EDITING SUITE AUDIO MIXERS

Serial II Protocol - Extended

(Revision 3)

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1. GENERAL

1.1 Purpose

This document defines the protocol for the control of a GPS Editing Suite Audio Mixer. There are two main elements to this protocol. The first is the transmission of data necessary to control communication, and the second is the transmission of data required to perform tasks. These two elements will be described independently.

In addition to the protocol definition, the basic electromechanical interface is specified. This conforms to ANSI standard PH22.207M, which specifies the connector pinout, word format (1 start bit, 8 data bits, 1 even parity bit, 1 stop bit), and baud rate (38.4 kbaud).

Finally, some discussion of the purpose of the commands, and some hints on their usage during editing, is included.

This extended version of the protocol allows up to eight output channels to be controlled simultaneously. While it has been necessary to add some new commands, full compatibility with the earlier version of Serial II is maintained[1].

1.2 Terms

Terms used in this document are generally familiar to the editing community, e.g. FROM refers to something at the start point of the edit, MONITOR is the audio actually heard at any time. Other terms, however, will benefit from some clarification. A SOURCE is a single monophonic input to the mixer. Sources are numbered from 1 to 255. A FADER is a single monophonic fader. Each fader controls the level of the source with same number. A MACHINE is a group of sources, the grouping and configuration of which is specified in the mixer. For example, if machine 2 is a stereo machine with track 1 feeding source 3 and track 2 feeding source 4, a command to select machine 2 will select sources 3 and 4. They may be selected as a stereo pair, but more complex machine assignments are also possible. Machines are numbered from 1 to 255.

1.3 Changes

This rev 3 document incorporates the following changes from rev 2:

- The document has been reformatted from the original troff into MS Word 6.0 format. The style has changed slightly, but the content is identical to previous releases of the *Serial II Protocol - Extended (rev 2)*.
- An addendum has been added detailing the *Monitor Mute* and *Delay* extensions to the protocol which are implemented in the Graham-Patten D/ESAM® mixer line.

[1] A minor exception: the editing system no longer has control over the monitor mute.

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2. COMMUNICATION PROTOCOL

Communications protocol for the Edit Suite Audio Mixer will conform to the SMPTE recommended practice #113[2]. Briefly, this protocol consists of a break character, to bring the device from an idle state to an active state, followed by two bytes of address. If this address is not that of the ESAM, it will return to the idle state. If the address does belong to the ESAM, it will enter the select state and prepare to receive further communication.

Because of the lack of standardized codes for audio mixers, the first data byte transmitted from the bus controller (editing system) must be an ESC (03 hex) character to enter the user defined communication area of the recommended practice. After receiving this the ESAM will respond with an ACK (04 hex) character. Receipt of any other character, or a parity or other communication error, will cause the ESAM to return to the idle state.

After each message (see Section 3, MESSAGE STRUCTURE AND TIMING) is received the ESAM will respond either with data or a status byte. The only exception is when a valid command is sent to an effects bank which does not exist. In this case no response is made. Other responses are as follows.

COMMERR (40 hex) This status byte is returned if a communication error, typically parity, occurs.

COMACC (80 hex) This status byte is returned to indicate that a WRITE command has been received correctly. It does not guarantee that the command will be processed as it might not be implemented.

STX (02 hex) This status byte is sent in response to a READ command. It is followed by the requested data sent in the form of a write command.

COMUIC (10 hex) This status byte is sent in response to a READ command which was correctly received, but which is not implemented.

It is never necessary for the controller to wait for a status or data response because received commands will be processed sequentially. However, if the controller does not wait it must be capable of associating each response with the correct command, and must recover gracefully from a received COMERR status byte.

Although the break-address-escape sequence required by RP113 is a significant overhead to communications, in typical radial interconnect systems it is only necessary to send the sequence once at the initiation of communications. From this point the ESAM will remain selected and no further communications protocol need be transmitted. After receipt of a COMERR response it is prudent, although not mandatory, for the controller to re-establish communication with the break-address-escape sequence.

The address defined for ESAM systems will be 88A6 hexadecimal.

[2]RP113-1983, "Supervisory Protocol for Digital Control Interface," *SMPTE J.*, 93:622-624, June 1984.

