Digital Video Recorder
Serial Control Protocol

Applies to
Omega HD™, Elite HD™, Micron HD™, HD3™, Q™,
Omega Deck™, DigiDeck™, Mini DVR Pro™, FieldPro™ DVR,
NDT 200™ DVR, Recon™ and Outrider™ DVR Products

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1. OVERVIEW

1.1 COMMUNICATION PROTOCOL

Fast Forward Video's series of digital video recorders implements remote control over a 9 pin D-subminiature connector. This 9 pin connector supports serial communication conforming to the industry standard electrical interface, data format, and command protocol used by Sony and other manufacturers.

Electrical Interface:

- EIA RS-422 or EIA RS-232, depending on DVR product configuration

Data Format:

- 38,400 bits per second (38.4 kbps)
- Asynchronous, full duplex communications
- 8 data bits, odd parity, 1 stop bit.

Contact Fast Forward Video if you need to change the bit rate and parity for your application.

Where possible, the recorder's commands are identical to those used by a Sony BVW-75 video tape recorder. For a comprehensive explanation of these commands, refer to *Protocol of Remote-1 (9-pin) Connector, 2nd Edition*. This document is available for purchase from Sony at (800) 538-7550 (USA). Order document number 9-977-544-13. However, many of the recorder's capabilities are not accessible through this command set. Fast Forward Video has implemented extensions to the existing protocol to support this additional functionality.

1.2 COMMAND BLOCK FORMAT

1 byte		1 byte	1 byte	n-2 bytes	1 byte	1 byte
Bits 7-4	Bits 3-0					
CMD-1	DATA COUNT	CMD-2	DATA-1	• • •	DATA-n	CHECKSUM

Summary of CMD-1 Categories

CMD-1 (hex)	Function	Direction
0	System control	To recorder
1	System control return	From recorder
2	Transport control	To recorder
4	Preset & select control	To recorder
6	Sense request	To recorder
7	Sense return	From recorder
A	Odetics / Panasonic "auto mode" extensions	To recorder
F	Fast Forward Video extensions	Bi-directional

Summary of Fast Forward Video Extensions

CMD-1 (hex)	CMD-2 (hex)	Function
F4	00	Status request
F1	01	Configuration request
F3	02	Configuration set
FA	03	Select play list
F2	04	Play list read request
F3	05	Format disk
F3, FF	06	Copy play list to clip or copy clip, play list or disk
FF	07	Delete
F1, F4, F5	08	Directory read request
F4	09	Title request
F6	0A	Go to
F0	0B	Save play list
F4	0C	Play speed
F6	0D	Read clip / play list features
F6	0E	Set clip / play list features
F8	0F	Chase enable
F0	20 - 21	Time lapse interval request
F4	20	Set time lapse interval – frames form
F4	21	Set time lapse interval – time code form
F0	24	Read real time clock time / date (not Omega Deck)
F7	24	Real time clock time / date set (not Omega Deck)
F0	25	Time / date read (not Omega Deck)
F0	26 - 29	Read user data fields
FF, F4	26-27, 28-29	Set user data fields
F7	2C	File operation (Convert native clip to QuickTime)
F5	2D	Disk parameter set
01	2F	Enter firmware update mode
F0	30	Event start (for Event Recording)
F0	31	Event mark
F0	40	Get device state
F6	42	Control device state
F1	4F	Disk power down
Fx	80	Status response
F3	81	Configuration response
FC	82	Boot code revision date response
FC	83	Firmware revision date response
FF	84	Play list message
F4	86	PCB revision response
FF	87	Disk info response
FD	88	Directory read response
FF	89	Title message
F6	8D	Clip / play list features response
F4	8E	Serial number response
F2	8F	Exception message
F4	A0 - A1	Time lapse interval response
F7	A4 - A5	Time / date read response (not Omega Deck)
FF, F4	A6-A7, A8-A9	User data fields response
F4	C0	Device state response

For further explanation, see the descriptions for the individual commands elsewhere in this document.

1.3 CHECKSUM

Note that the final byte in these commands is always a modulo-256 checksum, which is the sum of all bytes of the command not including the checksum byte itself. This checksum byte is included in the command tables that follow for commands that do not contain variable data. For example, the PLAY command consists of three bytes, 20 01 21. In this command, the third byte, 21, is the checksum. For commands and responses that contain variable data, the checksum byte is denoted in the tables as ***uu***.

1.4 ACK / NAK

The command descriptions and tables that follow often refer to an *ACK* or *NAK.* The recorder returns an ACK (acknowledge) or NAK (negative acknowledge) for commands that do not return a specific response containing, for example, time code or status information. There are different forms of a NAK for different communication errors.

	Data (hex)	Explanation
ACK	10 01 11	Command recognized. Recorder is attempting to perform the action called for in the command.
NAK	11 12 01 24	Command not supported or command not recognized due to communication error.
	11 12 02 25	Software overrun due to sending another command before previous command completed.
	11 12 04 27	Command had incorrect checksum.
	11 12 10 33	Parity error on serial line.
	11 12 20 43	Overrun error on serial line.
	11 12 40 63	Framing error on serial line.
	11 12 80 A3	Command timed out (not sent within 10 ms).

1.5 PROTOCOL TIMING

The communication protocol is a master-slave protocol between a “controller” (master) and the recorder (slave, or “device” in the Sony documentation). Except as noted in Sections 3.6 and 4.2 for Serial Port 0, the recorder only responds to commands issued by the controller.

The controller must maintain the single command - single response synchronization of the communication protocol. The controller must not transmit additional command data to the recorder prior to receiving a complete response from the recorder for the previous command. The controller must not interrupt transmission of bytes in a command data stream for more than 10 milliseconds. If the recorder detects errors, additional data or drop-outs in the command data stream, it will respond with the appropriate NAK. Upon receiving a NAK, the controller must immediately cease transmission and wait 10 milliseconds while the recorder recovers (the recorder will not accept command data during this 10 millisecond interval).

The Sony documentation indicates that the "device" must respond to the controller within 9 milliseconds. This is not the case for certain commands issued to FFV digital video recorders. In addition, although the recorder may respond with an ACK, this may not indicate a command has completed. Certain command processes take much longer, and the ACK merely indicates to the controller that the command was accepted. The controller can issue status request commands to the recorder to detect the completion of these longer time-domain processes (e.g., cueing operations and motion commands which change the recorder's state, disk formatting operations, etc.).

1.6 TIME CODE

Except for the pure binary format time code returned in the STATUS BLOCK, Section 4.1, commands and responses use a binary coded decimal (BCD) format for time code. This time code information is formatted as *ff ss mm hh*, where *ff* is frames, *ss* is seconds, *mm* is minutes, and *hh* is hours. In this BCD format, the upper most-significant nibble (4 bits) of each byte encodes the decimal tens value while the lower least-significant nibble encodes the decimal ones (units) value for each time code quantity. For example, time code 01:22:33:15 (decimal) would be formatted in hexadecimal as 15 33 22 01.

In addition, bit 6 (40 hex) will be set in the frames byte to indicate drop-frame format time code. The state of this bit will affect internal duration calculations performed by the recorder, as does the current configured frame rate setting.

1.7 LOCAL DISK AND MOE™ SOFTWARE NATIVE DISK FORMAT

The recorder stores video and other data required for operation on one or more SCSI (Omega Deck) or ATA/IDE (non-Omega Deck hardware) hard disks.

The recorder formats and maintains these disks using Fast Forward Video's Multimedia Operating Environment (MOE) software. The proprietary MOE Disk Format is optimized for maximum performance of the storage media assuming a model of sustained data transfer. Continuous uninterrupted data flow is key in recording and replaying high quality video. The data structure of the proprietary MOE Disk Format is available from FFV under non-disclosure agreement in the "MOE Disk Format Specification" document.

1.8 WINDOWS/DOS FAT32 FILE SYSTEM

In 2004, Fast Forward Video added support for recording video to disks formatted in the common Windows/DOS file system known as FAT32. This allows a standard PC to access the drive and to copy video files that were recorded by the digital video recorder from the hard disk. The data structure of the FAT32 file system is described in the "Microsoft Extensible Firmware Initiative FAT32 File System Specification" document available from Microsoft at the following URL:

http://www.microsoft.com/whdc/system/platform/firmware/fatgen.mspx

While it is theoretically possible for a PC also to copy video files TO a hard disk for playback by the digital video recorder, this functionality is not supported at this time. The DVR also does not support loading a hard disk with a changed volume ID or files that have been moved or renamed. The disk must be formatted by the DVR so it contains the extra information needed for proper DVR operation.

The MOE software creates files with short file names of the following format: RTIIISSS.EEE, where:

R = "R" for 'Record';
T = Record type: "A" for Available, "I" for Index, "M" for Media, and "Q" for QuickTime;
III = ASCII MS-DOS 8.3 filename character set encoded Record MOE ID number;
SSS = ASCII 8.3 encoded sequence number for Records of the same MOE ID number;
EEE = file name extension: "FFV" for native MOE Disk Format Records, or "MOV" for QuickTime files.

(See Section 5.2 for a description of file MOE IDs and MOE Disk IDs.) In addition to the short file name, QuickTime files will have a long file name corresponding to the clip title plus a space and a five character decimal sequence number. This sequence number will place the individual files in the sequence recorded. FAT32 formatted disks will have a volume label in a similar structure as a short file name above, with a Record type of "D" for Disk, a four character ASCII hexadecimal MOE Disk ID, two ASCII zeros, and "FFV" as the last characters.

1.9 QUICKTIME FILE FORMAT

In addition to support for the FAT32 file system, Fast Forward Video's firmware also supports recording directly to QuickTime files.

Currently, Fast Forward Video's High Definition DVRs produce a proprietary JPEG 2000 image compression format that requires conversion or transcoding to be viewed in an NLE system. A QuickTime Component is available at *http://www.ffv.com/page/support.htm* which allows you to use any Apple QuickTime library-based application to open, view and convert these FFV HD files. The recommended Mac specifications are: 8 Core / 2.8 GHz / 10 GB or better.

The use of FAT32/QuickTime allows a PC not only to copy files that were recorded on the digital video recorder, but also to play and edit these files directly using readily available software that runs on an IBM compatible or Apple PC. The data structure of the QuickTime file format is described in the "QuickTime File Format" document available from Apple Computer at the following URL:

http://developer.apple.com/documentation/QuickTime/QTFF/qtff.pdf

Note that the user may configure the digital video recorder to record video using:

1. the proprietary MOE file system and file format;
2. the FAT32 file system and MOE file format;
3. the FAT32 file system and QuickTime file format.

QuickTime files on the MOE file system are not supported. In other words, QuickTime files must be recorded on FAT32 formatted disks.

Once a disk is formatted as a Windows/DOS FAT32 disk, the user must either:

1. enable the creation of QuickTime files upon clip recording completion (closure); or
2. convert a native MOE clip to one or more QuickTime files.

Because of the file size limitations of the FAT32 file system, long clips will be converted to multiple QuickTime files as necessary.

1.10 VIDEO COMPRESSION AND IMAGE QUALITY

The recorder compresses video frames using the JPEG (Joint Photographic Experts Group) algorithm before storing the video to hard disk for random-access playback. There is an inverse relationship between compression level and image quality, with a threshold for most images occurring at about 5:1 compression where compression artifacts are invisible. At compression levels lower than this threshold (less compression, larger frame sizes), there is no visible improvement in image quality.

The user may set the desired compression level using the ***Target frame size*** item with the ***CONFIGURATION SET*** command.

The ***Target frame size*** field establishes a constant data rate for recording with the benefit of allowing the recorder to increase the image quality on less complex frames and to scale it back as necessary to stay within the limits of the hard disk. A constant data rate also enables the user to predict the amount of time available to record within the available space on disk.

1.11 ADDITIONAL CAPABILITIES AND LIMITATIONS

This document describes many configuration items and commands that implement advanced features of Fast Forward Video's digital video recorders. Some of these advanced features include:

- Play list creation and manipulation for random-access user defined playback order of recorded video material in real time. This allows video material stored on the recorder to be played back in a continuous stream without interruption when transitioning to a new section of source video material. This is described in Section 5.
- Loop recording and event capture recording that allows for continuous recording operation without termination at the end of storage media.
- Loop playback of selected video material for repeated or unattended playback situations.
- Various time code and real-time clock options on selected hardware.
- Video overlay of time code, real-time clock, date and user defined data as recorded and stored with video material on selected hardware. Some hardware also supports inclusion of GPS position data with the video material.

With the continuing increase in the storage capacities of hard disk media, integrators creating systems using Fast Forward Video digital video recorders should be aware of the sizing limitations of the hardware they intend to use. Please contact Fast Forward Video to find out what limitations to recording and playback are applicable to such hardware, and what options are available to help overcome these limitations.

2. MOTION CONTROL

2.1 TRANSPORT COMMANDS

The recorder responds to all of the following commands with an ACK or NAK.

Command	Data (hex)	Explanation
STOP	20 00 20	
PLAY	20 01 21	Play forward at 1X play speed.
REC	20 02 22	
FAST FWD	20 10 30	Native mode: seek to last frame in play list BVW-75 mode: seek to last frame recorded in current Odetics ID.
STEP FWD	20 14 34	Advance one frame forward.
REWIND	20 20 40	Native mode: seek to first frame in play list BVW-75 mode: shuttle reverse at 30X play speed to first frame in ID.
STEP REV	20 24 44	Step one frame back.
CUE UP WITH DATA	24 31 ff ss mm hh uu	Cue to the specified frame. Always relative to the first frame of the play list. For example, to cue to time 01:22:33:15: 24 31 15 33 22 01 C0
FULL EE OFF	20 60 80	Has no effect.
FULL EE ON	20 61 81	Switch to pass-through mode, where video at configured video inputs is visible at the video outputs.
EJECT	20 0F 2F	Has no effect.

Please note that during recording, because of the demands placed on the disk, other commands which access the disk should not be issued until the recording is completed, as indicated by the change of state in the motion indicators in the STATUS SENSE DATA and STATUS BLOCK. Such commands include directory, play list and title commands (Section 5) that refer to material stored on disk, DELETE (Section 6.3) and FORMAT DISK (Section 6.4).

2.2 VARIABLE SPEED COMMANDS

The following commands specify a playback speed. The recorder behaves identically for all of the following commands: it immediately starts playing at the specified speed.

The data byte(s) of the command conform to Sony's arcane formula for speed data. One byte or two bytes of speed data may be provided. Two-byte speed data gives greater speed resolution, most useful at lower play speeds.

As a point of reference, 40 hex defines normal playback speed; 20 hex defines 1/10 play speed; 60 hex defines 10 times play speed.

Command	Data (hex)
JOG FWD	21 11 xx uu 22 11 xx xx uu
VAR FWD	21 12 xx uu 22 12 xx xx uu
SHUTTLE FWD	21 13 xx uu 22 13 xx xx uu
JOG REV	21 21 xx uu 22 21 xx xx uu
VAR REV	21 22 xx uu 22 22 xx xx uu
SHUTTLE REV	21 23 xx uu 22 23 xx xx uu

2.3 TIME COMMANDS

The following commands retrieve a time code from the recorder. Within the response, the time information is formatted as described in Section 1.6.

