER field is set to zero; or
b) The ~~number of milliseconds~~ time specified by the value in the IDLE1 CONDITION TIMER field times 100 milliseconds has elapsed since the last activity (e.g., processing a command that requires the active power condition or performing a self test).

The value in the STANDBY1 CONDITION TIMER field specifies the inactivity time in 100 millisecond increments that the logical unit shall wait before transitioning to the standby1 power condition when the STANDBY1 bit is set to one. The standby1 condition timer is expired when:

a) The STANDBY1 CONDITION TIMER field is set to zero; or
b) The ~~number of milliseconds~~ time specified by the value in the STANDBY1 CONDITION TIMER field times 100 milliseconds has elapsed since the last activity (e.g., processing any command or performing a self test).

The value in the IDLE2 CONDITION TIMER field specifies the inactivity time in 100 millisecond increments that the logical unit shall wait before transitioning to the idle2 power condition when the IDLE2 bit is set to one. The idle2 condition timer is expired when:

a) The IDLE2 CONDITION TIMER field is set to zero; or
b) The time specified by the value in the IDLE2 CONDITION TIMER field times 100 milliseconds has elapsed since the last activity (e.g., processing a command that requires the active power condition or performing a self test).

The value in the IDLE3 CONDITION TIMER field specifies the inactivity time in 100 millisecond increments that the logical unit shall wait before transitioning to the idle3 power condition when the IDLE3 bit is set to one. The idle3 condition timer is expired when:

a) The IDLE3 CONDITION TIMER field is set to zero; or
b) The time specified by the value in the IDLE3 CONDITION TIMER field times 100 milliseconds has elapsed since the last activity (e.g., processing a command that requires the active power condition or performing a self test).

The value in the STANDBY2 CONDITION TIMER field specifies the inactivity time in 100 millisecond increments that the logical unit shall wait before transitioning to the standby2 power condition when the STANDBY2 bit is set to one. The standby2 condition timer is expired when:

a) The STANDBY2 CONDITION TIMER field is set to zero; or
b) The time specified by the value in the STANDBY2 CONDITION TIMER field times 100 milliseconds has elapsed since the last activity (e.g., processing a command that requires the active power condition or performing a self test).

The IDLE1 CONDITION RECOVERY TIME field specifies the time in 1 millisecond increments that the logical unit takes to transition from the idle1 power condition to the active power condition. This time does not include processing time for the command that caused this transition to occur. A value of zero indicates that the recovery time is not specified. A value of FFh indicates that the recovery time is more than 65.534 seconds.

The STANDBY1 CONDITION RECOVERY TIME field specifies the time in 1 millisecond increments that the logical unit takes to transition from the standby1 power condition to the active power condition. This time does not include processing time for the command that caused this transition to occur or protocol specific (e.g., SAS-2 NOTIFY (ENABLE SPINUP) primitive requirement) waiting time. A value of zero indicates that the recovery time is not specified. A value of FFh indicates that the recovery time is more than 65.534 seconds.

The IDLE2 CONDITION RECOVERY TIME field specifies the time in 1 millisecond increments that the logical unit takes to transition from the idle2 power condition to the active power condition. This time does not include processing time for the command that caused this transition to occur. A value of zero indicates that the recovery time is not specified. A value of FFh indicates that the recovery time is more than 65.534 seconds.

The IDLE3 CONDITION RECOVERY TIME field specifies the time in 1 millisecond increments that the logical unit takes to transition from the idle3 power condition to the active power condition. This time does not include processing time for the command that caused this transition to occur. A value of zero indicates that the recovery time is not specified. A value of FFh indicates that the recovery time is more than 65.534 seconds.

The STANDBY2 CONDITION RECOVERY TIME field specifies the time in 1 millisecond increments that the logical unit takes to transition from the standby2 power condition to the active power condition. This time does not include processing time for the command that caused this transition to occur or or protocol specific (e.g., SAS-2 NOTIFY (ENABLE SPINUP) primitive requirement)

waiting time. A value of zero indicates that the recovery time is not specified. A value of FFh indicates that the recovery time is more than 65.534 seconds.

