ADI Drive Polling Frames

A Proposal

T10/02-097r1

April 2002

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1 Introduction

The Automation Drive Interface (ADI) provides a means for automated tape libraries to communicate with drives across a serial interface to aid media handling and system management capabilities. The primary basis for the command set is encapsulated SCSI Command Descriptor Blocks (CDBs), but there is also a desire for the interface to support custom command and response frames to facilitate the retrieval of more consolidated and concise information tailored to the automation environment. The goal of this document is to propose potential response formats that can be used for this purpose.

Towards that end, the type of information typically needed by the library has been grouped into four different categories. The categories are:

- **Very high frequency data** – drive and tape motion status, issued during load/unload operations and possible runtime monitoring situations.
- **High frequency data** – values that can change throughout the duration of a cartridge being loaded such as Tape Alert flags and data counters, but are less time critical.
- **Low frequency data** – information needed perhaps once after a cartridge is loaded or unloaded.
- **Very low frequency data** – information needed perhaps once for the drive, during initialization or equivalent.

Candidate data for the different types is presented, and if the data is not reasonably available via encapsulated SCSI commands, a response frame is proposed. Some data that is better suited for encapsulated SCSI, but which may not be currently available, is listed for consideration in future definitions of SSC.
[Note: Per the ADI conference call on 4/15/02, we have the intent to represent all data via encapsulated SCSI. This document does not yet reflect that goal.]

By utilizing these drive polling frames in addition to the encapsulated SCSI CDBs, the hope is that interference with data path operations can be avoided, allowing the drive to concurrently support these requests while continuing to handle primary data path operations. These frames also allow some data to be gathered in a more condensed form, rather than issuing multiple SCSI commands and incur additional overhead.

In addition to these response frames, a Control Frame is also described which tells the library how the drive supports the polling frames.

1.1 Remaining Actions

This is just a quick list to capture where this is headed.

- An example state diagram using the Very High Frequency status can be developed.
- Initial data not presented in a frame needs to be investigated for availability via existing SCSI, and if not available (and still desirable), develop proposals for locating it (either in standard SSC, SPC, or ADI Device Type unique).
- Data that is presented in a frame needs to be mapped into encapsulated SCSI to support a pure encapsulation methodology.

- After discussion, the surviving contents of this document need to be transferred to the ADC specification.

2 Very High Frequency Data

The goal of this response frame is to define the most critical information that is needed the most frequently during normal operation such that it can be as concise and condensed as possible for performance.

Table 1 shows the Very High Frequency Data response format.

Bit Byte	7	6	5	4	3	2	1	0
0	Status Valid	Rsvd	Rsvd	Compress	Write Protect	Clean Requested	Clean Required	Drive Initialized
1	Access Allowed	Unload Complete	Load Complete	Media Present	Media Ejected	MAM Accessible	Media Seated	Media Threaded
2	Tape Motion Status							
3	Rsvd	Rsvd	Rsvd	Rsvd	Error	Error Changed	Interface Changed	TapeAlert Changed

Table 1 Very High Frequency Data Response Format

The fields are described below.

BYTE 0:

Status Valid – A value of 1 indicates that the contents of this response frame are valid; a value of 0 indicates that the status may still be changing and the contents may not be valid. This field is reset for each request.

Compress – A value of 1 indicates that the drive currently has data compression enabled; a value of 0 indicates that it is not. This field should reflect the value of the Data Compression Enable (DCE) bit of the Data Compression Mode Page.

Write Protected – A value of 1 indicates that any currently present media is physically write protected; a value of 0 indicates that it is not. This field is only valid if Media Present is 1, and should be set to 0 when not media is present in the drive. "Physically write protected" refers to any mechanism used within the media shell itself to write protect the media, such as sliding windows or tabs, and not logical states of write protection issued by command to the drive.

Clean Requested – A value of 1 indicates that the drive has requested a head cleaning; a value of 0 indicates that no cleaning is requested.

Clean Required – A value of 1 indicates that a head cleaning operation must be done before a data cartridge can be loaded, such that normal operation may not be possible. A value of 0 indicates that urgent cleaning is not required.

Drive Initialized – A value of 1 indicates that the drive is ready for operation; a value of 0 indicates drive initialization is required or incomplete.

BYTE 1:

[Note: a TBD state machine diagram would be helpful to demonstrate the use of these bits]

Access Allowed – A value of 1 indicates that the library may move media to or from the drive. A value of 0 indicates that the library should not move media to or from the drive. The drive should indicate that access is allowed by the robotics if it is reasonably certain that media can be successfully inserted into or removed from the drive. This field is not intended to reflect the value of any Prevent/Allow Media Removal command settings.