Command	Data (hex)	Response
CURRENT TIME SENSE	61 0C 01 6E 61 0C 10 7D	74 04 ff ss mm hh uu 74 05 xx xx xx xx uu (user bit data)
IN DATA SENSE	60 10 70	74 10 ff ss mm hh uu
OUT DATA SENSE	60 11 71	74 11 ff ss mm hh uu
PREROLL TIME SENSE	60 31 91	74 31 ff ss mm hh uu

The following command to set the time code of the time code generator, while accepted, currently has no effect.

TIME CODE PRESET	44 04 ff ss mm hh uu

Use the following command to set the User Bits in video being recorded. This data is stored with the [illegible]

COMMAND DISABLED

USER BIT PRESET	44 05 xx xx xx xx uu

2.4 STATUS SENSE COMMAND

STATUS SENSE	61 20 xx uu

The data byte (xx) of this command specifies which status bytes the recorder will send. The most-significant four bits indicate the first byte to be returned. The least-significant four bits indicate the number of status bytes to send. For example, a data byte of 25 hex causes the recorder to send bytes 2 through 6.

The recorder responds with the following message that contains the variable number of status bytes (ss) requested.

STATUS DATA	7x 20 ss .. uu

The format of status data is as follows. Positions that contain no entry are always zero.

Byte No.	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Busy					Hard Error		Local
1	1		Stop		Rewind	Fast Forward	Record	Play
2	Servo Lock		Shuttle	Jog	Variable Play	0=fwd 1=rev	Still	Cue Complete
3	Auto Mode						Out Preset	In Preset
4	Select EE On	Full EE On		Edit	Review		Preview	Preroll
5		Insert		Video		Time Code	Audio Ch. 2	Audio Ch. 1
6								
7								
8				Tape End				
9							Preview Out Preset	Preview In Preset
...								
0D	Start of Timeline	End of Timeline						

2.5 EDITING COMMANDS

The recorder is not intended to replace a record deck in a conventional linear editing configuration. For compatibility with existing linear edit controllers and operators, however, the recorder supports the editing commands defined below. **Note that these commands work only when the recorder is in BVW-75 mode.** You may set the recorder in BVW-75 mode on the front panel under SETTINGS – PERSONALITY, or by sending a native mode configuration command as described in Section 3.

In linear editing, an edit controller cues one or more source decks plus a record deck to a preroll point, which is some fixed number of frames ahead of a user-specified edit-in point. The edit controller then starts all decks playing. During the preroll period, the edit controller adjusts the speed of the decks as necessary to synchronize them. At the magic edit-in point, the edit controller switches the record deck into record mode. At the edit-out point, the edit controller switches the record deck out of record mode. This mechanical juggling act results in a recording of a precise length at a precise position on the tape in the record deck. In the linear tape based world, editing means making precise recordings.

A device that supports truly random-access, or non-linear, playback makes this process obsolete.

The recorder supports a much faster and more flexible form of editing by allowing the user to specify a *play list*. In this non-linear form of editing, the user does not painstakingly re-record small sections of the source material in a desired order. Instead, the user simply records the desired source material in any convenient order. The user then defines how this material shall be played in a play list, which is simply a list of starting and ending frames for each segment in order. Please refer to Section 5, **PLAY LIST COMMANDS**, for a complete explanation of how to use the recorder in this manner.

The recorder responds to all of the following commands with an ACK or NAK.

Command (see *)	Data (hex)	Explanation
PREROLL	20 30 50	Cue before the EDIT IN frame by the number of frames specified with the PREROLL TIME PRESET command. By default, the preroll time is set to five seconds.
PREVIEW	20 40 60	Cue to the PREROLL frame, play to the EDIT OUT frame, then stop.
REVIEW	20 41 61	Same as PREVIEW
SELECT EE ON	20 63 83	Switch to pass-through mode.
EDIT OFF	20 64 84	Stop recording.
EDIT ON	20 65 85	Start recording. Includes an intentional 3-frame latency to match the behavior of a BVW-75 tape deck. For this command to work as expected, the recorder MUST BE IN BVW-75 mode and this command must be preceded by a VIDEO REFERENCE DISABLE OFF command.
IN ENTRY	40 10 50	Set the edit-in point to the current position.
OUT ENTRY	40 11 51	Set the edit-out point to the current position.

Command (see *)	Data (hex)	Explanation
IN PRESET	44 14 ff ss mm hh uu	Set the edit-in point to the specified frame: ff frames ss seconds mm minutes hh hours
OUT PRESET	44 15 ff ss mm hh uu	Set the edit-out point to the specified frame.
EDIT PRESET	41 30 xx uu 42 30 xx xx uu	Has no effect. The recorder supports insert editing only, and always records video and all channels of audio.
PREROLL TIME PRESET	44 31 ff ss mm hh uu	Set the preroll time as specified.
TAPE/AUTO SELECT	41 32 xx uu	Currently not supported.
VIDEO REFERENCE DISABLE OFF	40 48 88	Causes the recorder to reference the video at the configured video input during playback.
VIDEO REFERENCE DISABLE ON	40 49 89	Causes the recorder to ignore video at the configured video input during playback. This is the default behavior of the recorder.

*** Note that these commands work only when the recorder is in BVW-75 mode.**

Please note that the controller convention for specifying the time code for an out point for recording or play back is ***one frame past*** the last frame recorded or displayed.

2.6 ODETICS PROTOCOL

The following commands support ***Auto Mode*** playback on the recorder. For a complete explanation of these commands, refer to *Video Disk Recorder Command and Control Specification*, Document number 4136201-F, 6/16/98, available from Odetics Broadcast.

Several commands in the following tables contain time code information. This time information is formatted as described in Section 1.6.

The commands in this table work when the recorder is configured either in Native Mode or in BVW-75 Mode and ***Auto Mode is enabled using the AUTO MODE ON command***.

Command	Data (hex)	Explanation
CUE UP WITH DATA	20 31 51	Cue for playback at 00:00:00:00.
IN ENTRY	40 10 50	Set the in preset to the current position.
OUT ENTRY	40 11 51	Set the out preset to the current position.
IN PRESET	40 14 54 44 14 ff ss mm hh uu	Set the in preset to 00:00:00:00. Set the in preset to the specified frame.
OUT PRESET	44 15 ff ss mm hh uu	Set the out preset to the specified frame.
IN SHIFT +	40 18 58	
IN SHIFT -	40 19 59	
OUT SHIFT +	40 1A 5A	
OUT SHIFT -	40 1B 5B	
IN RESET	40 20 60	Set the in preset to 00:00:00:00.
OUT RESET	40 21 61	Set the out preset to the end of the play list.
AUTO MODE OFF	40 40 80	
AUTO MODE ON	40 41 81	
AUTO SKIP	A0 01 A1	Skip to preview-in preset.
RECORD CUE UP WITH DATA	A0 02 A2 A4 02 ff ss mm hh uu	Cue for recording at 00:00:00:00. Cue for recording at specified time code.
PREVIEW IN PRESET	A0 04 A4 A4 04 ff ss mm hh uu	Set the preview-in preset to 00:00:00:00 Set the preview-in preset to the specified frame.
PREVIEW OUT PRESET	A4 05 ff ss mm hh uu	
PREVIEW IN RESET	A0 06 A6	Clear the preview-in preset.
PREVIEW OUT RESET	A0 07 A7	Clear the preview-out preset.

Several commands in the following table contain eight bytes for an ***ID*** as defined by Odetics. In the table, bytes reserved for ID data are indicated with ***ii***.

The commands in the following table work **only when the recorder is configured in BVW-75 Mode.**

Command	Data (hex)	Explanation
CUE UP WITH DATA	28 31 ii ii ii ii ii ii ii uu 2C 31 ff ss mm hh ii ii ii ii ii ii ii uu	
RECORD CUE UP WITH DATA	A8 02 ii ii ii ii ii ii ii uu AC 02 ff ss mm hh ii ii ii ii ii ii ii uu	
IN PRESET	48 14 ii ii ii ii ii ii ii uu 4C 14 ff ss mm hh ii ii ii ii ii ii ii uu	Set in preset to 00:00:00:00 in specified ID. Set in preset to specified time code in specified ID.
OUT PRESET	40 15 55	Set out preset to last recorded frame of ID for in preset.
PREVIEW IN PRESET	A8 04 ii ii ii ii ii ii ii uu AC 04 ff ss mm hh ii ii ii ii ii ii ii uu	
PREVIEW OUT PRESET	A0 05 A5	Set preview out preset to last recorded frame of ID for preview in preset.
ERASE ID	A0 10 B0 A8 10 ii ii ii ii ii ii ii uu	Delete all IDs. Delete specified ID.
ERASE SEGMENT	A8 11 ff ss mm hh ff ss mm hh uu	Erase segment in current ID between specified time code positions inclusive.
LIST FIRST ID	A0 14 B4	Recorder responds with 88 14 ii ii ii ii ii ii ii uu or 80 14 94 if there are no IDs.
LIST NEXT ID	A0 15 B5	Recorder responds with 88 14 ii ii ii ii ii ii ii uu or 80 14 94 if there are no more IDs.
LIST PREVIOUS ID	A0 22 C2	Recorder responds with 88 14 ii ii ii ii ii ii ii uu or 80 14 94 if there are no more IDs.
ID STATUS REQUEST	A8 18 ii ii ii ii ii ii ii uu	Recorder responds with 81 18 xx uu. Bit 0 of xx indicates ID exists; Bit 1 indicates ID is loaded.
GET CURRENTLY LOADED ID	B1 09 01 BB	Recorder responds with 99 09 01 ii ii ii ii ii ii ii uu or 99 09 01 A3 if no ID is loaded.
LONGEST CONTIGUOUS STORAGE REQUEST	A0 1C BC	Recorder responds with 84 1C ff ss mm hh uu to indicate time available for recording.

2.7 CONTROL COMMANDS

The following commands control various aspects of the recorder's hardware.

Command	Data (hex)	Explanation
TIMER MODE SELECT	41 36 xx uu	Has no effect.
OUTPUT H PHASE	40 98 D8 41 98 xx uu	Resets horizontal sync position to unity (default). Sets horizontal sync position.
OUTPUT SC PHASE	40 99 D9 42 99 xx xx uu	Resets subcarrier phase to unity (default). Sets subcarrier phase.

2.8 OTHER SENSE COMMANDS

Use the following command to retrieve the output horizontal sync position and subcarrier phase. While the Sony protocol supports other data blocks, only video data block 2 is supported.

SIGNAL CONTROL DATA SENSE	62 23 02 00 87

The recorder responds with:

SIGNAL CONTROL DATA	77 23 02 00 04 hh 00 ss ss uu

Where hh is the horizontal sync position and ss ss is the subcarrier phase (LSB, MSB).

Use the following command to retrieve the current playback speed.

COMMAND SENSE SPEED	60 2E 8E

The recorder responds with the playback speed using the Sony convention as follows:

COMMAND SPEED DATA	71 2E xx uu

The following command is provided for compatibility with various edit controllers.

Command	Data (hex)	Explanation
TIMER MODE SENSE	60 36 96	The recorder always responds with 71 36 00 A7 indicating time code mode.

3. CONFIGURATION

3.1 CONFIGURATION ITEM CODES

Following are supported ***Item Codes*** and associated ***Configuration Values*** for use with the ***CONFIGURATION REQUEST*** and ***CONFIGURATION SET*** commands.

Note that by default, the recorder saves its configuration settings in non-volatile memory so that it retains its most recent configuration when power is switched off. The recorder waits five seconds after configuration changes have been made, then saves the new settings. If the recorder is not in STOP or PASS-THRU mode, the recorder waits until it is in one of these motion states before saving the new settings.

When saving settings to flash memory, the recorder suspends all communication over the RS-422 port for a period of about three seconds. This lapse in communication may confuse a controller connected to the port, which typically expects a response to every message within ten milliseconds. The controller may prevent this lapse in communication by using the ***Configuration Save*** configuration setting (Item Code DA in the table below) to disable the recorder from saving its settings.

Item Code (hex)	Configuration Values
00	Reset operations
	3210 hex Re-boot board (resets firmware).
	FFA5 hex Reset configuration settings in flash memory to the defaults.
10	Video frame pixel resolution (standards available depends on hardware)
	0 PAL, 720 x 576 pixels (or 720 x 576i50.00)
	2 NTSC, 720 x 486 pixels (or 720 x 480i59.94)
	3 NTSC-Japan, 720 x 486 pixels
	4 NTSC, 720 x 480 pixels
	10 hex 1920 x 1080i59.94
	11 hex 1920 x 1080i60.00
	12 hex 1920 x 1080i50.00
	13 hex 1920 x 1080psf23.98
	14 hex 1920 x 1080psf24.00
	20 hex 1280 x 720p59.94
	21 hex 1280 x 720p60.00
	22 hex 1280 x 720p50.00
	23 hex 1280 x 720p23.98
	24 hex 1280 x 720p24.00
	28 hex 1280 x 720p29.97 (in QuickTime meta-data)
	29 hex 1280 x 720p30.00 (in QuickTime meta-data)
	2A hex 1280 x 720p25.00 (in QuickTime meta-data)

CONFIGURATION ITEM CODES 3.1

Item Code (hex)	Configuration Values
12	Audio data frame format (**Outrider and NDT 200 only**) Only Bit 3 can be changed. Other useful bits from value returned are: Bit 0 (0001) is bit order, 0 = little-endian, 1 = big-endian. Bit 1 (0002) is channel order, 0 = left first, 1 = right first. 0000 (Bit 3 clear) Audio channel samples interleaved in one block. 0008 (Bit 3 set) Each channel audio samples in a separate block.
20	Pass-through, composite video only 1 Digital E to E: output is input video after passing through internal circuitry that performs analog to digital conversion and back again to analog. 3 Analog pass-through: output is input video, looped from input to output passing only through an amplifier. Note: **Available on Omega Deck hardware only**.
21	Auto-detection of input video format **(HD hardware only)** 0 Disables auto-detection (format set by configuration item 10 hex) 1 Enables auto-detection (format set by video input signal)
30	Sync reference for video output 0 Video output locked to internal crystal 2 Video output genlocked to signal at REF input connector
31	Subcarrier phase adjust. Takes effect when genlocked. 0-255 Valid range. 128 is center value
32	Horizontal sync position. Takes effect when genlocked. 0-128 Valid range. 64 is center value
40	Video input select. Takes effect only if supported on hardware. 0 Composite video. 1 Y/C (S-video). 2 Y / R-Y / B-Y (analog component). 3 Serial digital input (CCIR-601). Takes effect only if Serial Digital Adapter is installed.
41	Component video output select. Takes effect only if supported on hardware. 0 Y / R-Y / B-Y 1 RGB 2 Y/C
50	Video field display mode, still frame and slow motion 0 Show both fields interlaced. 2 Show only field 1 of every frame. 84 Show both fields, one at a time. 4 Mix fields following telecine convention. For NTSC, displays 24 fps source material in 3:2 pulldown when play speed also is set to 4/5. 6 Multiplex 4 channels, one per field (Supported hardware only).