3. MESSAGE STRUCTURE AND TIMING

3.1 Basic Message Format

A message is comprised of a sequence of between 3 and 256 bytes. The significance of each byte is described below.

3.1.1 Byte Count.

The first byte is always a message length indicator and is equal to the total number of bytes in the message excluding the byte count itself. It has a minimum value of 2 and a maximum value of 255. It is used for buffer preparation and, possibly, message synchronization.

3.1.2 Effects Address.

This byte directs the message to the correct effects system within the audio mixer. Effects addresses specified to date are 1 for the main crosspoint and fader selection, 2 for a programmable equalizer, and 3 for programmable delay.

3.1.3 Command Code.

The third byte is always a command code. It identifies the syntax of the data, if any, which follows. It may also be used for message synchronization.

3.1.4 Data Bytes.

A number of bytes, equal to the byte count minus 2, are considered to be data, and are interpreted according to the syntax of the command.

3.2 Command Execution Timing

To avoid ambiguity in the time at which a command is executed by the ESAM, the following rules apply to the execution time.

a) A message received in its entirety by the end of field 1 will be executed at the beginning of the next field 1.

b) A message received in its entirety by the end of field 2 will be executed at the beginning of the next field 2.

c) A delay command received under one of the above conditions will delay the execution of commands received under the same condition by the specified amount. The delay will remain in effect for only one execution point.

4. THE COMMANDS

4.1 Descriptions

Most of the following commands are capable of being either a set data command (WRITE) or a send status command (READ). Write commands always have the most significant bit set to one. Read commands have the msb cleared and cause a response which is identical to the write command which would be sent to the mixer to effect that status.

Capability has been included to allow the operator to disable the ESAM response to certain groups of write commands. This allows specific control functions to be manually overridden when required. The effect of these external control enable/disable functions are specified for each individual command. See section 4.1.9 for currently defined control groups.

Commands flagged with a † have been modified from their original definitions. Commands flagged with a ‡ are new to this extended protocol. Commands flagged with a * are not currently implemented in GPS ESAMs, but are implemented in D/ESAMs. Commands flagged with a ** are not currently implemented in any GPS mixers.

All numerical data in these descriptions are in hexadecimal.

4.1.1 All Stop

Write only command, A0

Terminates all transitions currently in progress and returns the faders to the limit they were leaving. The monitor mode is restored to sources, see 4.1.7. Any internal flags will be set to their normal state. This command returns the mixer to a known state before the next edit. External transition control and external monitor control will disable their respective reset functions.

4.1.2 FROM Source

Read commands, 21 and 22 (channels 1 and 2)
Write commands, A1 and A2 (channels 1 and 2)

Sets, or reports the status of, the audio sources selected as being active at the FROM edit point. The data format allows for multiple simultaneous source selections. Write has no effect if external source control is disabled.

4.1.3 TO Source

Read commands, 23 and 24 (channels 1 and 2)
Write commands, A3 and A4 (channels 1 and 2)

Sets, or reports the status of, the audio sources selected as being active at the TO edit point. The data format allows for multiple simultaneous source selections. Write has no effect if external source control is disabled.

4.1.4 Monitor Source

Read commands, 25 and 26 (channels 1 and 2)
Write commands, A5 and A6 (channels 1 and 2)

Sets, or reports the status of, the audio sources selected for monitoring. The data format allows for multiple simultaneous source selections. Write has no effect if external monitor control is disabled.

NOTE

See section 5.2 for application of the MONITOR source command vs. the FROM source and TO source commands.

4.1.5 Transition Duration

Read commands, 27 and 28 (channels 1 and 2).
Write commands, A7 and A8 (channels 1 and 2).

Sets, or reports the status of, the rate for the edit transition. It is set in frames.

NOTE

The above four commands, while still valid, now have extended versions for multi-channel operation (see 4.1.24 through 4.1.27).

4.1.6 Transition Start†

Read command, 29
Write command, A9

Write starts a crossfade transition between the FROM and TO sources on the specified channels. The status returned following a read request has those data bits set which correspond to the transitions currently in progress. If external duration is enabled, data from the last Transition Duration command will determine the transition rate. With external duration disabled, the transition rate must be set on the ESAM control panel. The data format allows for simultaneous multi-channel starts. Write has no effect if external transition control is disabled.