Unload Complete – A value of 1 indicates that the drive has finished all processing for an unload operation. It is reset at the beginning of the next load operation (Unload remains complete until beginning of the next load cycle). A value of 0 is indeterminate (unload or load may be in progress). This field anticipates the existence of an *Unload* command, and this field is used to indicate its completion. *[Used to reflect SCSI initiated unload completion?]*

Load Complete – A value of 1 indicates that the drive has finished all processing for a load operation. It is reset at the beginning of the next unload operation (Load remains complete until the beginning of the next unload cycle). A value of 0 is indeterminate (load or unload may be in progress).

Media Present – A value of 1 indicates that the drive detects the presence of media; a value of 0 indicates that the drive does not detect any media present. This would typically be a direct reflection of some type of hardware sensor.

Media Ejected – A value of 1 indicates that the drive has media in the ejected position. A value of 0, in conjunction with a Media Present value of 1, indicates that media is inserted into the drive (present and not ejected). This field may or may not reflect a hardware sensor, and may only be based on "last known" position, such that this field could be set to 1 while Media Present is set to 0. If this is the case, then this field would be reset to 0 as early in the next Load cycle as possible (first media presence detection for example).

MAM Accessible – A value of 1 indicates that the media is located within the drive at a position where the Media Auxiliary Memory can be accessed. A value of 0 indicates that the MAM cannot be accessed. This field would only be valid for drives and media that support MAM. If supported, this field should only be set to 1 in conjunction with Media Present. This field may reflect a unique position within the drive that occurs prior to fully seating or threading the media. When set to 1, the drive should also support MAM access commands at that point.

Media Seated – A value of 1 indicates that the media is mechanically seated within the loading mechanism. This means that the physical loading process has completed. A value of 0 indicates that the media is not seated, and that further mechanical motion remains in order to complete the loading process (exclusive of tape threading).

Media Threaded – A value of 1 indicates that the media has been threaded by the drive, such that tape motion operations are possible. This may or may not correspond to the drive responding "Ready" to a SCSI Test Unit Ready command, as additional processing may be required by the drive after threading to achieve a SCSI "Ready" state.

BYTE 2:

Tape Motion Status – This field describes the current activity of the tape itself as follows:

- 00h No tape motion in progress
- 01h Cleaning operation in progress
- 02h Firmware upgrade in progress
- 03h Tape is being loaded
- 04h Tape is being unloaded
- 05h Tape in motion
- 06h Reading
- 07h Writing
- 08h Locating
- 09h Rewinding
- 0Ah-7Fh Reserved
- 80h-FFh Vendor Unique status

BYTE 3:

Error – A value of 1 indicates that the drive is in an error state; a value of 0 indicates it is not. This is a persistent field, such that it remains set to 1 as long as the drive remains in an error state (it is not reset upon reading it). It is reset to 0 when the drive no longer has an error condition. This field can be used to indicate a hardware error, media error, or both.

Error Changed – A value of 1 indicates that the reason of an Error condition has changed, such that the library may want to retrieve additional error information. This field is reset to 0 upon reading the error information. *[Source of error information is TBD]*.

Interface Changed – A value of 1 indicates that the Interface Status has changed since the last retrieval of the Interface Status frame. *[The Interface Status frame is TBD, but should contain status on active ports, etc.]* This field is reset to 0 after retrieval of the Interface Status frame.

TapeAlert Changed – A value of 1 indicates that at least one TapeAlert flag has changed since the last retrieval of the High Frequency Tape Alert Response Data frame. This field is reset to 0 after retrieval of the Response Data frame.

3 High Frequency Data

The goal of these response frames is to support monitoring of data that can change throughout the duration of a media load and that can provide feedback about the health of the drive and media combination.

The first group of data is information relating to Read and Write performance. This data is better suited to encapsulated SCSI, and is listed for reference purposes to determine availability via SCSI. Some of this information is available today in various Vendor Unique Log Pages, and may be suitable for consideration as part of standard SSC.

The second group of data is presented as a frame, as it contains a condensed version of the Tape Alert information.

3.1 Read and Write Performance Data

This data is to be investigated for availability via encapsulated SCSI.

Temporary Drive Read Errors – The current recovered drive read errors.

Permanent Drive Read Errors – The current unrecovered drive read errors.

Temporary Drive Write Errors – The current recovered drive write errors.

Permanent Drive Write Errors – The current unrecovered drive write errors.

Read Compression Ratio – The current drive read compression ratio (x 100).

Write Compression Ratio – The current drive write compression ratio (x 100).

Temporary Tape Read Errors – The current recovered tape read errors.

Permanent Tape Read Errors – The current unrecovered tape read errors.

Temporary Tape Write Errors – The current recovered tape write errors.

Permanent Tape Write Errors – The current unrecovered tape write errors.

3.2 Tape Alert Response Data Frame

Table 2 shows the High Frequency Tape Alert Data response format.