7.2.11 Start-Stop Cycle Counter log page

This subclause defines the Start-Stop Cycle Counter log page (page code 0Eh). A device server that implements the Start-Stop Cycle Counter log page shall implement one or more of the defined parameters. Table 286 shows the Start-Stop Cycle Counter log page with all parameters present.

Table 286 – Start-Stop Cycle Counter log page

Byte \ Bit	7	6	5	4	3	2	1	0
0	DS	SPF(0b)	PAGE CODE (0Eh)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (34h)						
3								(LSB)
4	(MSB)	PARAMETER CODE (0001h)						
5	Date of Manufacture							(LSB)
6	DU	Obsolete	TSD	ETC	TMC		FMT&LINKING	
7	PARAMETER LENGTH (06h)							
8	(MSB)	YEAR OF MANUFACTURE (4 ASCII characters)						
11								(LSB)
12	(MSB)	WEEK OF MANUFACTURE (2 ASCII characters)						
13								(LSB)
14	(MSB)	PARAMETER CODE (0002h)						
15	Accounting Date							(LSB)
16	DU	Obsolete	TSD	ETC	TMC		FMT&LINKING	
17	PARAMETER LENGTH (06h)							
18	(MSB)	ACCOUNTING DATE YEAR (4 ASCII characters)						
21								(LSB)
22	(MSB)	ACCOUNTING DATE WEEK (2 ASCII characters)						
23								(LSB)
24	(MSB)	PARAMETER CODE (0003h)						
25	Specified cycle count over device lifetime							(LSB)
26	DU	Obsolete	TSD	ETC	TMC		FMT&LINKING	
27	PARAMETER LENGTH (04h)							
28	(MSB)	SPECIFIED CYCLE COUNT OVER DEVICE LIFETIME						
31	(4 byte binary number)							(LSB)
32	(MSB)	PARAMETER CODE (0004h)						
33	Accumulated start-stop cycles							(LSB)
34	DU	Obsolete	TSD	ETC	TMC		FMT&LINKING	
35	PARAMETER LENGTH (04h)							
36	(MSB)	ACCUMULATED START-STOP CYCLES						
39	(4 byte binary number)							(LSB)
40	(MSB)	PARAMETER CODE (0005h)						
41	Specified load-unload count over device lifetime							(LSB)
42	DU	Obsolete	TSD	ETC	TMC		FMT&LINKING	
43	PARAMETER LENGTH (04h)							

44	(MSB)	SPECIFIED LOAD-UNLOAD COUNT OVER DEVICE LIFETIME				
47	(4 byte binary number)					(LSB)
48	(MSB)	PARAMETER CODE (0006h)				
49	Accumulated load-unload cycles					(LSB)
50	DU	Obsolete	TSD	ETC	TMC	FMT&LINKING
51	PARAMETER LENGTH (04h)					
52	(MSB)	ACCUMULATED LOAD-UNLOAD CYCLES				
55	(4 byte binary number)					(LSB)

[Note: Text describing parameters 0001h and 0002h is unchanged and not repeated here. The following log page text is updated to match SPC-4 rev. 16.]

The FORMAT AND LINKING field for log parameter 0003h (i.e., the Specified Cycle Count Over Device Lifetime parameter), log parameter 0004h (i.e., the accumulated start stop cycles), log parameter 0005h (i.e., the specified load-unload count over device lifetime parameter), and log parameter 0006h (i.e., the accumulated load unload cycles) in the Start-Stop Cycle Counter log page shall be set to 11b, indicating that the parameter is a binary format list parameter. The values of the bits and fields in the parameter control byte for binary format list parameters are described in 7.2.1.2.2.3.