4.1.7 Monitor Mode†

Read command, 2A
Write command, AA

Sets, or reports the status of, the monitoring outputs. Each channel is independently controllable and can monitor either the sources specified by the last MONITOR SOURCE command, or the output of the mixer. The data format handles multiple channels simultaneously.

4.1.8 Restore FROM Edit†

Write only command, AB

Restores the mixer source selection configuration to its status prior to the last edit transition. The command is always active. The data format handles multiple channels simultaneously.

4.1.9 Status

Read only command, 2C

Reports the status of the control functional groups, either enabled or disabled. The groups are: source (TO/FROM sources), monitor (sources and mode), transition (starts), rate (transition durations), level (faders) and learn (registers). The command is always active.

NOTE

An ESAM which does not allow a functional group to be disabled will always return "enabled" for that group. Similarly, an ESAM which does not provide for external control over a functional group will always return "disabled" for that group.

4.1.10 Fader Level*

Read command, 2D
Write command, AD

Sets, or reports the status of, the fader number specified as part of the data. The level data identifies absolute position and lies between 0 and 255, where 0 specifies a lower gain than 255. Write has no effect if external level control is disabled.

4.1.11 Save Mixer

Write only command, AE

Causes the current status of the mixer to be saved in the register number specified in the data. Has no effect if external learn control is disabled.

4.1.12 Recall Mixer

Write only command, AF

Causes the mixer to be configured according to the status saved in the register number specified in the data. Only those portions of the mixer which have their external control enabled will be reconfigured. The command is always active.

4.1.13 Transfer Register

Read command, 30
Write command, B0

Sets, or reports, the data in the storage register whose number is specified as part of the data. Write has no effect if external learn control is disabled.

NOTE

See section 5.10 for further information on the usage of this command

4.1.14 Configuration

Read only command, 31

Reports the configuration of the ESAM. Information includes the number of available learn registers, the number of machines, the number of sources and the number of effects banks.

4.1.15 Lamp Control**

Read command, 32 or 33
Write command, B2 (ON)
Write command, B3 (OFF)

Write turns on or turns off the panel indicator lamp specified in the data. The mixer will function according to the new panel configuration. Read will cause a response which is the appropriate write message depending on the status of the lamp specified in the data. The command is always active.

NOTE

See section 5.7 for further information on the usage of this command

4.1.16 FROM Machine

Read command, 34
Write command, B4

Sets, or reports the status of, the group of sources corresponding to a machine number selected as being active at the FROM edit point. Write has no effect if external source control is disabled.

4.1.17 TO Machine

Read command, 35
Write command, B5

Sets, or reports the status of, the groups of sources corresponding to a machine number selected as being active at the TO edit point. Write has no effect if external source control is disabled.

4.1.18 Monitor Machine

Read command, 36
Write command, B6

Sets, or reports the status of, the groups of sources corresponding to a machine number selected for monitoring. Write has no effect if external monitor control is disabled.

NOTE

See section 5.1 for the application of machine commands vs. source commands.

4.1.19 Delay Execution

Write command only, B7

Sets the amount of delay for the next associated execution point.

4.1.20 Fader Ramp*

Write command only, B8

Initiates a fader ramp. The command moves the specified fader to a new relative position in a specified number of frames. Write has no effect if external level control is disabled.

4.1.21 Initialize Changes**

Write command only, B9

Used in conjunction with the REPORT CHANGES command. The ESAM will begin recording all changes from the current state. It will exit the recording process and flush the data after 5 frames.

4.1.22 Report Changes

Read command only, 3A

Used in conjunction with INITIALIZE CHANGES command. The contents of the recorded changes buffer will be returned by the ESAM following a status byte. The buffer is then reinitialized equivalent to receiving the INITIALIZE CHANGES command.

NOTE

See section 5.5 for the application of initialize and report changes.