Bit Byte	7	6	5	4	3	2	1	0
0	FLAG 08	FLAG 07	FLAG 06	FLAG 05	FLAG 04	FLAG 03	FLAG 02	FLAG 01
1	FLAG 16	FLAG 15	FLAG 14	FLAG 13	FLAG 12	FLAG 11	FLAG 10	FLAG 09
2	FLAG 24	FLAG 23	FLAG 22	FLAG 21	FLAG 20	FLAG 19	FLAG 18	FLAG 17
3	FLAG 32	FLAG 31	FLAG 30	FLAG 29	FLAG 28	FLAG 27	FLAG 26	FLAG 25
4	FLAG 40	FLAG 39	FLAG 38	FLAG 37	FLAG 36	FLAG 35	FLAG 34	FLAG 33
5	FLAG 48	FLAG 47	FLAG 46	FLAG 45	FLAG 44	FLAG 43	FLAG 42	FLAG 41
6	FLAG 56	FLAG 55	FLAG 54	FLAG 53	FLAG 52	FLAG 51	FLAG 50	FLAG 49
7	FLAG 64	FLAG 63	FLAG 62	FLAG 61	FLAG 60	FLAG 59	FLAG 58	FLAG 57

Table 2 High Frequency Tape Alert Data Response Format

The fields represent the various Tape Alert flags. The Tape Alert flags should be maintained independently for the library, and reading them from the library should not impact the primary data side (host). The corollary should be true for flags maintained for the host side.

4 Low Frequency Data

The goal of these response frames is to provide information that changes infrequently, but in a consolidated form. One frame focuses on drive information while the other focuses on the media.

4.1 Drive Information Data

This data is to be investigated for availability via encapsulated SCSI.

Total Load Count – The total number of loads the drive has performed during its lifetime.

Total Clean Count – The total number of cleans the drive has performed during its lifetime.

Elapsed Clean Time – The number of hours since the last cleaning operation.

Power On Hours – The total number of power on hours for the drive's lifetime.

For the last two, the type of hours tracked could be expanded to include tape motion hours, and consideration for total meters of tape pulled past the heads might be worthwhile as a way to indicate overall usage.

4.2 Media Information Data

This data is to be investigated for availability via encapsulated SCSI. This data is relevant to a single piece of media currently loaded in the drive.

Total Load Count – The total number of loads a cartridge has had. In the case of cleaning media, this indicates the number of times a cleaning cartridge has been used.

Media Type – This indicates the type of cartridge as follows:

- Data cartridge
- Firmware cartridge
- Cleaning cartridge

Format Type – This is used in conjunction with Media Type to further refine the type of media. This is Vendor Unique and can be used to describe media length, format, generation, or other format qualifiers.

Cleans Remaining – This is only valid for cleaning media and indicates the remaining number of times a cleaning cartridge can be used.

5 Very Low Frequency Data

At this time, the encapsulated SCSI commands seem sufficient to accommodate this category.

6 Control Frame

In order to provide a way for the drive to indicate what support it has for the drive polling frames, as well as other capabilities, a Control Frame is defined as shown in Table 3.

Bit Byte	7	6	5	4	3	2	1	0
0	Rsvd	Rsvd	Rsvd	Rsvd	MC Protocol	Encaps Protocol	Basic Protocl	Legacy Protocol
1	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd	HFTA Valid	VHF Valid
2 3	VHF Polling Delay							
4	HFTA Polling Delay							

Table 3 Drive Polling Control Frame

The fields are described below.

BYTE 0

Legacy Protocol – A value of 1 indicates that the drive supports its previous library serial interface protocol, as applicable. A value of 0 indicates that it does not. This protocol may be supported concurrently with other protocols.

Basic Protocol – A value of 1 indicates that the drive supports the basic non-encapsulated Automation Drive Interface protocol (TBD). A value of 0 indicates that it does not. This protocol may be supported concurrently with other protocols.

Encaps Protocol – A value of 1 indicates that the drive supports the encapsulated SCSI Automation Drive Interface protocol. A value of 0 indicates that it does not. This protocol may be supported concurrently with other protocols. If supported, the library should query the drive as to the supported command set within the protocol.

MC Protocol – A value of 1 indicates that the drive supports passing Medium Changer commands to the library via this interface, representing the medium changer as a LUN. This protocol may be supported concurrently with other protocols.

Based on what protocol(s) the drive supports, the library would then negotiate and/or decide which to use. Drives may or may not simultaneously support more than protocol.

BYTE 1

Very High Frequency (VHF) Valid – A value of 1 indicates that this response frame is supported; a value of 0 indicates it is not.

High Frequency Tape Alert (HFTA) Valid – A value of 1 indicates that this response frame is supported; a value of 0 indicates it is not.

BYTE 2-3

VHF Polling Delay - The minimum delay in milliseconds the library must wait before requesting another Very High Frequency data response frame.

BYTE 4

HFTA Polling Delay - The minimum delay in seconds the library must wait before requesting another High Frequency Tape Alert data response frame.