The parameter value in the specified cycle count over device lifetime and specified load-unload count over device lifetime log parameters (parameter codes 0003h and 0005h, respectively) ~~shall~~ contain a four-byte binary value that indicates how many stop-start and load-unload cycles may typically be performed over the lifetime of the SCSI target device without degrading the SCSI target device's operation or reliability outside the limits specified by the manufacturer of the SCSI target device. If a LOG SELECT command attempts to change the value of ~~the specified cycle count over device lifetime~~ these log parameters, the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

~~The FORMAT AND LINKING field for log parameter 0003h (i.e., the Specified Cycle Count Over Device Lifetime parameter) in the Start-Stop Cycle Counter log page shall be set to 11b, indicating that the parameter is a binary format list parameter. The values of the bits and fields in the parameter control byte for binary format list parameters are described in 7.2.1.2.2.3.~~

~~The parameter value in the accumulated start-stop cycles log parameter (parameter code 0004h) shall contain a four-byte binary value that indicates how many stop-start cycles the SCSI target device has detected since its date of manufacture. The accumulated start-stop cycles counter is a saturating counter. If a LOG SELECT command attempts to change the value of the accumulated start-stop cycles log parameter, the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST. The time at which the count is incremented during a start-stop cycle is vendor specific. For rotating magnetic storage devices, a single start-stop cycle is defined as an operational cycle that begins with the disk spindle at rest, continues while the disk accelerates to its normal operational rotational rate, continues during the entire period the disk is rotating, continues as the disk decelerates toward a resting state, and ends when the disk is no longer rotating. For devices without a spindle or with multiple spindles, the definition of a single start-stop cycle is vendor specific. The count is incremented by one for each complete start-stop cycle. No comparison with the value of parameter 0003h shall be performed by the device server.~~

~~The FORMAT AND LINKING field for log parameter 0004h (i.e., the Accumulated Start-Stop Cycles parameter) in the Start-Stop Cycle Counter log page shall be set to 11b, indicating that the~~

~~parameter is a binary format list parameter. The values of the bits and fields in the parameter control byte for binary format list parameters are described in 7.2.1.2.2.3.~~

The parameter value in the accumulated start stop cycles log parameter (i.e., parameter code 0004h) and the accumulated load unload cycles log parameter (i.e., parameter code 0006h) contain a four-byte binary value that indicates a number of cycles the SCSI target has detected since its date of manufacture. These counters are saturating counters. The count is incremented by one for each complete cycle. The time in the cycle at which the count is incremented is vendor specific. If a LOG SELECT command attempts to change the value of any of these log parameters, the command shall be terminated with CHECK CONDITION status, with sense key set to ILLEGAL REQUEST and additional sense code set to INVALID FIELD IN PARAMETER LIST.

For rotating magnetic storage devices supporting the accumulated start-stop cycles log parameter (i.e., parameter code 0004h), a single start-stop cycle is defined as an operational cycle that begins with the disk spindle at rest, continues while the disk accelerates to its normal operational rotational rate, continues during the entire period the disk is rotating, continues as the disk decelerates toward a resting state, and ends when the disk is no longer rotating. For devices without a spindle or with multiple spindles, the definition of a single start-stop cycle is vendor specific. No comparison with the value of parameter 0003h shall be performed by the device server.

For rotating magnetic storage devices supporting the accumulated load-unload cycles log parameter (i.e., parameter code 0006h), a single load-unload cycle is defined as an operational cycle that begins with the heads unloaded from the medium, continues while the heads are loaded onto the spinning medium, and ends when the heads are unloaded from the medium. For devices without unloadable heads, this parameter is not applicable. No comparison with the value of parameter 0005h shall be performed by the device server.

7.2.x Power Transitions log page

This subclause defines the Power Transitions log page (page code 1Ah). A device server that implements the Power Transitions log page shall implement one or more of the defined parameters. Table new1 shows the Power Transitions log page with all parameters present.