Item Code (hex)	Configuration Values
51	Audio input select 0 Line inputs 1 Balanced inputs (Omega Deck hardware only) 2 Microphone inputs (Supported hardware only)
52	Mute audio 0 Audio not muted. 1 Audio muted.
53	Input audio gain (right and left channel in 1.5dB increments) RRLL format (MSB = R gain, LSB = L gain). Bytes are **signed** value. Gain range determined by hardware. Affects line and balanced inputs, not mic input. **G4 and Recon**: 0 to +22.5dB (00 to 0F). **Outrider**: -34.5 to +12dB (E9 to 08).
54	Audio de-emphasis filter (**Outrider, MiniDvrPro, FieldPro, Recon ver. 4 only**) 0 Disable filter. Enables flat audio response to 20kHz. 1 (Default) Enable filter to limit hi-freq. noise, rolls off –6dB @ ~7.2kHz.
60	Single frame recording mode 0 Record command performs conventional recording. 1 Record command grabs a single frame.
62	Loop recording across available space (disables event recording) 0 Recording stops when available disk space exhausted. 1 Recording continues until a STOP command. At the end of available disk space, recording overwrites the oldest video in current clip.
63	Event recording and pre-event capture duration (disables loop recording) 0 Disable event recording. 1-15 Minutes of recorded video before **Event Start** command to keep.
68	Recording auto-start modes (when DVR is ready and in pass-through mode) Bit 0 (0001) 0 disables auto-start modes. 1 enables auto-start modes. Bit 1 (0002) Non-persistent hold bit. Prevents enable until next initialization. Bit 2 (0004) 0 sets single (one-shot) auto-start. 1 sets repeated auto-start. Bit 3 (0008) When set, performs auto-start when input time code changes.
69	Recording auto-start delay 0 Recording auto-starts immediately when enabled. 1-FFFF Recording auto-start delay in seconds.
6A	Recording auto-stop delay 0 Disables auto-stop. 1-FFFF Recording auto-stop delay in seconds.
70	Loop playback 0 Playback stops on last frame of play list. 1 Playback loops from last frame of play list to first frame of play list.
71	GOTO command QuickTime file cueing mode (set before activating play list) 0 Cue on recorded clip boundary (potentially multiple QuickTime files). 1 Cue on QuickTime file boundary (differs from native mode clip cueing).

CONFIGURATION ITEM CODES 3.1

Item Code (hex)	Configuration Values
7E	Power fail safe recording 0 Disable power fail safe recording. 1 Recordings can be recovered should power fail during a recording. Note: **Startup video recovery** (7F hex) must be enabled for recovery.
7F	Startup video recovery 0 Disable startup video recovery. (Video recovery can take a long time!) 1 Damaged video clips will be recovered upon directory initialization.
80	Underrun recovery 0 Playback stops if disk cannot sustain data rate required for playback. 1 Playback recovers if disk cannot sustain data rate required for playback. When problem occurs, playback pauses, then resumes when disk catches up.
81	Use source time code during playback 0 Use play list ("destination") time code on playback. 1 Use source time code on playback. The time code output and front panel display indicate the time code recorded with the frame being displayed. This most likely results in discontinuous time code during playback, but may be useful in case, for example, video was recorded at a particular time of day and you wish to display that time with the picture.
82	Time code output at non-1:1 speeds 0 Disable (time code is output only during 1:1 motion). 1 Outputs time code at all times. (Reader may not yield stable reading.)
84	Drop frame time code enable (applicable only with NTSC video) Note: Frame offsets derived from time code provided with CUE commands and derived from input time code are calculated based on the input time code convention, non-drop or drop frame. This configuration only affects the **output** time code. 0 Use non-drop frame SMPTE time code on playback. 1 Use drop frame time code on playback.
86	Jam sync time code to real time clock (on supported hardware) 0 Jam sync time code generator to time code input 1 Jam sync time code to internal real time clock
88	Time code input source 0 Default order (ancillary, then SMPTE, then cue point time code) 1 Use SMPTE input. 2 Use ancillary time code (HD DVRs only). 4 Use real time clock (on supported hardware) (affects configuration item 86 hex).
8A	Use user data from source video during playback 0 User data fields are loaded from normal input source. 1 User data fields are loaded from source video during playback.

Item Code (hex)	Configuration Values
91	Disk for next recording (setting disables instant startup mode) 0-6 Specifies the device number for the desired disk. 40 hex - FFFE hex Specifies the MOE Disk ID of the desired disk. FFFF hex Use any disk without restriction.
9F	Instant startup mode. Allows for rapid start of recording after power-up. Instant startup mode disables directory initialization, which allows for a rapid, time duration consistent startup after power is applied to the unit. Since the directory is not initialized, previously recorded material is not available for playback in recording mode. Configuration save (DA hex) must be enabled. Disk (C0 hex) and file (C1 hex) formats must be configured for native MOE. Personality (D0 hex) must be configured for native mode. Loop recording (62 hex) must be disabled. 0 Disables instant startup mode. 1 Enable recording mode (formats disks if prior state was disabled). 2 Enable playback mode (disables recording).
A0	Target frame size for next recording (**applicable to SD DVRs only**) Specify value in kilobytes. If target frame size times frame rate for the configured video standard exceeds the maximum transfer rate of the disk, compression level is automatically increased until the disk can sustain recording. The minimum value is 2 kilobytes per frame. NOTE that this item overrides ***Compression Ratio for Next Recording*** (A1 hex).
A1	Compression ratio for next recording (**applicable to SD DVRs only**) Specified value is the numerator of the desired ratio. For example, use 5 for a 5:1 compression ratio. If resultant data rate exceeds the maximum transfer rate of the disk, compression level is automatically increased until the disk can sustain recording. NOTE that this item overrides ***Target Frame Size for Next Recording*** (A0 hex).
B0	SAA7151 register settings (on supported hardware) Allows user to set and clear specific bits in the internal registers of the Philips SAA7151B video decoder chip. Within configuration value, MSB specifies the register's IIC subaddress and the LSB specifies a value for the register. Refer to the Philips Desktop Video data book for details. This documentation is NOT AVAILABLE FROM FAST FORWARD VIDEO. You must be expert with the Philips chip to use this feature. Technical support for this feature is also NOT AVAILABLE FROM FAST FORWARD VIDEO.
B1	SAA7185 register settings (on supported hardware) Allows user to set and clear specific bits in the internal registers of the Philips SAA7185 video encoder chip. See B0 above for more details.
B8	Installed video board Use this item code to request the model of video circuit board installed. 2 20/20 card 4 G4-HJ7 card 5 Recon miniature recorder 7 Outrider miniature recorder 8 NDT 200 DVR 9 4 channel multiplexed DVR 10 PC039 based HD DVRs

CONFIGURATION ITEM CODES 3.1

Item Code (hex)	Configuration Values
C0	Disk format NOTE: for a new format to take effect, disks need to be (re)formatted after this command using the **DELETE** command. In other words, this command enables the specified format but does not perform the disk format work. 0 Default to MOE format. Note that under this configuration, the format for individual disks may still be selected on a disk by disk basis using the **DISK PARAMETER SET, NEXT FORMAT** command. 1 Format all disks using MOE file system. 2 Format all disks using FAT32 file system.
C1	File format for new recordings 0 Native MOE format. 1 QuickTime file format. Disk MUST be formatted in FAT32 file system. 2 QuickTime file format with frame data track (HD DVRs only).
CF	Automatic disk format 0 Disable automatic disk formatting. 1 Enable automatic disk formatting of unformatted disks on startup.
D0	Personality Specify the desired mode of operation. Note that this command is not intended to be used frequently, and incurs substantial overhead when issued. 1 Native mode 1000 hex BVW-75 emulation mode
DA	Configuration save (not persistently saved in flash memory) 0 Disable saving configuration changes to flash memory. 1 Enable saving configuration changes to flash memory.
DB	Disk information Use this item to request information about the currently installed disks. See the following section for the format of the response.
E5	Front panel board type 00F0 Stanley LCD and matrix touch screen 00F2 Optrex LCD and analog touch screen
E6	Digital video recorder board PCB revision Use this item code to request the video board's PCB revision code. See the following section for the format of the response.
EC	Firmware revision date Use this item code to request the video board's firmware revision date. See the following section for the format of the response.
ED	Boot firmware revision date Requests the video board's boot firmware revision date.
EE	Front panel firmware revision date Requests the front panel's firmware revision date, if front panel installed.
EF	Front panel boot firmware revision date Requests the front panel's boot firmware revision date, if front panel installed.
F0	Digital video recorder board serial number Use this item code to request the video board's serial number. See the following section for the format of the response.

Item Code (hex)	Configuration Values (Not Available On Omega Deck Hardware)
44	Character overlay on/off
	0 Overlay off.
	1 Overlay on.
45	Character overlay background on/off
	0 Background transparent.
	1 Black background on.
46	Time code character overlay frames digits on/off
	0 Time code frames display on, displays HH:MM:SS:FF
	1 Time code frames display off, displays HH:MM:SS
48	Time code character overlay horizontal position
	0 Time code display off.
	1-D (hex) Sets time code display horizontal position
49	Time code character overlay vertical position
	1-D (hex) Sets time code display vertical position
4A	Date character overlay horizontal position
	0 Date display off.
	1-D (hex) Sets date display horizontal position
4B	Date character overlay vertical position
	1-D (hex) Sets date display vertical position
4C	Date character overlay format
	0 Displays date as MM/DD/YY
	1 Same as format 0 except drops leading zeros if any
	2 Displays date as DD/MM/YY
	3 Same as format 2 except drops leading zeros if any
4D	User data overlay horizontal position
	0000 (hex) User data display off (MSB to LSB).
	xxxN (hex) N = 1-D (hex) Horizontal display position for data field 1.
	xxNx (hex) N = 1-D (hex) Horizontal display position for data field 2.
	xNxx (hex) N = 1-D (hex) Horizontal display position for data field 3.
	Nxxx (hex) N = 1-D (hex) Horizontal display position for data field 4.
4E	User data overlay vertical position
	xxxN (hex) N = 1-D (hex) Vertical display position for data field 1.
	xxNx (hex) N = 1-D (hex) Vertical display position for data field 2.
	xNxx (hex) N = 1-D (hex) Vertical display position for data field 3.
	Nxxx (hex) N = 1-D (hex) Vertical display position for data field 4.
E7	Serial port 0 configuration (see Section 3.6 regarding changing configuration)
	0 Default – Communicate with Front Panel.
	1 Normal Sony Protocol operation.
	2 GPS data input – 4800 Baud NMEA 0183 GPS position fix data.
	4 Embedded serial data stream protocol.
E8	Serial port 0 baud rate (set immediately after setting configuration item E7 hex)
	0 38400 baud
	1 9600 baud
	2 57600 baud
	3 115200 baud
E9	Serial port 0 parity (set immediately after setting configuration item E7 hex)
	0 No parity
	1 Odd parity

3.2 CONFIGURATION REQUEST COMMAND

The controller may determine the current setting of any supported configuration item by sending the ***CONFIGURATION REQUEST*** command with the ***Item Code*** field set for the desired item. See Section 3.1 for a summary of supported Item Codes.

Byte	Data (hex)	Description
0	F1	CONFIGURATION REQUEST
1	01	
2	xx	Item code
3	uu	Checksum of bytes 0 – 2

The recorder responds with the following data structure:

Byte	Data (hex)	Description
0	F3	CONFIGURATION RESPONSE
1	81	
2	xx	Item code
3	lsb	Configuration value
4	msb	
5	uu	Checksum of bytes 0 - 4

If the ***Item Code*** field of the ***CONFIGURATION REQUEST*** command was set to the **Revision Date** code, the recorder responds with the following data structure:

Byte	Data (hex)	Description
0	FC	REVISION DATE RESPONSE
1	xx	82 Boot code revision date 83 Firmware revision date
2		12 byte null-terminated ASCII string for revision date in the form: JAN 01 1997
•		
•		
13		
14	uu	Checksum of bytes 0 – 13

If the ***Item Code*** field of the ***CONFIGURATION REQUEST*** command was set to the **PCB Revision** code, the recorder responds with the following data structure:

Byte	Data (hex)	Description
0	F4	PCB REVISION RESPONSE
1	86	
2		4 byte PCB revision code. The bytes are the last four digits of the board PCB Part Number plus a subsequent board revision code (e.g., 309-PC028-1 Rev A returns 00 02 08 01, while 309-PC028-1 Rev D returns 00 02 08 1D).
3		
4		
5		
6	uu	Checksum of bytes 0 – 5

If the ***Item Code*** field of the ***CONFIGURATION REQUEST*** command was set to the **Serial Number** code, the recorder responds with the following data structure:

Byte	Data (hex)	Description
0	F4	SERIAL NUMBER RESPONSE
1	8E	
2	lsb	4 byte DVR board serial number. Boards that do not support an embedded serial number will return a value of ZERO.
3	•	
4	•	
5	msb	
6	uu	Checksum of bytes 0 – 5

CONFIGURATION REQUEST COMMAND 3.2

If the ***Item Code*** field of the ***CONFIGURATION REQUEST*** command was set to the **Disk Information** code, the recorder responds with the following data structure:

Byte	Data (hex)	Description
0	FF	DISK INFO RESPONSE
1	87	
2	lsb	MOE Disk ID for disk installed at device number 0.
3	msb	
4	lsb	Space available for recording on disk installed at device number 0, in kilobytes.
5	•	
6	•	
7	msb	
8	lsb	MOE Disk ID for disk installed at device number 1.
9	msb	
10	lsb	Space available for recording on disk installed at device number 1, in kilobytes.
11	•	
12	•	
13	msb	
14	lsb	MOE Disk ID for disk installed at device number 2.
15	msb	
16	lsb	Space available for recording on disk installed at device number 2, in kilobytes.
17	•	
18	•	
19	msb	
20	lsb	MOE Disk ID for disk installed at device number 3.
21	msb	
22	lsb	Space available for recording on disk installed at device number 3, in kilobytes.
23	•	
24	•	
25	msb	
26	lsb	MOE Disk ID for disk installed at device number 4.
27	msb	
28	lsb	Space available for recording on disk installed at device number 4, in kilobytes.
29	•	
30	•	
31	msb	
32	lsb	MOE Disk ID for disk installed at device number 5.
33	msb	
34	lsb	Space available for recording on disk installed at device number 5, in kilobytes.
35	•	
36	•	
37	msb	
38	lsb	MOE Disk ID for disk installed at device number 6.
39	msb	
40	lsb	Space available for recording on disk installed at device number 6, in kilobytes.
41	•	
42	•	
43	msb	
44	00	Reserved
45	uu	Checksum of bytes 0 – 44

3.3 CONFIGURATION SET COMMAND

The controller may configure many aspects of the recorder's operation by sending the ***CONFIGURATION SET*** command with the ***Item Code*** and ***Configuration Value*** fields set as desired. See Section 3.1 for a summary of supported Item Codes and associated Configuration Values.