4.1.23 Crossfade Limits**

Read command, 3B
Write command, BB

Sets, or reports the status of, the limits of the crossfade travel. A crossfade normally transitions completely from the FROM sources to the TO sources. This command allows the FROM sources to fade down to a specified level rather than completely off, and/or the TO

sources to fade up from a specified level. The command affects only the next transition. Receipt of an ALL STOP will terminate the effectivity of the command.

NOTE

See section 5.6 for the application of crossfade limits.

4.1.24 FROM Sources (Multi-channel)‡

Read command, 3C
Write command, BC

Sets, or reports the status of, the audio sources selected as being active on the specified channel at the FROM edit point. The data format allows for simultaneous selection of multiple sources on multiple buses. Write has no effect if source control is disabled.

4.1.25 TO Sources (Multi-channel)‡

Read command, 3D
Write command, BD

Sets, or reports the status of, the audio sources selected as being active on the specified channel at the TO edit point. The data format allows for simultaneous selection of multiple sources on multiple buses. Write has no effect if source control is disabled.

4.1.26 Monitor Sources (Multi-channel)‡

Read command, 3E
Write command, BE

Sets, or reports the status of, the audio sources selected on the specified monitoring channel. The data format allows for simultaneous selection of multiple sources on multiple buses. Write has no effect if monitor control is disabled.

4.1.27 Transition Duration (Multi-channel)‡

Read command, 3F
Write command, BF

Sets, or reports the status of, the rate for the edit transition on the specified channel. It is set in frames. The data format allows the duration on multiple channels to be set simultaneously.

NOTE

See section 5.8 for the application of the new multi-channel commands.

4.1.28 Swap Machine*‡

Write only command, C0

Exchanges the identity of the two named logical machines including associated crosspoint numbers and input channels. This command applies only to ESAMs having assignable logical machines. The command is always active.

4.1.29 Crosspoint Assignment*‡

Read command, 41
Write command, C1

Sets, or reports the status of, the crosspoint associated with the named logical machine. This command applies only to ESAMs having assignable logical machines. The command is always active.

NOTE

See section 5.9 for further information on the usage of Swap Machine and Crosspoint Assignment commands.

4.2 DATA FORMATS

The following definitions describe the format of the data associated with each specific command or group of commands. Any unused bits should be considered as reserved and should be set to zero for consistency.

All numerical data are in hexadecimal, except where otherwise specified. B0 is the least significant bit and b7 is the most significant bit. For completeness, the byte count for each command is included.

See section 4.1, Descriptions, for notes regarding the † , ‡, * and ** symbols.

4.2.1 All Stop (A0)

Write only command, length 02

No data

4.2.2 Sources (21-26 and A1-A6)

Read command, length 02

No data

Write command, length variable (03-22)

1-32 decimal data bytes, individual bits

Byte 1:
b0=1 select source 1 on specified bus.
=0 clear source 1 from specified bus.
b1 ditto source 2.
b2 ditto source 3.
b3 ditto source 4.
b4 ditto source 5.
b5 ditto source 6.
b6 ditto source 7.
b7 ditto source 8.

Byte 2:
ditto sources 9-16.

Byte 3:
etc.

4.2.3 Transition Duration (27-28 and A7-A8)

Read command, length 02

No data

Write command, length 04

2 data bytes, binary data

Mix duration in frames, 0-32767 decimal.

4.2.4 Transition Start (29 and A9)†

Read command, length 02

No data

Write command, length 03

1 data byte, individual bits

b0=1 start channel 8 transition.
=0 channel 8 unaffected.
b1 ditto channel 7.
b2 ditto channel 6.
b3 ditto channel 5.
b4 ditto channel 4.
b5 ditto channel 3.
b6 ditto channel 2.
b7 ditto channel 1.

4.2.5 Monitor Mode (2A and AA)†

Read command, length 02

No data

Write command, length 03

1 data byte, individual bits

b0=1 monitor mixer output channel 8.
=0 monitor source bus channel 8.
b1 ditto channel 7.
b2 ditto channel 6.
b3 ditto channel 5.
b4 ditto channel 4.
b5 ditto channel 3.
b6 ditto channel 2.
b7 ditto channel 1.