Table new1 – Power Transitions log page

Byte \ Bit	7	6	5	4	3	2	1	0
0	DS	SPF(0b)	PAGE CODE (1Ah)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (28h)						
3								(LSB)
4	(MSB)	PARAMETER CODE (0001h)						
5	Accumulated transitions to idle1							(LSB)
6	DU	Obsolete	TSD	ETC	TMC	FMT&LINKING		
7	PARAMETER LENGTH (04h)							
8	(MSB)	ACCUMULATED TRANSITIONS TO IDLE1						
11	(4 byte binary number)							(LSB)
12	(MSB)	PARAMETER CODE (0002h)						
13	Accumulated transitions to idle2							(LSB)

14	DU	Obsolete	TSD	ETC	TMC	FMT&LINKING
15	PARAMETER LENGTH (04h)					
16	(MSB)	ACCUMULATED TRANSITIONS TO IDLE2				
19	(4 byte binary number)					(LSB)
20	(MSB)	PARAMETER CODE (0003h)				
21	Accumulated transitions to idle3					(LSB)
22	DU	Obsolete	TSD	ETC	TMC	FMT&LINKING
23	PARAMETER LENGTH (04h)					
24	(MSB)	ACCUMULATED TRANSITIONS TO IDLE3				
27	(4 byte binary number)					(LSB)
28	(MSB)	PARAMETER CODE (0007h)				
29	Accumulated transitions to standby2					(LSB)
30	DU	Obsolete	TSD	ETC	TMC	FMT&LINKING
31	PARAMETER LENGTH (04h)					
32	(MSB)	ACCUMULATED TRANSITIONS TO STANDBY2				
35	(4 byte binary number)					(LSB)
36	(MSB)	PARAMETER CODE (0008h)				
37	Accumulated transitions to standby1					(LSB)
38	DU	Obsolete	TSD	ETC	TMC	FMT&LINKING
39	PARAMETER LENGTH (04h)					
40	(MSB)	ACCUMULATED TRANSITIONS TO STANDBY1				
43	(4 byte binary number)					(LSB)

The DS bit, SPF bit, PAGE CODE field, SUBPAGE CODE field, and PAGE LENGTH field are described in 7.2.1.

The FORMAT AND LINKING field for log parameter 0001h (i.e., the accumulated transitions to idle1 parameter), log parameter 0002h (i.e., the accumulated transitions to idle2 parameter), log parameter 0003h (i.e., the accumulated transitions to idle3 parameter), log parameter 0007h (i.e., the accumulated transitions to standby2 parameter), and log parameter 0008h (i.e., the accumulated transitions to standby1 parameter) in the Start-Power Transitions log page shall be set to 11b, indicating that the parameter is a binary format list parameter. The values of the bits and fields in the parameter control byte for binary format list parameters are described in 7.2.1.2.2.3.

The parameter value for parameter codes 0001h, 0002h, 0003h, 0007h, and 0008h contain a four-byte binary value that indicates a number of cycles the SCSI target has detected since its date of manufacture. These counters are saturating counters. The count is incremented by one for each complete cycle. The time in the cycle at which the count is incremented is vendor specific. If a LOG SELECT command attempts to change the value of any of these log parameters, the command shall be terminated with CHECK CONDITION status, with sense key set to ILLEGAL REQUEST and additional sense code set to INVALID FIELD IN PARAMETER LIST.

For SCSI target devices that support the accumulated transitions to idle1 log parameter (i.e., parameter code 0001h), a single idle1 power transition count is defined as an operational cycle that begins in a power condition other than idle1 and transitions to the idle1 power condition.

For SCSI target devices that support the accumulated transitions to idle2 log parameter (i.e., parameter code 0002h), a single idle2 power transition count is defined as an operational cycle that begins in a power condition other than idle2 and transitions to the idle2 power condition.

For SCSI target devices that support the accumulated transitions to idle3 log parameter (i.e., parameter code 0003h), a single idle3 power transition count is defined as an operational cycle that begins in a power condition other than idle3 and transitions to the idle3 power condition.

For SCSI target devices that support the accumulated transitions to standby2 log parameter (i.e., parameter code 0007h), a single standby2 power transition count is defined as an operational cycle that begins in a power condition other than standby2 and transitions to the standby2 power condition.

For SCSI target devices that support the accumulated transitions to standby1 log parameter (i.e., parameter code 0008h), a single standby1 power transition count is defined as an operational cycle that begins in a power condition other than standby1 and transitions to the standby1 power condition.

SBC-3 changes:

4.16.1 START STOP UNIT and power conditions overview

The START STOP UNIT command (see 5.19) allows an application client to control the power condition of a logical unit. This method includes specifying that the logical unit transition to a power condition.