Byte	Data (hex)	Description
0	F3	CONFIGURATION SET COMMAND
1	02	
2	xx	Item code
3	lsb	Configuration value
4	msb	
5	uu	Checksum of bytes 0 - 4

3.4 DEVICE TYPE REQUEST

The recorder implements the standard Sony protocol DEVICE TYPE REQUEST command that can allow the controller to determine the operating personality of the recorder. This is similar to sending the CONFIGURATION REQUEST command with Item Code D0 hex.

Command	Data (hex)	Response
DEVICE TYPE REQUEST	00 11 11	Native mode: 12 11 D8 50 4B BVW-75 mode: 12 11 20 25 68

Please note that the least significant bit (01 hex) of byte 2 will be set if the recorder is set to PAL (i.e., D8 becomes D9, and 20 becomes 21).

3.5 UPDATE RECORDER FIRMWARE

Using an ordinary terminal emulator program such as Windows' *HyperTerminal* utility, a computer can transfer firmware updates to the recorder over the 9-pin interface.

Since this update utility is designed to work with a personal computer, the serial communication settings were chosen to be compatible with a broad range of computers and are different from those used for ordinary remote control. Follow this procedure to update your recorder's firmware.

1) The file to be uploaded must be in the correct binary format. Obtained from Fast Forward Video's World Wide Web site at http://www.ffv.com, proper files have the .OF or .FUD extension. OF stands for (O)mega (F)irmware: for example, OMEGA.OF, FP.OF. FUD stands for (F)irmware (U)p(D)ate, and is used for firmware that uses later technology.

2) Your computer serial port may be configured for 9600 baud, 8 data bits, no parity, 1 stop bit OR 38400 baud, 8 data bits, odd parity, 1 stop bit OR 57600 baud, 8 data bits, no parity, 1 stop bit. Note in the case of 38400 baud, when using HyperTerminal set for 2 stop bits. Set flow control to none.

3) Your terminal emulator must be configured NOT to translate an outbound CR (carriage return) character to a CR-LF combination. You must use the XMODEM-CRC protocol.

4) If using an RS-232 port and your recorder is configured with an RS-422 port, you must connect to the recorder's RS-422 port through an RS-232 to RS-422 adapter. Adapters that convert a PC's serial port to RS-422 are available from Fast Forward Video.

5) On OmegaDeck products, use the recorder's front panel touch screen and go to the FIRMWARE display. On single-channel machines, press the **?** at the main screen. On two-channel machines, access the FIRMWARE display from the menu. Press the button on the touch screen that corresponds to the baud rate you have configured your terminal emulator for. On other products with a user interface, navigate to the firmware update screen and follow a similar procedure to enter firmware update mode. On other hardware, use the appropriate application to send a firmware update serial command as specified below. (These applications may handle the firmware update automatically in a different fashion, rather than require switching applications to a terminal emulator.)

6) The recorder responds with a message that prompts you to "Begin your XMODEM-CRC transfer now..." and starts emitting the XMODEM handshake character, a capital C. The recorder is now ready to receive the new file.

7) Upload the file to the recorder using the XMODEM protocol.

8) The transfer completes after several minutes. Be sure the recorder sends a message that states "success".

9) Turn the recorder off, wait several seconds, then turn it on. The new firmware is now running.

To place the recorder in its firmware update state using a serial command, send:

Byte	Data (hex)	Description
0	01	FIRMWARE UPDATE
1	2F	
2	xx	31 Go into firmware update mode at 9600 baud. 32 Go into firmware update mode at 38400 baud. 33 Go into firmware update mode at 57600 baud.
3	uu	Checksum of bytes 0 - 2

3.6 SERIAL PORT 0 CONFIGURATION (GPS OR OTHER INPUT)

The recorder circuit board's **Serial Port 0** may be reconfigured using the CONFIGURATION SET command with item code E7 hex. This port uses EIA RS-232 interface signal levels, but does not support all of the various RS-232 interface signals. This port is only available on Fast Forward Video OEM board-level digital video recorder products. In Fast Forward Video end-user digital video recorder products, this port is used to communicate with the Front Panel display and control board or other user interfaces, and should not be re-configured.

The configuration of the port cannot be changed while in operation. To change the configuration, **send** the CONFIGURATION SET command with item code E7 hex and the desired configuration value. **Wait** for the configuration setting to be saved in flash memory (up to 10 seconds), **then** power cycle or otherwise reset the recorder board to restart in the new configuration.

Configuration Value 0000 (Default Front Panel Communication)

In this configuration, the port provides asynchronous, full duplex serial communication at 38400 bps, 8 data bits, no parity, and 1 stop bit. The port communicates using the remote control protocol described in this document. **However**, it also outputs an **unsolicited** STATUS RESPONSE message as described in Section 4.2.

Configuration Value 0001 (Normal Sony Protocol Operation)

In this configuration, the port provides normal Sony remote control protocol operation described in this document for an external controller at 38400 bps, 8 data bits, odd parity, and 1 stop bit.

Configuration Value 0002 (GPS Position Input)

In this configuration, the port provides asynchronous, serial input of GPS position data at 4800 baud, 8 data bits, no parity and 1 stop bit per the NMEA 0183 specification. GPS position data is read from the input NMEA 0183 'GPGGA' sentence, and placed into the user data fields as ASCII in the following format:

User Data Field	Data Format	Data Contents
1	DDMM.MMMMH AAAAA	Latitude and Altitude
2	DDDMM.MMMMH HHMM	Longitude and UTC Hrs., Min.
3	SS	UTC Seconds
4	UU Q	Satellites Used and Fix Quality

For latitude and longitude: D = Degrees, M = Decimal Minutes, and H = Hemisphere (N, S, E or W). The altitude (AAAAA) is given in meters above/below mean sea level, to the nearest tenth of a meter, unless truncated to five characters (e.g., >999.9 meters displays as meters with a decimal point, and >9999.9 meters displays as meters without a decimal point). For the UTC time: H = Hours, M = Minutes, and S = Seconds. The number of satellites used (UU) for the fix will range from 00 to 12. The fix quality (Q) has the following values: 0 = No Fix, 1 = Non-differential GPS Fix, 2 = Differential GPS Fix, and 6 = Estimated Fix. If there is no fix data available, User Data Field 1 will be set to "NO FIX". If there is no UTC time available, User Data Field 2 will be set to "UTC?".

Configuration Value 0004 (Embedded Serial Data Stream Protocol)

Recent FFV high definition DVR hardware supports embedding a serial data stream in video frame meta-data during recording, and recovering this data during playback. The default serial port configuration for this protocol is 57600 baud, 8 data bits, no parity, 1 stop bit.

This protocol is based on a fixed bit-rate 8-bit byte oriented asynchronous physical transport layer, so bit and byte framing are technically unnecessary. (Each byte is framed with a start and stop bit, as opposed to a bit-synchronous physical transport layer, where byte alignment has to be defined by additional "framing" information.) However, since the protocol supports full binary data transmission with additional "out-of-band" signaling information through the use of an "escape character", certain framing sequences are provided for proper alignment of these "escape sequences". Out-of-band signal byte definitions are taken from the ASCII standard. The bytes used by this protocol are:

Symbol	Byte	Definition
<E>	0xFF	out-of-band "escape" byte
NUL	0x00	null byte (used for framing synchronization)
SOH	0x01	start of header
STX	0x02	start of text
SYN	0x16	synchronous idle
ETB	0x17	end of transmission block
CAN	0x18	cancel
SUB	0x1A	substitute

An "escape sequence" provides out-of-band signaling information. An "escape" sequence" is the <E> byte followed by a second byte, in transmission order. The sequence <E> SUB represents the <E> byte within the binary data stream (also called "byte-stuffing"). Because there are situations where there may be garbage buffered prior to an escape sequence, which may include the <E> byte, the sequence <E> <E> will merely continue the scan for an escape sequence with the next byte. The sequence <E> NUL can be used to terminate a multiple <E> sequence, and will be ignored. Also, the sequence <E> CAN will terminate and cancel any previous transmission (flushing an input buffer). Therefore, the sequence <E> CAN should be used upon link initiation or when resynchronization is needed. Escape sequences not specified here are ignored, and can be used by the application.

The DVR stores input packets of data with video frames during recording. Packets start with a flushed data stream or previous packet termination. A packet is stored with the active video frame upon the receipt of the sequence <E> ETB. (This means that the packet transmission duration may exceed the duration of a frame.) Packets are subject to size limitations. Packets are stored uncompressed, with a maximum size of 256 bytes. Consideration must be made for <E> byte-stuffing required in the binary data stream, and that the input data rate and additional output data will limit the size of a constant input stream. Packets that are over-size will suffer data loss due to truncation at the allocated length.

During recording, the sequence <E> SYN <4-byte little-endian frame number*> is output, initiated on the vertical interval. (This sequence is also output in E-E pass-through mode, but the frame number will reset upon the transition to recording mode.) Upon playback when an embedded data packet exists within a frame, the sequence <E> SOH <4-byte little-endian frame number*> <E> STX <data packet> <E> ETB will be output, initiated on the vertical interval for that frame. Data packets will be output as frames are displayed. That means in slow or stop motion playback, data packets will be repeated. In fast motion playback, data packets in skipped frames will not be output. In reverse motion playback, data packets will be output in reverse order as well.

* Note that the frame number is also encoded. Thus, if a byte has the value <E>, it will be encoded <E> SUB, causing the transmitted value to exceed 4 bytes.

3.7 DISK PARAMETER SET, NEXT FORMAT

Sets the disk format and other disk parameters for the NEXT time the disk is formatted.

This command should be issued after a disk is installed and just before it is (re)formatted, otherwise other disk actions may cause these parameters to be reset.

Byte	Data (hex)	Description
0	F5	DISK PARAMETER SET, NEXT FORMAT
1	2D	
2	lsb	Disk MOE ID or disk unit number
3	msb	
4	xx	Flag
5	lsb	Data
6	msb	
7	uu	Checksum of bytes 0 – 6

Values for ***flag*** field and associated use of the ***data*** field:

	FLAG	DATA
00	Specify disk format. Note that configuration item C0 hex (disk format) must be set to value 0.	0 or 1: Native MOE format 2: FAT32 format
01	Set the MOE ID of the disk.	Value to be assigned as the MOE ID. Must be in the range 40 hex to FFFE hex.
02	Set maximum file size. Valid only on FAT32 disks.	Maximum file size in multiple of 10000 hex disk blocks. For example, for a data value of 1234 hex, the maximum file size is set to 12340000 hex blocks.

Note that if the provided disk MOE ID or disk unit number is invalid (i.e., the values 07 hex to 3F hex), then the parameter setting will apply to ALL installed disks.

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4. STATUS

4.1 STATUS BLOCK

The recorder maintains a data structure that contains status information. You may retrieve all or part of this data structure using the ***STATUS REQUEST*** command.

STATUS BLOCK

Byte	Data (hex)	Description
0	lsb	Error code. Reading this field clears it. This is the earliest error detected since this field was cleared.
1	msb	
2	lsb	Frame number for frame on screen (0..n). Reflects time code offsets and corresponds to time code in bytes 6-9 below.
3	•	
4	•	
5	msb	
6	Hours	Time code for frame on screen. Each value is encoded as a pure number within its range (i.e., it is **not** binary coded decimal as in Section 1.6).
7	Minutes	
8	Seconds	
9	Frames	
10	lsb	Motion state: 0001 Stopped (paused) in playback mode. 0002 Moving in playback mode. 0006 Recording. 0008 Pass-through (record ready). 0030 (hex) Copying video from disk to disk. 0044 (hex) Cueing in playback mode.
11	msb	
12	lsb	Play speed numerator. Negative for reverse.
13	msb	
14	lsb	Play speed denominator. Always positive.
15	msb	
16	lsb	Size of frame on screen, in bytes.
17	•	
18	•	
19	msb	
20	lsb	Total storage installed, in kilobytes.
21	•	
22	•	
23	msb	
24	lsb	Available space on disk for recording, in kilobytes.
25	•	
26	•	
27	msb	

STATUS BLOCK
(continued)

Byte	Data (hex)	Description
28	lsb	ID of active play list: 0001 Source list. 0003 Busy. In process of activating play list. 0004 User play list.
29	msb	
30	lsb	Clip MOE ID for current clip on screen. Value is FFFF when no clip is on screen.
31	msb	
32	lsb	MOE Disk ID for current clip on screen. Value is 0000 when no clip is on screen.
33	msb	
34	lsb	During playback, frame number **within clip** for frame on screen. During recording, frame number from the **start** of recording for frame on screen. In both cases, counts from one.
35	•	
36	•	
37	msb	
38	xx	Input gain setting for audio channel 1. Range 0 - 15.
39	xx	Input gain setting for audio channel 2.
40	xx	Output attenuation setting for audio channel 1. Range 0 - 63.
41	xx	Output attenuation setting for audio channel 2.
42	xx	Actual output level for audio channel 1. Range 0 – 255.
43	xx	Actual output level for audio channel 2.
44	xx	Flags: 01 (hex) Recording in progress. 02 (hex) Deletion in progress. 04 (hex) Directory not yet initialized. 08 (hex) Copy in progress. 10 (hex) Frame grab in progress. 20 (hex) Play list I/O, config save in progress. 40 (hex) Chase mode enabled. 80 (hex) Chase locked to input time code.

Please note that it is important to observe the motion state (bytes 10 and 11) and flags (byte 44) in the STATUS BLOCK after terminating a recording. Since the recorder is saving digital data to disk asynchronously with the actual video input, there can be some significant post-recording processing necessary to complete a recording after the termination signal has been issued. This post-processing must complete (as indicated by the STATUS BLOCK) before another recording is started, or the recorder power is turned off.

The following table lists the error codes returned in the status block.

Error Name	Error code (decimal)	Meaning
EM_OK	0	No errors detected
EM_MOECFG	65535	Unrecognized MOE configuration code
EM_MEMORY	1	Out of memory
EM_BADPARAM	2	Function called with unusable parameter
EM_SINIT	5	Initialization missed
EM_MEMTEST	6	Memory test failed
EM_IIC	7	Failure communicating on IIC bus
EM_INTERRUPTS	9	Hardware interrupts not detected
EM_RESOURCE	10	Not enough resources to fulfill request
EM_HWINIT	11	Hardware initialization failure
EM_VFORMAT	12	Attempt to play incompatible video format
EM_NOTCONFIG	13	Cannot change configuration item
EM_BADCLIP	18	Media and Control Records do not agree
EM_DIREMPTY	19	Directory is empty (no Records on disk)
EM_BADTYPE	20	Unsupported MOE directory type
EM_BADID	21	MOE ID not found in directory
EM_END	22	End of directory / QuickTime file creation error
EM_NOCONTROL	23	Media Record has no Control Record
EM_CORRUPTDIR	24	MOE directory corrupted
EM_CORRUPTLINK	25	Bogus link in Record descriptor on disk
EM_CORRUPTREC	26	Corrupt MOE Record descriptor on disk
EM_OLDREV	27	Disk using obsolete format
EM_DIROVF	28	Directory is full
EM_BADSIZE	29	Record descriptor contains bad size field
EM_PLRANGE	30	"Locate" outside of play list
EM_PLNONE	31	No play list or no elements in play list
EM_IDXOVF	32	Index table overflow (low level play list out of space)
EM_CORRUPTIDX	33	Index table has been corrupted
EM_BADPLENTRY	34	Bad play list entry, activating play list
EM_TOODEEP	35	Too many levels of sub-play-lists
EM_RECURSE	36	Play list recursion detected
EM_IDXRANGE	37	Requested index beyond last recorded frame
EM_MOTION	38	Not in motion state required for operation
EM_PLOVRFLOW	39	Play list out of space
EM_OVERFLOW	40	Video data rate too high for mass storage
EM_BUFFER	41	Not enough space in play list buffer memory
EM_NOFRAMES	42	No frames in video buffer memory
EM_ELISTDEL	43	Recording frame list deletion error
EM_ELISTADD	44	Playback frame list addition error
EM_DLOGIC	45	Data stream logic error
EM_STATE	46	Request not possible in present state
EM_PLAYDEAD	47	Playback disk I/O hung up
EM_RECORDHUNG	48	Hardware stuck in record mode.
EM_RECGOING	49	Operation not allowed during recording.