4.2.6 Restore FROM Edit (AB)†

Write only command, length 03

1 data byte, individual bits

b0=1 restore channel 8.
=0 channel 8 unaffected.
b1 ditto channel 7.
b2 ditto channel 6.
b3 ditto channel 5.
b4 ditto channel 4.
b5 ditto channel 3.
b6 ditto channel 2.
b7 ditto channel 1.

4.2.7 Status (2C)

Read only command, length 02

No data

Response (write command), length 03

1 data byte, individual bits

b0-b1 not used.
b2=1 external learn control enabled.
=0 external learn control disabled.
b3 ditto external level control.
b4 ditto external rate control.
b5 ditto external transition control.
b6 ditto external monitor control.
b7 ditto external source control.

4.2.8 Fader Levels (2D and AD)*

Read command, length 03

1 data byte, binary data

Fader number, between 1 and 255 decimal, being interrogated.

Write command, length 04

2 data bytes, binary data

Byte 1:
Fader number, between 1 and 255 decimal, being set.

Byte 2:
Value, between 0 and FF, to which fader must be set. The value FF gives more gain than the value 0.

4.2.9 Save Mixer (AE)

Write only command, length 04

2 data bytes, binary data

Byte 1:
b0-b3 most significant nibble of register number.
b4-b7 unused

Byte 2:
Least significant byte of register number.

NOTE

The register number must be between 1 and the maximum specified in the CONFIGURATION command. It must never be greater than 4095 decimal.

4.2.10 Recall Mixer (AF)

Write only command, length 04

2 data bytes, binary data

Byte 1:
b0-b3 most significant nibble of register number.
b4-b7 unused

Byte 2:
Least significant byte of register number.

NOTE

See SAVE MIXER for limits on register numbers.

4.2.11 Transfer Register (30 and B0)

Read command, length 04

2 data bytes, binary data

Byte 1:
b0-b3 most significant nibble of register number.
b4-b7 unused

Byte 2:
Least significant byte of register number.

Write command, length variable

Data bytes

Byte 1:
b0-b3 most significant nibble of register number.
b4-b7 number of segments remaining after this transfer.

Byte 2:
Least significant byte of register number.

Remaining bytes:
Register segment contents.

NOTE

See SAVE MIXER for limits on register numbers.

4.2.12 Configuration (31)

Read only command, length 02

No data

Response (write command), length 07

5 data bytes, binary data

Byte 1 & 2:
The highest register number available in the mixer. It must not exceed 4095 decimal. Zero means that no registers are available.

Byte 3:
The number of machines available, 1-255 decimal. Zero means machine select is not available.

Byte 4:
The number of sources available, 1-255 decimal. Zero means source select is not available.

Byte 5:
The number of effects banks available.

4.2.13 Lamp Control (32-33 and B2-B3)**

Read command, length 03

1 data byte, binary data

Number of the lamp being interrogated.

Write command, length 03

1 data byte, binary data

The number of the lamp to be turned on or off.

4.2.14 Machines (34-36 and B4-B6)

Read command, length 02

No data

Write command, length 03

1 data byte, binary data

Machine number, 0-255 decimal.

4.2.15 Delay Execution (B7)

Write only command, length 03

1 data byte, binary data

Delay in 1/10 fields, 1-9 decimal.

4.2.16 Fader Ramp (B8)*

Write only command, length 06

4 data bytes, binary data

Byte 1:
Fader number, between 1 and 255 decimal, being set.

Bytes 2 & 3:
Duration of fader move in frames, 0-32767. The msb indicates movement direction, 1 = increase gain, 0 = decrease gain.

Byte 4:
Number of units to move fader, 1-255 decimal.

4.2.17 Initialize Changes (B9)**

Write only command, length 02

No data

4.2.18 Report Changes (3A)**

Read only command, length 02

No data

Response, length variable (overall byte count is used)

Byte 1: Binary data
0 = not initialized
1 = no changes made since initialization
2 = changes made as follows:

Remaining bytes: those commands, including their individual byte counts, which, when written back, will effect the changes which have taken place.

4.2.19 Crossfade Limits (3B and BB)**

Read command, length 02

No data

Write command, length 04

2 data bytes, binary data

Byte 1:
The FROM source level at the end of the crossfade, 0-255 decimal. 0 is normal, i.e. fully off at the end of the crossfade, 255 is fully on.