In addition to the START STOP UNIT command, the power condition of a logical unit may be controlled by the Power Condition mode page (see SPC-4). If both the START STOP UNIT command and the Power Condition mode page methods are being used to control the power condition of the same logical unit, then the power condition specified by any START STOP UNIT command shall override the Power Condition mode page's power control.

There shall be no notification to the application client that a logical unit has transitioned from one power condition to another. The REQUEST SENSE command (see SPC-4) indicates if a logical unit is in the idle power condition or the standby power condition and may indicate if a logical unit is in the stopped power condition.

If the logical unit is in the idle power condition, then the device server shall process a REQUEST SENSE command by:

1) returning parameter data containing sense data with the sense key set to NO SENSE and the additional sense code set to:
   A) LOW POWER CONDITION ON if the reason for entry into the idle power condition is unknown;
   B) IDLE1 CONDITION ACTIVATED BY TIMER if the logical unit entered the idle1 power condition due to the idle1 condition timer (see SPC-4); ~~and~~
   C) IDLE1 CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle1 power condition due to a START STOP UNIT command or receipt of a command requiring the idle1 power condition while it was in ~~the standby~~ a lower power condition;
   D) IDLE2 CONDITION ACTIVATED BY TIMER if the logical unit entered the idle2 power condition due to the idle2 condition timer (see SPC-4);
   E) IDLE2 CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle2 power condition due to a START STOP UNIT command or receipt of a command requiring the idle2 power condition while it was in a lower power condition;
   F) IDLE3 CONDITION ACTIVATED BY TIMER if the logical unit entered the idle3 power condition due to the idle3 condition timer (see SPC-4); or
   G) IDLE3 CONDITION ACTIVATED BY COMMAND if the logical unit entered the idle3 power condition due to a START STOP UNIT command or receipt of a command requiring the idle3 power condition while it was in a lower power condition;

   and
2) completing the REQUEST SENSE command with GOOD status.

If the logical unit is in the standby power condition, then the device server shall process a REQUEST SENSE command by:

1) returning parameter data containing sense data with the sense key set to NO SENSE and the additional sense code set to:
   A) LOW POWER CONDITION ON if the reason for entry into the standby power condition is unknown;
   B) STANDBY2 CONDITION ACTIVATED BY TIMER if the logical unit entered the standby2 power condition due to the standby2 condition timer (see SPC-4);
   C) STANDBY2 CONDITION ACTIVATED BY COMMAND if the logical unit entered the standby2 power condition due to a START STOP UNIT command;

D) STANDBY1 CONDITION ACTIVATED BY TIMER if the logical unit entered the standby1 power condition due to the standby1 condition timer (see SPC-4); ~~and~~ or
E) STANDBY1 CONDITION ACTIVATED BY COMMAND if the logical unit entered the standby1 power condition due to a START STOP UNIT command;

and

2) completing the REQUEST SENSE command with GOOD status.

If the logical unit is in the stopped power condition, then the device server shall process a REQUEST SENSE command by:

1) returning parameter data containing sense data with:
   A) the sense key set to NO SENSE and the additional sense code set to NO ADDITIONAL SENSE INFORMATION; or
   B) the sense key set to NOT READY and the additional sense code set to LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED;

and

2) completing the REQUEST SENSE command with GOOD status.

No power condition shall affect the supply of any power required for proper operation of a service delivery subsystem.

5.19 START STOP UNIT command

Table 60 – START STOP UNIT command

Byte \ Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (1Bh)							
1	Reserved							IMMED
2	Reserved							
3	Reserved				POWER CONDITION MODIFIER			
4	POWER CONDITION				Resvd	N_FLUSH	LOEJ	START
5	CONTROL							

The OPERATION CODE field is defined in SPC-4 and shall be set to the value defined in table 60.

If the immediate (IMMED) bit is set to zero, then the device server shall return status after the operation is completed. If the IMMED bit set to one, then the device server shall return status as soon as the CDB has been validated.