Error Name	Error code (decimal)	Meaning
EM_BKGND	50	Disk I/O failed because recording or playback in progress
EM_FORMAT	51	Disk not formatted in a supported format
EM_DISKFULL	52	Disk full
EM_BLOCK	53	Disk blocking factor too large
EM_DNOINFO	55	Disk failed READ CAPACITY command
EM_DNOTDISK	56	Not a valid disk drive identifier
EM_EWAIT	57	Disk I/O transaction still pending
EM_ENORESP	58	No response from disk
EM_FORMATFAIL	59	Unable to format disk
EM_ABORT	60	Disk operation aborted by higher level request
EM_NODISK	61	No disk drive(s) detected.
EM_STREAMOFF	62	Record/playback stream disabled
EM_DISKCHANGE	63	Detected device change on disk bus
EM_DBADRAID	64	RAID disks not a RAID set
EM_CLIPEMPTY	65	Clip closed with no frames recorded
EM_CORRUPTBOOT	66	Disk boot sector corrupted
EM_EINT	200 - 212	Unexpected disk interrupts (SCSI devices only)
EM_EPHASE	220 - 232	Unexpected disk phase change (SCSI devices only)
EM_EBUSY	240	Disk transaction rejected: still busy
EM_EBAD	242	SCSI interface not responding
EM_EINIT	243	SCSI interface already initialized
EM_EOVER	244	Disk buffer overflow while reading
EM_EUNKTARG	245	SCSI device reselected from unknown target
EM_ELOGUNIT	246	Illegal logical unit response
EM_ENOSTATUS	247	Received command complete without status
EM_EUNDER	248	Disk buffer underrun while sending
EM_ENODATA	250	Can't transfer 0 bytes of data
EM_ETIMEOUT	251	Timeout during disk transaction
EM_EABORT	252	Disk transaction aborted
EM_EADDRESS	253	Address for disk I/O too big
EM_ECOMMAND	254	SCSI transaction failed during command phase
EM_INQUIRY	255	No response to SCSI INQUIRY command
EM_NOTREADY	256	Disk device returned "not ready" status
EM_DEVICE	257	SCSI device reported a problem
EM_ERESET	258	Disk bus reset occurred
EM_DISKERR	260	Generic disk error code
EM_UNKNOWNCMD	300	Unknown command
	500 - 599	Operating system errors
	600 - 699	Status messages, not errors
EM_DISKFORMAT	620	Disk format in progress
EM_VIDRECOVERY	621	Video recovery
	1000+	Commands to front panel

4.2 STATUS REQUEST

Byte	Data (hex)	Description
0	F4	STATUS REQUEST
1	00	
2	lsb	Offset to first byte desired from **STATUS BLOCK**.
3	msb	
4	lsb	Number of bytes desired from **STATUS BLOCK**.
5	msb	
6	uu	Checksum of bytes 0 - 5

The recorder returns the requested bytes from the **STATUS BLOCK** in the following format.

Byte	Data (hex)	Description
0	Fx	STATUS RESPONSE. The 'x' indicates the number of bytes from the **STATUS BLOCK** this message contains. If the response contains more than 15 bytes, 'x' is set to F hex.
1	80	
2	xx	First byte requested from **STATUS BLOCK**.
•	xx	
•	xx	
•	xx	Last byte requested from **STATUS BLOCK**.
n	uu	Checksum of bytes 0 through (n - 1)

In the default configuration, the recorder also provides an **unsolicited** STATUS RESPONSE message on the circuit board's **Serial Port 0**. This serial port is configured as an EIA RS-232 port at 38400 bps, 8 data bits, no parity, and 1 stop bit. This STATUS RESPONSE message is evoked approximately every 40 milliseconds, has leading CMD-1 and CMD-2 bytes of hexadecimal F2 and 00 respectively, and contains the entire STATUS BLOCK.

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5. PLAY LIST COMMANDS

5.1 OVERVIEW

The recorder keeps track of stored video in terms of ***clips*** and ***frames***, where a clip is one or more sequential frames. The recorder assigns a unique clip ID (a two byte number) whenever it adds a new clip either by recording from its video input or through a digital transfer. Frame numbers count up from one within a clip.

There are two user-definable parameters associated with each clip: 1) a 32 byte identification string, intended for an ASCII description; and 2) a starting time code for the clip. Use the SET TITLE command to specify the description for a clip or play list.

The controller may retrieve a list of all recorded clips with a series of DIRECTORY READ REQUEST commands.

The recorder can play frames from any recorded clip in any order. The recorder follows a ***play list*** to determine which frame to display. The play list simulates a sequence of video tape. Transport controls such as play, step, rewind, and fast forward move through this video tape as expected. A play list can reference a particular frame several times, even though the frame only exists in a clip once. A play list can reference frames in any order and can freely omit frames.

5.2 NATIVE MODE

The recorder can store any number of play lists to disk. Only one play list at a time is kept in memory: this play list is called the ***current play list***. In addition to the current play list, the recorder automatically constructs a play list containing all clips in the directory in the order they were recorded: this play list is called the ***source list***. The play list that the recorder is using at any given time is called the ***active play list***.

A controller may send the recorder a new play list with a series of PLAY LIST MESSAGE commands. This new list becomes the current play list. To make the new play list the active play list, the controller must send the SELECT PLAY LIST command with the MOE ID field set to indicate the current play list. Transport controls now follow this list. Before sending the new play list, the host must ensure that every clip and frame references a clip and frame in the recorder's directory. If not, the recorder rejects the new play list.

Note that if the controller does not specify a play list, the current play list is empty and the source list serves as the only active play list.

Once a controller has specified the current play list by sending a series of PLAY LIST MESSAGE commands, the controller may use the SELECT PLAY LIST command to switch between the source list and the current play list without re-sending the play list. In other words, the controller can switch the active play list between the source list and the current play list.

A controller may save the current play list to the recorder's disk with the SAVE PLAY LIST command. Once saved to disk, a play list appears in the recorder's directory as if it were a clip. Note that a play list saved in this way can be included in other play lists as if it were a single clip. The size field of a play list's directory entry is set to zero to permit the controller to distinguish a clip from a play list on disk.

Record adds a clip to the directory. When the controller switches to play mode after a record, the recorder's behavior depends on which play list is active:

- If the source list is the active play list, the recorder cues up to the last frame of the new clip. This also happens to be the last frame of the active play list, since the recorder appends the new clip to the end of the source list. The controller may, of course, cue up to any desired frame using the CUE UP WITH DATA or native mode GOTO command.

- If the current play list is the active play list, the newly recorded material is not visible since it is not included in the current play list. The controller must either switch the source list to the active play list or send a new play list that includes the new clip in order to play back the newly recorded clip.

Unlike a video tape, a new recording does not erase video that already exists. The controller may delete frames, clips, or entire play lists with the DELETE command.

Every recorded frame has a time code. If time code is not present at the recorder's Time Code In connector when recording video, the recorder assigns a time code to every frame. By default, the time code counts up from zero within each clip. The host may specify the starting time code for a clip with the SET SOURCE TIME CODE command.

When playing, the recorder outputs sequential time code as if the video were playing back from a tape that has continuous time code recorded on it. This output time code is called the recorder's ***destination time code***. The destination time code does not correspond to the time codes from the source list. Rather, the destination time code is relative to the start of the play list.

The recorder assigns unique identifiers to clips and play lists. The controller has no control over these identifiers, yet must often use the identifier in play list commands. The controller may retrieve this information with the ***DIRECTORY READ REQUEST***. Throughout the following command descriptions, these identifiers are referred to as the ***MOE ID***. “MOE” is an acronym for Media Operating Environment, which is Fast Forward Video’s software that the recorder uses to record and play back video. Valid MOE IDs for clips and play lists stored on disk have the range of 000A to FFF0 hexadecimal (10 to 65520 decimal), inclusive. Special MOE IDs used within commands are outside of this range.

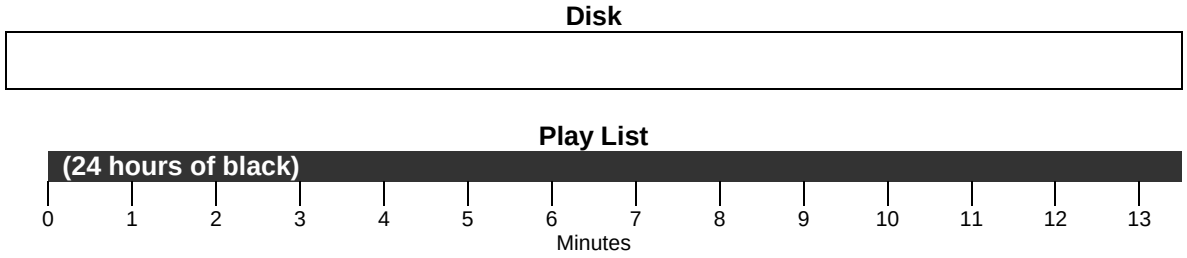
The recorder also assigns unique identifiers to disk drive units installed in the recorder. Throughout the following command descriptions, these identifiers are referred to as the ***MOE Disk ID***. Valid MOE Disk IDs have the range of 0040 to FFFE hexadecimal (64 to 65534 decimal), inclusive. In most cases, commands can also use the physical disk device number, which for SCSI disks falls in the range of 0000 to 0006, or for ATA/IDE disks can be 0000 or 0001. However, since disks may be moved from one slot to another, in practice it is better to use the logical MOE Disk ID rather than the physical disk device number to identify disks in play lists, etc. Special MOE Disk IDs used within commands will be outside the ranges of MOE Disk IDs or physical disk device numbers specified above.

5.3 BVW-75 MODE

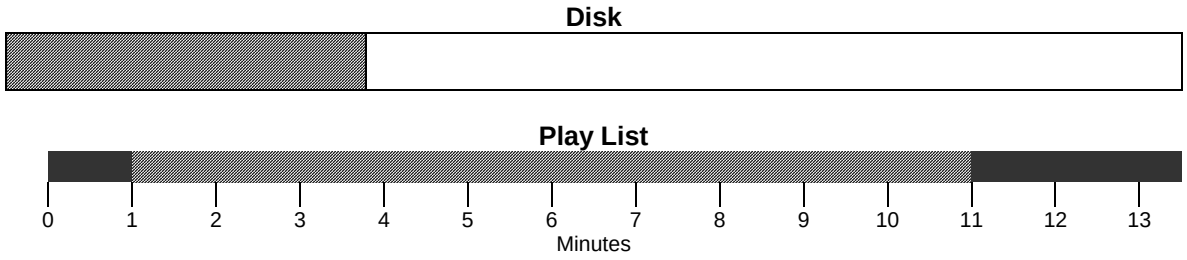
In BVW-75 mode, the recorder emulates the behavior of a tape deck. On video tape, the physical position of the tape at the moment of recording dictates where that material plays back relative to other video on the tape. Furthermore, a recording erases any video that previously occupied that physical location on the tape.

To emulate this behavior, the recorder automatically generates a play list that positions newly recorded material at the position that the deck is cued to at the moment recording starts. This play list is never empty: after clearing the disk, this play list still contains a single entry consisting of 24 hours of black. In addition, the controller can configure the recorder automatically to delete any video that is "recorded over". The following example illustrates the physical process of recording to disk versus the logical process of arranging this material into a "linear" play list.

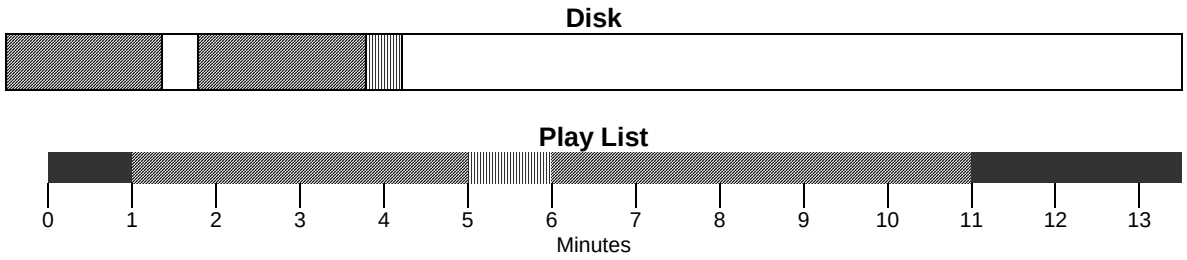
At first the disk is empty:



Now, you cue up to 00:01:00:00 and record for 10 minutes.



Next, you cue up to 00:05:00:00 and record for 1 minute.



When you cue up to 00:00:00:00 and push play, you see the following:

1) 1 minute of black.
2) 4 minutes of the first video recorded.
3) The entire 1 minute of video recorded last.
4) 5 minutes of the first video recorded.
5) Black until 24:00:00:00.

This result is exactly what you would see if you had used a professional tape deck to make two recordings as insert edits on a tape that had been "pre-striped" with 24 hours of black and time code.

Note these points about how the recorder stores video to disk:

- In native mode, the recorder never overwrites existing video. You must explicitly delete video before recording to make that disk space available for recording.
- In BVW-75 mode, the recorder automatically deletes material that has been "recorded over", making that disk space available for future recordings. However, this deletion does not occur until ***after*** a recording completes. This means space must be available for a recording prior to initiating the recording.
- The physical location of video on disk has no relationship to that video's position in a play list.
- Because of the type of compression the recorder uses, frames vary in size depending on image complexity. Therefore, two recordings of identical duration probably use different amounts of disk space.

5.4 DIRECTORY READ REQUEST

Requests an entry from the recorder's directory of stored clips and play lists. The recorder returns directory information as a ***DIRECTORY RESPONSE*** (see below).

Use the following form of the DIRECTORY READ REQUEST to retrieve a directory entry at a specific position in the list. This form of the command combines the features of the subsequent two other forms and should be used for future interface development.