Byte 2:
The TO source level at the beginning of the crossfade, 0-255 decimal. 0 is normal, i.e. fully off at the beginning of the crossfade, 255 is fully on.

4.2.20 Sources (3C-3E and BC-BE)‡

Read command, length 03

1 data byte, individual bits

b0=1 report sources on channel 8.
=0 ignore channel 8.
b1 ditto channel 7.
b2 ditto channel 6.
b3 ditto channel 5.
b4 ditto channel 4.
b5 ditto channel 3.
b6 ditto channel 2.
b7 ditto channel 1.

Write command, length variable (04-23)

2-33 decimal data bytes, individual bits

Byte 1:
b0=1 set sources on channel 8.
=0 channel 8 unaffected.
b1 ditto channel 7.
b2 ditto channel 6.
b3 ditto channel 5.
b4 ditto channel 4.
b5 ditto channel 3.
b6 ditto channel 2.
b7 ditto channel 1.

Byte 2:
b0=1 select source 1 on specified buses.
=0 clear source 1 from specified buses.
b1 ditto source 2.
b2 ditto source 3.
b3 ditto source 4.

b4 ditto source 5.
b5 ditto source 6.
b6 ditto source 7.
b7 ditto source 8.

Byte 3:
ditto sources 9-16.

Byte 4:
etc.

4.2.21 Transition Duration (3F and BF)‡

Read command, length 03

1 data byte, individual bits

b0=1 report duration on channel 8.
=0 ignore channel 8.
b1 ditto channel 7.
b2 ditto channel 6.
b3 ditto channel 5.
b4 ditto channel 4.
b5 ditto channel 3.
b6 ditto channel 2.
b7 ditto channel 1.

Write command, length 05

3 data bytes

Byte 1:
b0=1 set duration on channel 8.
=0 channel 8 unaffected.
b1 ditto channel 7.
b2 ditto channel 6.
b3 ditto channel 5.
b4 ditto channel 4.
b5 ditto channel 3.
b6 ditto channel 2.
b7 ditto channel 1.

Bytes 2-3:
Mix duration in frames, 0-32767 decimal.

4.2.22 Swap Machine (C0)*‡

Write only command, length 04

2 data bytes, binary data

Byte 1 & 2:
The two logical machines to be swapped. The translation between logical machine name and the value for bytes 1 & 2 is as follows:

A = 1, B = 2, C = 3, ... Z = 1A,
REC1 = FF, REC2 = FE, ... REC16 = F0,
AUX1 = EF, AUX2 = EE, ... AUX16 = E0,
(0 is illegal).

4.2.23 Crosspoint Assignment (41 and C1)*‡

Read command, length 03

1 data byte, binary data

The logical machine name. The translation between logical machine name and the value of the data byte is as follows:

OFF = 0, A = 1, B = 2, C = 3, ... Z = 1A,
REC1 = FF, REC2 = FE, ... REC16 = F0,
AUX1 = EF, AUX2 = EE, ... AUX16 = E0.

Write command, length 04

2 data bytes, binary data

Byte 1:
The logical machine name. The translation between logical machine name and the value of this data byte is as follows:

OFF = 0, A = 1, B = 2, C = 3, ... Z = 1A,
REC1 = FF, REC2 = FE, ... REC16 = F0,
AUX1 = EF, AUX2 = EE, ... AUX16 = E0.

Byte 2:
The crosspoint number between 0 - 255 decimal.

NOTE

The following apply to the above commands.

a) Commands A1-A6 and BC-BE have a variable number of data bytes to accommodate up to 255 sources without overburdening communication in smaller systems. If a write command sends data for less sources than exist in the mixer, all unspecified sources will be turned off. Similarly, any excess sources specified will be ignored.

b) Commands specifying transition duration have a maximum of 32767 frames. If the duration exceeds the capability of an ESAM it will use its maximum duration.

c) If the mixer bus status does not conform to any particular machine when a machine status (command 34-36) is requested, zero will be returned as the machine number. Writing machine zero will select silent.

d) Registers may be transferred in segments to accommodate very large register contents. If multiple segments are required the header of a segment will specify the number of segments remaining after this transfer.

e) Only 3 messages are valid for effects bank #2, the programmable equalizer. They are SAVE MIXER, RECALL MIXER, and TRANSFER REGISTER.

f) All binary data is transmitted most significant byte first when more than one byte is required.

g) Commands which can write data to multiple channels (buses) simultaneously (BC-BF) should not be used in their read form (3C-3F) with multiple channels specified. If so used the response of the ESAM is unpredictable.