The POWER CONDITION MODIFIER field defined in table 61 is used to specify additional information about the power condition specified in the POWER CONDITION field.

Table 61 — power condition modifier field

power condition field value	Code	Description
All values that are not reserved	0h	Reserved Perform the power condition action specified by the power condition field.
02h (i.e., idle)	0h	Transition the logical unit into the idle power condition.
	1h	Specifies that the device server shall increase the tolerance of the direct access block device to external physical forces Transition the logical unit into the idle2 power condition (e.g., causes a device that has movable read/write heads to move those heads to a safe position).
	2h	Specifies that the device server shall increase the tolerance of the direct access block device to external physical forces (e.g., causes a device that has movable read/write heads to move those heads to a safe position) and should cause the device to use less power than when this field is set to 1h Transition the logical unit into the idle3 power condition (e.g., cause a device that has rotating media to rotate the media at a lower RPM).
All other combinations		Reserved

The power condition field is used to specify that the logical unit be placed into a power condition or to adjust a timer as defined in table 62. If this field is supported and is set to a value other than 0h, then the start and loej bits shall be ignored.

Table 62 — power condition field

Code	Name	Description
0h	START_VALID	Process the START and LOEJ bits.
1h	ACTIVE	Place Transition the device logical unit into the active power condition.
2h	IDLE	Place Transition the device logical unit into the idle power condition.
3h	STANDBY	Place Transition the device logical unit into the standby power condition.
4h	Reserved	Reserved
5h	Obsolete	Obsolete
6h	Reserved	Reserved
7h	LU_CONTROL	Transfer control of power conditions to the logical unit.
8h — 9h	Reserved	Reserved
Ah	FORCE_IDLE_0	Force the idle condition timer to zero.
Bh	FORCE_STANDBY_0	Force the standby condition timer to zero.
Ch - Fh	Reserved	Reserved

The POWER CONDITION field and POWER CONDITION MODIFIER field are used to specify that the logical unit be placed into a power condition as defined in table 61. If the POWER CONDITION field is supported and is set to a value other than 0h, then the START and LOEJ bits shall be ignored.

Table 61 – POWER CONDITION and POWER CONDITION MODIFIER fields

POWER CONDITION value	POWER CONDITION name	POWER CONDITION MODIFIER value	Description
0h	START_VALID	0h	Process the START and LOEJ bits.
1h	ACTIVE	0h	~~Place~~ Transition the ~~device~~ logical unit into the active power condition and disable device server control of power conditions.
02h	IDLE	0h	Transition the logical unit into the idle1 power condition and disable device server control of power conditions.
		1h	~~Specifies that the device server shall increase the tolerance of the direct access block device to external physical forces~~ Transition the logical unit into the idle2 power condition (e.g., cause a device that has movable read/write heads to move those heads to a safe position) and disable device server control of power conditions.
		2h	~~Specifies that the device server shall increase the tolerance of the direct access block device to external physical forces (e.g., causes a device that has movable read/write heads to move those heads to a safe position) and should cause the device to use less power than when this field is set to 1h~~ Transition the logical unit into the idle3 power condition (e.g., cause a device that has rotating media to rotate the media at a lower RPM) and disable device server control of power conditions.
3h	STANDBY	0h	~~Place~~ Transition the ~~device~~ logical unit into the standby1 power condition and disable device server control of power conditions.
		1h	Transition the logical unit into the standby2 power condition and disable device server control of power conditions.
5h		0h	Obsolete
7h	LU_CONTROL	0h	Transfer control of power conditions to the ~~logical unit~~ device server.
Ah	FORCE_IDLE_0	0h	Force the idle1 condition timer to ~~zero.~~ be expired and transfer control of power conditions to the device server.
		1h	Force the idle2 condition timer to be expired and transfer control of power conditions to the device server.
		2h	Force the idle3 condition timer to be expired and transfer control of power conditions to the device server.
Bh	FORCE_STANDBY_0	0h	Force the standby1 condition timer to ~~zero.~~ be expired and transfer control of power conditions to the device server.
		1h	Force the standby2 condition timer to be expired and transfer control of power conditions to the device server.
All other combinations			Reserved