Byte	Data (hex)	Description
0	F5	DIRECTORY READ REQUEST
1	08	
2	lsb	MOE ID for clip or play list, or may be one of the following special IDs (overrides Flags byte): 0000 Return first clip or play list entry. 0004 Return current or most recently saved play list. 0006 Return most recently recorded clip. 0008 Return current on screen clip.
3	msb	
4	lsb	MOE Disk ID for clip or play list
5	msb	
6	xx	Flags. Format in binary (and in order of precedence): 7 6 5 4 3 2 1 0 — — — CLIP PLYLST RECENT FIRST NEXT CLIP and PLYLST: 10 = Return a directory entry for a video clip. 01 = Return a directory entry for a play list. 00 = Return a directory entry for a clip or play list. RECENT: 1 = Return most recent clip recorded (bit 4 set), or current or most recent saved play list (bit 3 set). FIRST: 1 = Return first entry of the directory (see bits 4-3). NEXT: 1 = Return the next directory entry after ID. 0 = Return the specified directory entry for ID.
7	uu	Checksum of bytes 0 - 6

DIRECTORY READ REQUEST 5.4

Use the following form of the DIRECTORY READ REQUEST to sequentially retrieve directory entries by stepping through the directory list, or retrieve a 'most recent' directory entry:

Byte	Data (hex)	Description
0	F1	DIRECTORY READ REQUEST
1	08	
2	xx	Flags: 00 = send the next directory entry. 02 = send the first directory entry. 04 = send the directory entry for the clip most recently recorded or for the play list most recently saved. 08 = send directory entries pertaining to saved play lists. If this flag is zero, the recorder returns entries pertaining to video clips.
3	uu	Checksum of bytes 0 - 2

Note that if the *Flags* field is set to 02 hex, the recorder returns the first directory entry. To retrieve all directory entries:

1) Check the *Flags* field of the DIRECTORY RESPONSE sent by the recorder, byte 14, to see if bit 0 (01 hex) is set.
2) If it is, additional directory entries exist. Send another ***DIRECTORY READ REQUEST*** command with the *Flags* field set to 0 to retrieve the next directory entry.
3) Repeat steps 1 and 2 until bit 0 in the *Flags* field of the DIRECTORY RESPONSE is zero.

Alternatively, use the following form of the DIRECTORY READ REQUEST to retrieve the directory entry following the specified directory entry, or retrieve designated special entries.

Byte	Data (hex)	Description
0	F4	DIRECTORY READ REQUEST – NEXT
1	08	
2	lsb	MOE ID for clip or play list
3	msb	
4	lsb	MOE Disk ID for clip or play list
5	msb	
6	uu	Checksum of bytes 0 - 5

A specific MOE ID and MOE Disk ID in the DIRECTORY READ REQUEST – NEXT command causes the recorder to return the directory entry for the next clip or play list in the directory. In addition, you may use the following special values in the MOE ID field. In these cases, the value in the MOE Disk ID field is ignored:

0000 hex	Return first clip or play list entry.
0004 hex	Return an entry that describes the current play list.
0006 hex	Return the entry of most recent clip recorded.
0008 hex	Return current on screen clip.

The recorder returns directory information in the following format.

Byte	Data (hex)	Description
0	FD	DIRECTORY RESPONSE
1	88	
2	lsb	MOE ID for this clip or play list.
3	msb	
4	lsb	MOE Disk ID for disk on which clip is recorded. If a MOE Disk ID was not assigned to the disk when it was formatted, this field contains the disk's device number.
5	msb	
6	lsb	Number of frames in clip or play list.
7	•	
8	•	
9	msb	
10	lsb	For a video clip: size on disk in kilobytes. For a play list: number of elements in play list.
11	•	
12	•	
13	msb	
14	xx	Flags. Format in binary: 7 6 5 4 3 2 1 0 — — — — PLYLST RECENT FIRST MORE PLYLST 1 = This directory entry refers to a play list. 0 = This directory entry refers to a video clip. RECENT 1 = This is the most recent clip recorded. FIRST 1 = This is the first entry of the directory. MORE 1 = There are more directory entries to follow. 0 = This is the last directory entry.
15	uu	Checksum of bytes 0 - 14

If there are no more directory entries in a sequence, or the requested directory entry was not found, the DIRECTORY RESPONSE will be returned with a MOE ID of 0000 and a MORE flag of 0.

5.5 PLAY LIST READ REQUEST

Requests an entry from the recorder's current play list.

Byte	Data (hex)	Description
0	F2	PLAY LIST READ REQUEST
1	04	
2	lsb	Play list entry desired, from 0.
3	msb	
4	uu	Checksum of bytes 0 - 3

In addition to a specific number, you may use the following special codes in the ***Play List Entry Desired*** field (byte offset 2 & 3):

FFFF hex — Return a play list entry that describes the entire play list. Useful for finding out the presently configured start and end frames of the active play list.

FFFE hex — Return the next play list entry. Use this after issuing a ***PLAY LIST READ REQUEST*** with a specific number in the ***Play List Entry Desired*** field to retrieve play list entries in sequence.

The recorder returns the requested play list entry as a ***PLAY LIST MESSAGE***. See the following section.

5.6 PLAY LIST MESSAGE

The recorder returns play list entries requested with the ***PLAY LIST READ REQUEST*** (see previous section) using this message.

You may specify a new play list for the recorder by *sending* this message to the recorder. Note that the recorder must be in **NATIVE MODE** to accept a user specified play list.

A controller may also use this message to set and clear ***fences*** in the active play list. Fences are temporary first and/or last frames for the play list. Fences are useful to restrict playback to a region of the play list. Once set, motion control commands such as play and shuttle do not roll past the *out fence* or before the *in fence*. Looping playback, when enabled, rolls from the out fence to the in fence.

To specify fences for the active play list, set the *MOE ID* field to FFFF hex. The starting and ending frames are taken as the new fences. To clear the in fence, set the *Starting frame* field to 0. To clear the out fence, set the *Ending frame* field to FFFFFFFF hex.

Byte	Data (hex)	Description
0	FF	PLAY LIST MESSAGE
1	84	
2	lsb	MOE ID for this element. May refer to a clip or another play list, or may be one of the following special IDs: 5 Element is a black frame. Use in conjunction with the still frame feature in the *Play Mode* field below to insert black of any duration.
3	msb	
4	lsb	MOE Disk ID for disk on which clip is recorded. When sending this message to the recorder, this field may contain either the MOE Disk ID as listed in the directory or the disk's device number.
5	msb	
6	lsb	Starting frame number within clip or play list (0..n)
7	•	
8	•	
9	msb	
10	lsb	Ending frame number
11	•	
12	•	
13	msb	
14	lsb	Play mode: 0 = Normal play mode. 1 = Still frame. When this mode is specified, use the ***Starting frame*** and ***Ending frame*** fields to set the desired duration to hold the still frame during playback.
15	msb	
16	xx	Flags. Format in binary: 7 6 5 4 3 2 1 0 — — — — — — **FIRST** **MORE** FIRST 1 = This is the first entry of the play list. 0 = This is not the first entry of the play list. MORE 1 = There are more play list entries to follow. 0 = This is the last play list entry.
17	uu	Checksum of bytes 0 - 16

5.7 SELECT PLAY LIST

Use this command to change the recorder's play list between the source list, the play list currently in memory, or a play list that was previously saved to disk.

Byte	Data (hex)	Description
0	FA	SELECT PLAY LIST
1	03	
2	lsb	MOE ID for the desired play list. May be a MOE ID for a play list saved to disk, or may be one of the following special IDs: 0 Unload play list. Resets recorder to 'no play list loaded' state. 1 Source list 4 Current play list
3	msb	
4	lsb	MOE Disk ID for disk on which play list is saved, if selecting a play list on disk. If using one of the special IDs above, set this field to 0.
5	msb	
6	00	Unused. Set to 0000.
7	00	
8	lsb	Frame number within play list for first frame to display (0..n)
9	•	
10	•	
11	msb	
12	uu	Checksum of bytes 0 - 11

5.8 SAVE PLAY LIST

Use this command to save the play list currently in memory to the recorder's disk. The recorder must be in **NATIVE MODE** or this command will not work.

Use the following procedure to determine the MOE ID the recorder assigns to the saved play list. You will use the MOE ID in a future ***SELECT PLAY LIST*** or ***DELETE*** command or to include this play list in another play list: issue a ***DIRECTORY READ REQUEST*** with the ***flags*** field set to 0C hex (both the ***recent*** flag and the ***play list*** flag set). The DIRECTORY RESPONSE sent by the recorder will contain the MOE ID and MOE Disk ID for the play list.

Byte	Data (hex)	Description
0	F0	SAVE PLAY LIST
1	0B	
2	FB	Checksum of bytes 0 - 1

5.9 TITLE REQUEST

Requests the 32-byte description field for a clip or play list stored on the recorder 's disk(s).

Byte	Data (hex)	Description
0	F4	TITLE REQUEST
1	09	
2	lsb	MOE ID for clip or play list.
3	msb	
4	lsb	MOE Disk ID for clip or play list.
5	msb	
6	uu	Checksum of bytes 0 – 5

The recorder returns the title for the specified clip or play list as a ***TITLE MESSAGE***. See the following section.

5.10 TITLE MESSAGE

The recorder uses this message to return the title for a clip or play list requested with the ***TITLE REQUEST*** (see previous section) using this message.

You may specify a new title for a clip or play list by *sending* this message to the recorder.

Byte	Data (hex)	Description
0	FF	TITLE MESSAGE
1	89	
2	lsb	MOE ID for clip or play list. A response with a MOE ID of 0000 indicates there was an error in reading the title, which is invalid.
3	msb	
4	lsb	MOE Disk ID for clip or play list.
5	msb	
6	xx	32 byte title. May be null terminated or padded with ASCII spaces. However, all 32 bytes will be placed into the title and not truncated by a terminating null.
•	xx	
•	xx	
37	xx	
38	uu	Checksum of bytes 0 – 37

Note that you may pre-set the title for the next clip to be recorded or for a clip currently being recorded by setting the MOE ID field to 0007 hex. You may set the title for the current play list by setting the MOE ID field to 0004. In these cases, the MOE Disk ID field is ignored.

Also note that if a title is pre-set for a clip to be recorded which ends with one or more ASCII numerical digits (i.e., ASCII ‘0’ through ‘9’), the numerical portion of the clip title will increment after each recording is completed. This way, successive recordings can automatically be sequentially numbered in their titles. The initial default clip title, “CLIP0000”, uses this feature.

5.11 COPY PLAY LIST TO CLIP

Byte	Data (hex)	Description
0	F3	COPY PLAY LIST TO CLIP
1	06	
2	xx	Flags: 00 = Do not delete from disk all clips in the play list when copy is complete. 01 = Delete from disk all clips in the play list when the copy is successfully complete. 02 = Abort the copy in progress.
3	lsb	Destination disk. May be either the MOE Disk ID assigned to the disk when the disk was formatted, or it may be the disk's device number.
4	msb	
5	uu	Checksum of bytes 0 - 4.

Copies the currently active play list to the specified disk. In order for this command to take effect, the following conditions must be true:

1) Recorder is in NATIVE MODE.
2) The recorder's currently active play list is user-specified.

When the copy process has started, the recorder sets the ***Motion State*** field of the **STATUS BLOCK** to 30 hex and reports in the ***Play Speed Denominator*** field the fraction of the progress that has been completed, expressed as a percentage from 0 to 100.

5.12 CLIP / PLAY LIST FEATURES

Use these commands to set / clear or read features of clips or play lists stored on disk. Currently, only one feature is defined: Automatic playback of a clip or play list upon NATIVE MODE start up. Only one clip or play list may have this feature assigned.

Byte	Data (hex)	Description
0	F6	SET CLIP / PLAY LIST FEATURES
1	0E	
2	lsb	MOE ID for clip or play list.
3	msb	
4	lsb	MOE Disk ID for clip or play list.
5	msb	
6	xx	Feature bits: 01 = Automatic playback.
7	xx	Set to 01 to set feature(s), or set to 00 to clear feature(s)
8	uu	Checksum of bytes 0 – 7

Byte	Data (hex)	Description
0	F6	READ CLIP / PLAY LIST FEATURES
1	0D	
2	lsb	MOE ID for clip or play list.
3	msb	
4	lsb	MOE Disk ID for clip or play list.
5	msb	
6	xx	Feature bits: 01 = Automatic playback.
7	00	Unused, set to 00.
8	uu	Checksum of bytes 0 – 7

The following response will be returned for each clip or play list that has the requested features set:

Byte	Data (hex)	Description
0	F6	CLIP / PLAY LIST FEATURES RESPONSE
1	8D	
2	lsb	MOE ID for clip or play list.
3	msb	
4	lsb	MOE Disk ID for clip or play list.
5	msb	
6	xx	Feature bits: 01 = Automatic playback.
7	00	Unused.
8	uu	Checksum of bytes 0 – 7

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6. OTHER NATIVE MODE COMMANDS

6.1 GOTO

Cue up to the specified frame within the play list. The specified frame is displayed on screen, and future motion control commands start at that point.

Byte	Data (hex)	Description
0	F6	GOTO
1	0A	
2	lsb	Flag
3	msb	
4	lsb	Frame within element, starting from 0.
5	•	
6	•	
7	msb	
8	uu	Checksum of bytes 0 – 7

To specify the last frame of the play list, set the ***frame*** field to a number greater than or equal to the number of frames in the play list, or use the flag value below.

Values for ***flag*** field:

FFFF hex	Go to the specified frame counting from the beginning of the play list.
FFFE hex	Go to the first frame of the previous element in the play list.
FFFD hex	Go to the first frame of the next element in the play list.
FFFC hex	Go to the last frame in the play list.
FFFB hex	Display black.
FFFA hex	Go to the previous marked event (see note below).
FFF9 hex	Go to the next marked event (see note below).
FFF8 hex	Go to the current marked event (see note below).
FFF7 hex	Step specified frame increment reverse.
FFF6 hex	Step specified frame increment forward.
FFF5 hex	Start of specified clip number (in frame field) from play list beginning.
MOE ID	Specified frame number in clip (in source list only).

Note: Flags FFFA, FFF9 and FFF8 are used with events marked by the RECORDING EVENT MARK command. See that section for a description of the operation of these flags.

6.2 PLAY SPEED

Play at the specified speed. The command expresses the speed as a fraction with a 16-bit numerator and a 16-bit denominator. If either the numerator or denominator is zero, causes playback to pause.

Byte	Data (hex)	Description
0	F4	PLAY SPEED
1	0C	
2	lsb	Play speed numerator, range –32768 to +32767. Plays in reverse when the numerator is less than zero.
3	msb	
4	lsb	Play speed denominator, range 0 – 65535.
5	msb	
6	uu	Checksum of bytes 0 – 5

6.3 DELETE

Irretrievably deletes from disk an entire clip or specified frames within a clip. Warning: This command can only delete frames from native mode clips. It will delete an entire QuickTime file irregardless of the frame range specified when used with QuickTime files.