5. COMMAND USAGE

This section discusses the operation of various command groups. It also provides guide lines for their use during editing.

5.1 SOURCES vs. MACHINES

There are three commands in each of these groups. They allow the appropriate channels of each playback machine to be routed to the record machine or monitoring system inputs, but achieve the result in different ways.

Source commands allow the editing system to directly control the configuration of each playback machine, as it is selected, on an edit by edit basis. It requires that the editing system include the necessary dialog to allow the editor (the person) to assign arbitrarily complex machine configurations. It also requires that the editing system be told the exact number of audio tracks associated with a given playback machine. (It is not sufficient to know the type of VTR being used as another audio machine might be slaved to it.) This style of operation is very flexible, allowing all configuration to be performed via the editing system keyboard. It is, however, alien to editing systems in as much as entities other than complete machines must be handled. Also, keeping all the track configuration in the EDL may lead to confusion.

Machine commands allow the editing system to deal with the audio content of the edit in basically the same way as the video content. Although requiring that the editor specify the machine's audio track configuration via the ESAM panel, rather than the keyboard, this is not an unnatural place to do it. It significantly lessens the impact of changes to the number of tracks on the editing system; a machine is a machine is a machine. (For example, the change from 2-track to 4-track machines would require no change to the editing system input selection software.) The playback configuration can still be saved with the edit decision list, through the use of register saves, recalls, and transfers, while reducing list clutter.

Because machine commands are synergistic with the essence of video editing, and because they isolate the editing system from the detail of audio track assignment, it is strongly recommended that they be used in preference to source commands.

5.2 FROM/TO vs. MONITOR

The use of FROM and TO commands (either sources or machines) is apparent from the command names. They are used to configure the inputs for an edit event. However, the use of the monitor machine is not necessarily so obvious. The purpose is to give the editor the flexibility to use the audio from a machine differently at different times without reconfiguring. One example is when not all the tracks from a machine are to be used during the edit, but all tracks must be monitored while the in and out points are being marked. Another is that the normal record machine might always be monitored post-fader but must be pre-fader when temporarily used as a source in an edit.

The different capabilities available between FROM/TO and monitor selections may vary from mixer to mixer, but having separate commands allows the different functions to be distinguished.

As a general rule the monitor commands should be used for selecting inputs any time that a machine is being played for a purpose other than recording its output as part of an edit.

5.3 MONITOR MODE

This command allows the ESAM to simulate to function of the preview switcher normally associated with an editing system. It switches between monitoring the mixer output and the inputs specified by the last monitor command. This has the advantage over a standard preview switcher that all machines are available as inputs on one side of the switch, not just the normal record machine. This minimizes the amount of patching required when the record machine is reassigned.

The command should be used in exactly the same way as the editing system normally controls its own preview switcher. There are some editing systems that cannot identify the current record machine in the mixer/switcher interface software modules. A useful feature

of the Graham-Patten Systems ESAMs in these cases is the ability to store the current record machine and optionally recall this when the monitor mode is switched back to the input side.

5.4 RESTORE EDIT

It is frequently necessary for the editor to disable source external control with current editing systems. This introduces the problem of having the FROM and TO sources reversed after each preview edit. A simple remedy is available by using the All Stop and Restore Edit commands correctly.

The All Stop command should be sent at the end of every edit as a precaution to ensure that the mixer is in a well defined state. Additionally, a Restore Edit should be sent after a preview edit or an aborted perform edit if the dissolve ran to termination.

A secondary use of this command is in performing zero frame dissolves and cuts. A cut which is effected by simply sending source or machine selection commands will fail when external source control is disabled, preventing the editor from manually overriding the editing system. As the Restore Edit command simply reverses the roles of the FROM and TO sources, a cut will occur when the command is received regardless of the state of the source control enable.