If the START STOP UNIT command is processed with the POWER CONDITION field set to ACTIVE, IDLE, or STANDBY then:

1) the device server shall obey any transport protocol specific (e.g., the SAS-2 NOTIFY (ENABLE SPINUP) primitive requirement) power transition restrictions;
2) the logical unit shall transition to the specified power condition; and

3) the device server shall disable all of the idle condition ~~timer if it is~~ timers that are enabled ~~active~~ (see SPC-4) and disable all of the standby condition ~~timer if it is active~~ timers that are enabled (see SPC-4) until another START STOP UNIT command is processed that returns control of the power condition to the logical unit, or a logical unit reset occurs.

[Note: I changed the abc list to a 123 list. It is important that step 1 be performed first.]

If the START STOP UNIT command is processed with the POWER CONDITION field set to LU_CONTROL, then the device server shall ~~enable~~ activate all of the idle condition ~~timer if it is active~~ timers that are enabled (see SPC-4) and ~~disable~~ activate all of the standby condition ~~timer if it is active~~ timers that are enabled (see SPC-4). The logical unit may not change to a different power condition as a result of processing this command.

If the START STOP UNIT command is processed with the POWER CONDITION field set to FORCE_IDLE_0 or FORCE_STANDBY_0, then the device server shall:

a) force the specified timer to ~~zero~~ be expired, may cause the logical unit to transition to the specified power condition, and return control of the power condition to the device server; or
b) terminate a START STOP UNIT command that selects a timer that is not supported by the device server or a timer that is not ~~active~~ enabled. The device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

If the START STOP UNIT command is processed with POWER CONDITION and POWER CONDITION MODIFIER field values that are supported but is not performed due to a conflicting request (e.g., the device server has a media access command in the task set when a START STOP UNIT command is processed) then the device server may terminate the command with CHECK CONDITION status, the sense key set to ILLEGAL REQUEST, and the additional sense code set to ILLEGAL POWER CONDITION REQUEST.
[alternative: If the START STOP UNIT command specifies a power condition request that conflicts with another request (e.g., the device server has a media access command in the task set when a START STOP UNIT command is processed) then the power condition after completion of the START STOP UNIT command may not be the power condition that was requested.]

It is not an error to specify that the logical unit transition to its current power condition.

If the NO_FLUSH bit is set to zero, then logical units that contain cache shall write all cached logical blocks to the medium (e.g., as they would do in response to a SYNCHRONIZE CACHE command (see 5.20 and 5.21) with the SYNC_NV bit set to zero, the LOGICAL BLOCK ADDRESS field set to zero, and the NUMBER OF LOGICAL BLOCKS field set to zero) prior to entering into any power condition that prevents accessing the medium (e.g., before the rotating media spindle motor is stopped during transition to the stopped power condition). If the NO_FLUSH bit is set to one, then cached logical blocks should not be written to the medium by the logical unit prior to entering into any power condition that prevents accessing the medium.

If the load eject (LOEJ) bit is set to zero, then the logical unit shall take no action regarding loading or ejecting the medium. If the LOEJ bit is set to one, then the logical unit shall unload the medium if the START bit is set to zero. If the LOEJ bit is set to one, then the logical unit shall load the medium if the START bit is set to one.

If the START bit is set to zero, then the logical unit shall:

a) transition to the stopped power condition;
b) disable all of the idle condition ~~timer if it is active~~ timers if they are enabled (see SPC-4); and
c) disable all of the standby condition ~~timer if it is active~~ timers if they are enabled (see SPC-4).

If the START bit set to one, then the logical unit shall:

1) satisfy requirements imposed by transport protocol standards (e.g., the SAS-2 NOTIFY (ENABLE SPINUP) primitive requirement);
2) transition to the active power condition;
3) ~~enable~~ activate all of the idle condition ~~timer if it is active~~ timers if they are enabled; and
4) ~~enable~~ activate all of the standby condition ~~timer if it is active~~ timers if they are enabled.

[Note: I changed the abc list to a 123 list. It is important that the first two items occur before the timers are activated.]