Byte	Data (hex)	Description
0	FF	DELETE
1	07	
2	lsb	MOE ID for clip or play list to be deleted.
3	msb	
4	lsb	MOE Disk ID for disk on which clip is recorded. If a MOE Disk ID was not assigned to the disk when it was formatted, this field contains the disk's device number.
5	msb	
6	lsb	Frame number within clip for first frame to delete (0..n)
7	•	
8	•	
9	msb	
10	lsb	Frame number within clip for last frame to delete. Set this field to FF FF FF FF hex to delete the entire clip.
11	•	
12	•	
13	msb	
14	00	Reserved. Set to 0.
15	00	Reserved. Set to 0.
16	00	Reserved. Set to 0.
17	uu	Checksum of bytes 0 - 16.

Set the ***MOE ID*** field to zero (00 00 hex) to delete all clips and play lists stored on disk.

6.4 FORMAT DISK

Initializes a disk in the MOE format. This process prepares a disk for recording video. If there was any video previously recorded, that video is irretrievably deleted.

NOTE that this command should be used only when the disk is known not to be in the MOE format or when the disk is known to have no video present. The command is provided to allow the user to specify a User ID for a disk. This command does not cause an existing directory to be reinitialized.

If your intention is to clear a disk of existing video, or to format a disk without specifying a User ID, use the DELETE command with the ***MOE ID*** field set to 0 (zero). See Section 6.3 above.

Byte	Data (hex)	Description
0	F3	FORMAT DISK
1	05	
2	xx	Device number for disk to be formatted.
3	lsb	User ID
4	msb	
5	uu	Checksum of bytes 0 - 4.

Set the ***User ID*** field to a unique number that you know will not conflict with any other MOE disks (especially removable disks) you may install in the recorder. Set this field to 0 to make the recorder assign a number that does not conflict with any installed disks. You may use either this User ID or the device number in the ***MOE Disk ID*** field of a play list message, or in any other command that requires a MOE Disk ID.

6.5 COPY CLIP, PLAY LIST OR DISK

This command can be used to copy all or part of a clip, or a play list, to another clip or play list, respectively. The copy created can be on the same or another disk drive. This command can also be used to copy all clips and play lists from one disk drive to another disk drive. In all cases, the directory is not reinitialized, and thus the copies cannot be used until after the recorder is restarted. In the case of entire disk-to-disk copies, the disk drives are assigned the ***same MOE Disk ID***, and the destination disk ***must be removed*** from the recorder prior to restart.

Byte	Data (hex)	Description
0	FF	COPY CLIP, PLAY LIST OR DISK
1	06	
2	xx	Flags: 00 = Do not delete from disk all clips in the play list when copy is complete. 01 = Delete from disk all clips in the play list when the copy is successfully complete. 02 = Abort the copy in progress.
3	lsb	Destination disk. May be either the MOE Disk ID assigned to the disk when the disk was formatted, or it may be the disk's device number.
4	msb	
5	lsb	MOE ID for clip or play list to be copied. Set to 0000 to copy an entire disk.
6	msb	
7	lsb	Source disk. May be either a MOE Disk ID or a device number.
8	msb	
9	lsb	Starting frame number, from 0. Unused when copying a disk.
10	•	
11	•	
12	msb	
13	lsb	Ending frame number, from 0. Set to FF FF FF FF to copy an entire clip or play list. Unused when copying a disk.
14	•	
15	•	
16	msb	
17	uu	Checksum of bytes 0 - 16.

6.6 CHASE ENABLE

Byte	Data (hex)	Description
0	F8	CHASE ENABLE
1	0F	
2	lsb	Desired fixed offset to maintain from input time code, in frames. May be negative.
3	•	
4	•	
5	msb	
6	lsb	Numerator of a fractional play speed to maintain when locked to input time code. Zero gives 1:1 play speed.
7	msb	
8	lsb	Denominator of a fractional play speed to maintain when locked to input time code.
9	msb	
10	uu	Checksum of bytes 0 - 9.

Device must be in playback mode to enter chase mode. Specified offset is maintained from current play list.

Any motion control command (STOP, PLAY, etc.) exits chase mode.

When chase mode is enabled, bit 0x40 is set in the ***Flags*** field of the **STATUS BLOCK**. When playback is successfully locked to input time code, bit 0x80 is also set in the ***Flags*** field of the **STATUS BLOCK**.

6.7 EVENT RECORDING WITH PRE-EVENT CAPTURE DURATION

When event recording is enabled (configuration item code 63), the recorder will capture video from the configured interval before the EVENT START command until the recording is stopped or runs out of storage space. Placing the recorder in record mode starts event recording, and the recorder will loop record continuously until an EVENT START command is issued, or the recording is terminated. If the recording is terminated **without** an EVENT START command being issued, the recorded video **will not be saved**, thus retaining storage space for further event capture. Event recording will not start if there is insufficient calculated space to preserve the video from the configured pre-event interval.

EVENT START	F0 30 20

6.8 RECORDING EVENT MARK

This command places an event mark at the current frame being recorded. A total of 99 event marks are supported during a single recording. Note that if a clip is modified (for example, by frame deletion), all event marks in the clip may be lost.

EVENT MARK	F0 31 21

Event marks are stored in a table with the following format:

- 4 byte table length in bytes, little-endian.
- 4 byte ASCII signature, 'EVL=' in byte order.
- 4 byte first event mark, frame number in clip, from ZERO, little-endian.
- and so on to the length of the table…

In a native MOE format clip, the table is located at offset 60 hex in the first block of the first Media Record of the clip. In a QuickTime file, the table is located at offset 5A hex in the first block of the file within the second user data ('udta') atom.

During playback, event marked frames can be cued to using special flags in the GOTO command. Event marks are always sought based on the current playback position, using flag FFFA hex (previous), and flag FFF9 hex (next). If a valid event mark is found, it can always be cued back to using flag FFF8 hex (current), irregardless of where playback has been cued to using non-event mark cue commands. However, if playback is cued outside the range of a clip's event marks, and then a previous or next event mark cue is issued that is still outside the range of event marks, the 'current' event mark will be invalidated and no cue will be performed. Normal 'previous' or 'next' cueing to another event mark updates the 'current' event mark. If the 'current' event mark is a bounding event mark (i.e., the first or last), an event mark cue beyond the range of event marks will not change the 'current' event mark, and no cue will be performed.

6.9 TIME LAPSE

Byte	Data (hex)	Description
0	F4	SET TIME LAPSE INTERVAL
1	20	
2	lsb	Desired time lapse interval between frames during recording, in frames.
3	•	
4	•	
5	msb	
6	uu	Checksum of bytes 0 - 5.

The time lapse interval controls how often captured frames are saved to disk during recording. An interval of 10 saves every tenth frame, an interval of 2 saves every other frame, and an interval of 1 or 0 saves every frame, disabling time lapse.

NOTE that the recorder must be also configured for SINGLE FRAME RECORD mode for time lapse to take effect. To enable single frame record, send a CONFIGURATION SET command with item code 60 hex. See Section 3.1 and 3.3 for further explanation.

Byte	Data (hex)	Description
0	F4	SET TIME LAPSE INTERVAL, TIME CODE FORM
1	21	
2	ff	Desired time lapse interval between frames during recording, ff ss mm hh (see Section 1.6). The time code is converted in terms of the current time code settings (i.e., NTSC/PAL, non-drop/drop) to a frame interval, and stored internally as such.
3	ss	
4	mm	
5	hh	
6	uu	Checksum of bytes 0 - 5.

The time code form of the command works the same as the version above.

Byte	Data (hex)	Description
0	F0	TIME LAPSE INTERVAL REQUEST
1	20 or 21	20 for interval as a number of frames. 21 for interval as time code ff ss mm hh.
2	uu	Checksum of bytes 0 – 1.

Send this command to retrieve the current time lapse interval. The response is the same format as the SET TIME LAPSE INTERVAL commands above except the value in byte 1: instead of 20 hex, byte 1 of the response is A0 hex; instead of 21 hex, byte 1 of the response is A1 hex.

6.10 REAL TIME CLOCK TIME / DATE SET

Byte	Data (hex)	Description
0	F7	SET REAL TIME CLOCK TIME / DATE
1	24	
2	lsb	Year (hex) (for example 2002 decimal is 07D2 hex)
3	msb	
4	Month	1 through C (hex) (C hex = 12 decimal)
5	Day	1 through 1F (hex) (1F hex = 31 decimal)
6	Hour	0 through 17 (hex) (17 hex = 23 decimal)
7	Minute	0 through 3B (hex) (3B hex = 59 decimal)
8	Second	0 through 3B (hex) (3B hex = 59 decimal)
9	uu	Checksum of bytes 0 - 8.

This command is **not available on Omega Deck hardware**.

The command may require more than 10 milliseconds to respond with an ACK.

Sets the real time clock to the specified values. Supported hardware has an on-board real time clock with battery that continues running when power is off. To tag new recordings with the time and date, enable the recorder to "jam sync to the real time clock" with a CONFIGURATION SET command, item code 86 hex.

To read the current value of the real time clock:

Byte	Data (hex)	Description
0	F0	READ REAL TIME CLOCK TIME / DATE
1	24	
2	14	Checksum of bytes 0 - 1.

The recorder responds in the same format as the SET REAL TIME CLOCK TIME / DATE command except that byte 1 is set to A4 hex. Again, the recorder requires more than 10 milliseconds to respond to this request.

6.11 TIME / DATE READ

Byte	Data (hex)	Description
0	F0	TIME / DATE READ
1	25	
2	15	Checksum of bytes 0 - 1.

This command is **not available on Omega Deck hardware**.

Reads the time/date field from the frame currently on screen. These fields are set during recording only when the recorder is set to jam sync to its on-board real time clock. Enable this feature with a CONFIGURATION SET command, item code 86 hex.

The recorder responds:

Byte	Data (hex)	Description
0	F7	TIME / DATE READ RESPONSE
1	A5	
2	lsb	Year (hex) (for example 2002 decimal is 07D2 hex)
3	msb	
4	Month	1 through C (hex) (or Day, see Note)
5	Day	1 through 1F (hex) (or Month, see Note)
6	Hour	0 through 17 (hex)
7	Minute	0 through 3B (hex)
8	Second	0 through 3B (hex)
9	uu	Checksum of bytes 0 - 8.

Note: The month and day order in the response depends on the format the date was stored in the frame originally based on configuration item code 4C hex, Date character overlay format.

6.12 USER DATA FIELDS

Sets or retrieves user data fields stored in each frame during recording. To retrieve user data from the source video during playback, configuration item 8A hex must be set to 1.

Byte	Data (hex)	Description
0	FF	SET USER DATA FIELD
1	26 or 27	26 for field 1, 27 for field 2.
2	xx	16 bytes of user data.
•	xx	
•	xx	
17	xx	
18	uu	Checksum of bytes 0 - 17.

Byte	Data (hex)	Description
0	F4	SET USER DATA FIELD
1	28 or 29	28 for field 3, 29 for field 4.
2	xx	4 bytes of user data.
3	xx	
4	xx	
5	xx	
6	uu	Checksum of bytes 0 - 5.

Use the following command to read the user data fields from the frame currently on screen.

Byte	Data (hex)	Description
0	F0	READ USER DATA FIELD
1	26 - 29	26 for field 1, 27 for field 2, 28 for field 3, 29 for field 4.
2	uu	Checksum of bytes 0 - 1.

The recorder returns the user data field information in the format of the SET USER DATA FIELD command for the specified field, except byte 1 is set to A6 for field 1, A7 for field 2, A8 for field 3 or A9 for field 4.

6.13 CONVERT NATIVE CLIP TO QUICKTIME

Converts a native MOE file format clip to one or more QuickTime file(s) (depending on the length of the clip). The disk must be already formatted in the FAT32 format. Available on SD hardware only.

Byte	Data (hex)	Description
0	F7	CONVERT NATIVE CLIP TO QUICKTIME
1	2C	
2	lsb	MOE ID for clip to be converted.
3	msb	
4	lsb	MOE Disk ID for clip to be converted.
5	msb	
6	01	Command byte.
7	00	Unused. Set to 0000.
8	00	
9	uu	Checksum of bytes 0 – 8.

6.14 DEVICE CONTROL

These commands allow the retrieval and control of the state of on-board hardware devices. Devices available are DVR product circuit-board specific. The device state is not persistent, and must be reinitialized each time the board is reinitialized.

Byte	Data (hex)	Description
0	F0	GET DEVICE STATE
1	40	
2	30	Checksum of bytes 0 - 1.

The recorder responds with:

Byte	Data (hex)	Description
0	F4	DEVICE STATE RESPONSE
1	C0	
2	lsb	Device under user control:
3	msb	Bit 0 = 0001: USB-ATA/ATAPI Bridge
4	lsb	Device state (bit pattern is the same as devices in bytes 2-3):
5	msb	Bit 0: 0 = Disabled, 1 = Enabled for USB access to ATA bus
6	uu	Checksum of bytes 0 - 5.

Devices are controlled with:

Byte	Data (hex)	Description
0	F6	CONTROL DEVICE STATE
1	42	
2	lsb	Device(s) to change the state of:
3	msb	Bit 0 = 0001: USB-ATA/ATAPI Bridge
4	lsb	Device control (bit pattern is the same as devices in bytes 2-3):
5	msb	0 = Controlled by hardware, 1 = Controlled by user.
6	lsb	Device state (bit pattern is the same as devices in bytes 2-3):
7	msb	Bit 0: 0 = Disabled, 1 = Enabled for USB access to ATA bus
8	uu	Checksum of bytes 0 - 7.

The “device control” bit(s) must be set to 1 (controlled by user) in order to change the device state per the “device state” bit(s).

Bit 0, USB-ATA/ATAPI Bridge: Disabling user control (default state) allows control by cable attachment (the bridge is enabled when a cable is attached).

6.15 DISK POWER DOWN (SLEEP)

Allows the user to place one or both ATAPI/IDE disks into sleep mode, parking the disk heads, prior to shutting off power to the board. Please note that some ATAPI disk drives still respond when in sleep mode, which will cause the normal disk scanning mechanism of the firmware to issue a "disk reset" and re-enable the disk(s) after ten or more seconds. This command **has no effect on Omega Deck SCSI disks**.

Byte	Data (hex)	Description
0	F1	DISK POWER DOWN (SLEEP)
1	4F	
2	xx	Disk unit number (00 or 01), or FF for all disk drives.
3	uu	Checksum of bytes 0 - 2.

DISK POWER DOWN (SLEEP) 6.15

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7. CALCULATING DVR FRAME SIZES, DATA RATES AND DISK SPACE USAGE

The following sections apply to Fast Forward Video's line of standard definition Digital Video Recorders.

7.1 JPEG COMPRESSION OF VIDEO FIELDS

Fast Forward Video's Digital Video Recorders (DVRs) decode input video fields into 16-bit ITU CCIR-656 YUV 4:2:2 encoded pixels. The initial uncompressed image size in pixels depends on configuration of the DVR (see configuration item 10 hex, "Frame Pixel Resolution"). Typically, this is 720 pixels per horizontal video line wide by 486 lines high (i.e., 720 x 486) for NTSC or 720 x 576 for PAL. These encoded video fields are then compressed to create ISO/IEC 10918-1 standard JPEG compressed images, and then stored in the frame buffer memory of the DVR. The amount that the fields are compressed is specified by a target frame size within the DVR (see configuration item A0 hex, "Target Frame Size for Next Recording", which is in kilobytes (2^{10} bytes)). Typically, a user sets the compression ratio (see configuration item A1 hex, "Compression Ratio for Next Recording"), which calculates the target frame size based on the configured resolution and the fact that there are 2 video fields per video frame. It is important to note that the amount of image compression depends on the complexity of the image, and the hardware dynamically modifies the actual image compression rate to try to maintain the target frame size of the compressed frame data. This means that actual frame sizes will fluctuate depending on the input video stream, and typically no two sets of the same number of frames will compress to the exact same size. The target frame size excludes the JPEG marker segments, which can be up to 699 bytes per field.

Therefore,

target frame size (in kilobytes) =
((720 pixels per line) * (resolution lines) * (2 fields per frame)) /
((compression ratio) * (1024 bytes per kilobyte))

7.2 AUDIO FRAME AND ASSEMBLY OF FRAME STORED TO DISK

Fast Forward Video DVRs encode input stereo audio into uncompressed little-endian 16-bit twos-complement linear PCM per channel at a 48 kHz sampling rate. (Newer hardware may also encode input audio into big-endian and/or channel separated blocks of audio sample data.) This means there are 4 bytes of data per sample (2 channels times 2 bytes per sample). The number of samples in an audio frame depends on the length of the video frame. For NTSC, there are 29.97 frames per second; and for PAL, there are 25 frames per second. Therefore, there are 6408 bytes of sample data in an NTSC frame, and 7680 bytes in a PAL frame.

The frame assembled in the DVR's frame buffer and stored on disk consists of a 64-byte frame header, an audio frame, and two JPEG compressed video fields. Because of internal alignments of the frame data elements, it is best to round up to the next kilobyte block when calculating a typical frame size.

7.3 CALCULATING DATA RATES AND DISK SPACE USAGE

Typically, a user is not interested the actual frame size, but rather in the rate of disk space used per unit time or the recording time remaining in the space available. Therefore, calculating a data rate that is a function of the compression ratio allows rapid access to either of these quantities:

data rate (bytes per second) =
((720 * (lines) * 2 * (frames per second)) / (compression ratio)) +
(48000 * 2 * 2) + ((64 + (2 * 699)) * (frames per second))

Fundamentally, the data rate gives the rate of disk space used per unit time. Also,

recording time remaining = (available space) / (data rate)

In calculating disk space usage, this calculated data rate will be low for a number of major reasons. First of all, data element alignments cause up to a kilobyte per frame of additional space to be used. Secondly, additional space is set aside on disk for meta-data and file system use. This additional space grows as length and number of recordings grows. Finally, as multiple recordings fragment disk space, chunks of available space smaller than about 2 MB will not get used.

Given this uncertainty, modifying the final factor in the data rate calculation to (2048 * (frames per second)) is certainly justified. To the programmer implementing the calculation in code, be sure to scale your calculations properly to maintain precision without exceeding variable sizes. The caveats about multiplying and dividing large numbers apply.

APPENDIX A
SUMMARY OF CHANGES IN THIS DOCUMENT

REVISION 1.1

- Explanation for PLAY LIST READ REQUEST expanded. Section changed from 3 to 4.
- New command added, section 3.2: STATUS REQUEST.
- New command added, section 4.2: DIRECTORY READ REQUEST and DIRECTORY RESPONSE.
- New command added, section 4.5: DELETE.
- New command added, section 4.6: FORMAT DISK.
- New command added, section 4.7: COPY PLAY LIST TO CLIP.

REVISION 1.2

- CONFIGURATION SET command, Horizontal sync position: range changed from 255 to 128.
- CONFIGURATION SET command: added code for changing Native/BVW-75 mode.
- CONFIGURATION REQUEST command, Revision date: code changed to E0 hex.
- TITLE REQUEST command added.
- TITLE MESSAGE command/response added.
- SELECT PLAY LIST command added.
- GOTO command added.

REVISION 1.4

- SAVE PLAY LIST command added.

REVISION 1.5

- Added Section 2, MOTION CONTROL. Following sections re-numbered.
- UPDATE RECORDER FIRMWARE procedure revised.
- DIRECTORY READ COMMAND: corrected explanation for FLAGS field in DIRECTORY RESPONSE.
- SELECT PLAY LIST command: corrected value for Source List in MOE ID field.
- STATUS BLOCK: structure corrected.
- CONFIGURATION: added Configuration Save Enable and Disk Information.
- CONFIGURATION REQUEST: added data structure returned for Disk Information request.
- DIRECTORY READ REQUEST: added long title form and short title form.

REVISION 1.6

- CONFIGURATION: added video board type query and switch for YUV/RGB outputs.
- added native mode PLAY SPEED command

SUMMARY OF CHANGES IN THIS DOCUMENT

REVISION 1.7

- added description of the UPDATE FIRMWARE command.

REVISION 1.8

- added description of the CHASE ENABLE command.
- ***Flags*** field of status block (byte 44) defined.
- CONFIGURATION: added Y/C input select.
- CONFIGURATION: added loop record switch.
- CONFIGURATION: added commands to retrieve boot firmware revision date and front panel firmware revision date.
- Special values defined for ***element*** field of GOTO command.

REVISION 1.9

- added description of the TIME LAPSE commands.
- added description of REAL TIME CLOCK TIME / DATE SET command (Recon hardware only).
- CONFIGURATION: corrected value documented for LOOP RECORD.
- CONFIGURATION: added value under “Frame pixel resolution” for NTSC-Japan.
- CONFIGURATION: corrected item codes for “Boot firmware revision date”, “Front panel firmware revision date” and “Front panel boot firmware revision date”. Added item code and response values for “Front panel board type”.
- CONFIGURATION: deleted obsolete “Q Factor for Next Record” setting.
- CONFIGURATION: added “Use Source Time Code During Playback” setting.
- CONFIGURATION: added character overlay and real time clock jam sync, available only on Recon hardware.
- CONFIGURATION RESPONSE for revision date requests includes new byte 1 value for boot code response.
- GOTO: *elements* field now obsolete. Reworded explanation.
- TITLE MESSAGE: added explanation for pre-setting the title for the next clip to be recorded.
- ACK / NAK: additional forms of NAK defined
- DIRECTORY RESPONSE (Section 5.4): explanation for bytes 10-13 corrected: for play lists, this field contains number of elements in play list.
- DIRECTORY READ REQUEST (Section 5.4): added new form of this command, DIRECTORY READ REQUEST – NEXT

REVISION 2.0

- CONFIGURATION ITEM codes for *Firmware revision date*, *Boot firmware revision date*, *Front panel firmware revision date*, and *Front panel boot firmware revision date* changed to EC hex, ED hex, EE hex, and EF hex respectively; CONFIGURATION RESPONSE for revision date request byte 0 value changed from FB hex to FC hex.
- Added description of TIME / DATE READ command (Recon hardware only).
- CONFIGURATION ITEM code 81 hex added to select output of source time code on playback.
- CONFIGURATION ITEM code 84 hex added to support drop frame time code enable.
- FORMAT DISK command (Section 6.4) explains that command does not cause reinitialization of directory.
- STATUS BLOCK definitions for bytes 2-5, 30-31, 32-33 and 34-37 modified.
- 2 successive EJECT commands no longer format the disk drives.
- SELECT PLAY LIST definitions for bytes 6-7 and 8-11 modified. A MOE ID of 0000 now unloads the play list.
- DIRECTORY READ REQUEST – LONG TITLE VERSION and DIRECTORY READ REQUEST – SHORT TITLE VERSION commands removed because they were never implemented.
- DIRECTORY READ REQUEST – NEXT now accepts MOE ID 0008 to return the current on screen clip data as reported by the STATUS BLOCK.
- Added a new form of the DIRECTORY READ REQUEST command that allows retrieval of a specific directory entry without stepping through the entire directory list.
- Added note about unsolicited STATUS RESPONSE message on circuit board serial port 0.
- Added note about out preset time code being one past last frame recorded or displayed.
- FAST FORWARD in BVW-75 mode now seeks to last frame recorded.
- CONFIGURATION ITEM code A0, target frame size, minimum is now 2 kilobytes per frame.
- TITLE MESSAGE now accepts MOE ID 0004 to set the current play list title. Added a note about auto-incrementing clip titles.
- Added a note to Section 2.5 regarding not issuing disk accessing commands during recording.
- Added additional NAK responses in Section 2.2.
- Added a note to Section 2.10 indicating Auto Mode must be enabled for commands to work.
- Added new Section 6.5 COPY CLIP, PLAY LIST OR DISK. Succeeding sections renumbered.
- Added new Section 5.12 CLIP / PLAY LIST FEATURES.
- Added new Section 6.10 USER DATA FIELDS.
- Serial interface bit rate and parity are now configurable. Contact Fast Forward Video if needed.
- Added CONFIGURATION ITEM codes 7E hex for Power fail safe recording, and 7F for Startup video recovery.

REVISION 2.1

- Added new Section 1.5 ADDITIONAL CAPABILITIES AND LIMITATIONS.
- Added new Sections 2.11 CONTROL COMMANDS and 2.12 OTHER SENSE COMMANDS.
- Added new Section 3.5 SERIAL PORT 0 CONFIGURATION (GPS INPUT).
- Added new Section 6.7 EVENT RECORDING WITH PRE-EVENT CAPTURE DURATION. Succeeding sections renumbered.
- Added CONFIGURATION ITEM codes for Audio input select, Event recording and pre-event capture duration, Time code at non-1:1 speeds, Serial port 0 configuration, and User data field overlay.
- Added EVENT START command to Summary of FFV Extensions table.
- Added Y/C selection to Component video output selection list.
- Added note to indicate that Analog pass-through is not available on Recon.
- Added various supported commands and responses previously missing from this document.

SUMMARY OF CHANGES IN THIS DOCUMENT

REVISION 2.2

- Clarified command hardware-specifics.
- Merged in the "Commands for QuickTime File Format and FAT32 File System" document. Added new Section 1.4, WINDOWS/DOS FAT32 FILE SYSTEM, and new Section 1.5, QUICKTIME FILE FORMAT. Succeeding sections renumbered. Added configuration item code C0, Disk Format, and code C1, File Format for New Recordings. Added new Section 3.6, DISK PARAMETER SET, NEXT FORMAT. Added new Section 6.12, CONVERT NATIVE CLIP TO QUICKTIME.
- Added ERASE SEGMENT Odetics Protocol command to Section 2.10.
- Added Microphone Input selection to Audio input select configuration item.
- Added CONFIGURATION ITEM codes for Instant startup mode and Automatic disk format.
- Added status block flags for 'copy' and 'other', and erroneous redundant checksum.
- Added comment about what was returned by the DIRECTORY RESPONSE at the end of a sequence or directory entry not found.
- SET TIME LAPSE INTERVAL, TIME CODE FORM command time code revised to Sony protocol format.
- Added comment in TIME / DATE READ RESPONSE about alternate month/day ordering.
- Added new Section 6.13, DEVICE CONTROL.
- Added new Section 6.14, DISK POWER DOWN (SLEEP).

REVISION 2.3

- Added NTSC 720x480 resolution to CONFIGURATION ITEM code 10 hex.

REVISION 2.4

- Combined Section 2.1, OVERVIEW, with Section 1.1, COMMUNICATION PROTOCOL. Moved Section 2.2, ACK/NAK and Section 2.3, CHECKSUM to Section 1. Moved Section 2.4, DEVICE TYPE REQUEST to Section 3. Added Section 1.5, TIME CODE to consolidate explanations removed from other sections. Renumbered Sections 1, 2 and 3 appropriately.
- Revised loop recording description (CONFIGURATION ITEM code 62 hex) to indicate across available space rather than total disk space.
- Bolded BVW-75 only note on Section 2.5 and appended note to table.
- Fixed typo in checksum of PREVIEW OUT RESET command in Section 2.6.
- Added Byte 8 information to table in Section 2.4.
- Fixed typo in Byte 1 (4F) of DISK POWER DOWN (SLEEP), Section 6.14, and revised time window for disk power down to ten seconds.
- Added CONFIGURATION ITEM codes for Audio data frame format, Audio gain and Audio de-emphasis filter.
- Added comment in STATUS BLOCK Clip ID and Disk ID values when no clip is on screen in Section 4.1.
- Added comment about DELETE command deleting entire QuickTime files irregardless of frame range specified.
- Added Section 7, CALCULATING DVR FRAME SIZES, DATA RATES AND DISK SPACE USAGE.

REVISION 2.5

- Added additional HD video standards to CONFIGURATION ITEM code 10 hex.
- Added 4 channel multiplex option to CONFIGURATION ITEM code 50 hex.
- Added additional board types to CONFIGURATION ITEM code B8 hex.
- Added CONFIGURATION ITEM code and response for DVR board PCB revision.
- Added CONFIGURATION ITEM code and response for DVR board serial number.
- Revised Section 3.5, Update Recorder Firmware for non-OmegaDeck hardware.
- Updated Section 3.6, Serial Port 0 Configuration.
- Added Section 6.8, RECORDING EVENT MARK. Subsequent sections renumbered.

REVISION 2.6

- Added note to Section 1.8 regarding QuickTime file use with FFV HiDef DVRs.
- CONFIGURATION item codes A0 and A1 are applicable to Standard Definition DVRs only.
- Added Embedded Serial Data Stream Protocol definition to Section 3.6.

Revision 2.7

- Added Section 1.5 on serial protocol timing. Renumbered subsequent sections.
- Revised Section 1.8 FAT32 file naming convention description. Also added additional firmware limitations.
- Added LIST PREVIOUS ID and GET CURRENTLY LOADED ID commands to Section 2.6.
- Added CONFIGURATION ITEM code 00 hex, reset operations.
- Added additional HD video standards to CONFIGURATION ITEM code 10 hex.
- Added CONFIGURATION ITEM code 21 hex, auto-detection of input HD video format.
- Added CONFIGURATION ITEM codes 68 hex, recording auto-start modes, 69 hex, recording auto-start delay and 6A hex, recording auto-stop delay.
- Added CONFIGURATION ITEM code 71 hex, GOTO command QuickTime file cueing mode. This provides backward compatibility with older firmware cueing operation.
- Added CONFIGURATION ITEM code 88 hex, input time code source selection.
- Clarified restrictions in CONFIGURATION ITEM code 9F hex, instant startup mode.
- Added configuration value 2 to CONFIGURATION ITEM C1 hex, file formats.
- Added CONFIGURATION ITEM codes E8 hex and E9 hex, Serial Port 0 baud rate and parity.
- Clarified STATUS BLOCK flag 20 hex and added a table of error codes in Section 4.1.
- Clarified error response of MOE ID 0000 in TITLE MESSAGE, Section 5.10.
- Added GOTO command flags FFF7, FFF6, FFF5 and use of a MOE ID.
- Clarified value ranges in REAL TIME CLOCK TIME/DATE SET and READ commands.