Although this technique produces the desired result, the preferred technique for performing a cut is to use a zero frame dissolve. This not only preserves all the control features of a dissolve, but, in GPS ESAMs, results in a *softer* transition (about 1.5 ms) than a straight cut.

5.5 INITIALIZE/REPORT CHANGES

The initialize changes and report changes commands can be used by an editing system to follow manual operations performed on the mixer control panel. This is useful when the editing system operates under the philosophy that all complex operations can first be performed manually, stored in the list *on the fly*, and subsequently trimmed to achieve the desired result.

To do this, the editing system must send the initialize changes command at the beginning of the event to be recorded. Then, on a field-by-field or frame-by-frame basis, the editing system must send the report changes command to find out the events that took place in the last field or frame. These events will be stored in the EDL.

When the event is completed, the editing system need not send any more commands as the recording process in the ESAM will be aborted five frames after the last report changes command is received.

5.6 CROSSFADE LIMITS

The crossfade limits command provides a simple way for the editing system to control a *voice-over* edit. The following paragraph describes how to do a simple dissolve from VTR-A to VTR-B over a reduced level VTR-A, and back again.

Send commands *FROM machine VTR-A* and *TO machine VTR-B*. Set up the required dissolve duration. Send the *crossfade limits* command with the first data byte (finishing FROM level) set to a non-zero value, equivalent to the desired amount of audio dip, and the second byte (starting TO level) set to zero. Start the dissolve; VTR-A will fade down, but not out, and VTR-B will fade in. Repeat the process in reverse (FROM VTR-B, TO VTR-A) with the *crossfade limits* data set to zero for the first byte and the same non-zero value as used initially for the second byte. Start the dissolve; VTR-B will fade out and VTR-A will fade back up.

The operation of this voice-over sequence is very simple for the editing system but does suffer from a limitation–once the voice-over mix has been initiated no other dissolves can take place before *backing-out* of the voice-over. For more complex situations, the fader levels command can be used to produce a change in the input fader setting at the same time as the dissolve occurs. Because the actual input level has been changed, rather than just stopping the crossfade before completion, the new reduced level can be used in subsequent edits before eventually being returning to its original setting.

5.7 LAMP CONTROL

This command was intended to allow the editing system to access features implemented in a mixer but not covered by this protocol. As this implies that the protocol is no longer standard, and the purpose of the protocol is to standardize the editing system's control of different mixers, the command should not be used.

5.8 MULTI-CHANNEL COMMANDS

These new commands have been added to allow control over mixers having up to eight buses feeding the record VTR. The new commands are FROM, TO, and monitor sources, and transition duration. The old, single-channel commands directed selection information to a specific bus, and were limited to two buses. The newly introduced multi-channel commands include the target bus information as part of their data, and can address up to eight buses.

Each of the new commands has one additional data byte used to specify the target bus or buses. Although one byte could be used to address up to 256 buses, the format chosen is a single bit-per-bus, rather than a binary number, and so is limited to eight buses. This reduces the amount of communication necessary to set up the more usual types of edit, e.g. the same transition duration can be set on all eight buses with a single command instead of having to transmit the same data individually for each of the eight.

Each of the new, multi-channel commands is directly compatible with its single-channel predecessor, and should be used in exactly the same way as, and in preference to, the older commands. (For compatibility, the old-style commands are still valid in the extended protocol.)

5.9 SWAP MACHINE/CROSSPOINT ASSIGNMENT

These commands accommodate the special needs of ESAMs with assignable logical machines, such as the GPS D/ESAM® 800. (An ESAM with assignable logical machines can change both the crosspoint number and the physical inputs associated with a logical machine name.)

Some editing systems give the operator the ability to exchange the identities of the record machine and a source machine to aid in multi-layer compositions. The industry has informally dubbed this function "*swap*".

For ESAMs without assignable logical machines, this swap is accomplished by exchanging the crosspoint numbers of the logical machines to be swapped within the edit controller. No special action is required by the ESAM.

In the case where the ESAM has assignable logical machines, information regarding the swap is required by the ESAM. The ESAM must respond to the Swap Machine message by doing two things:

1. Exchange the crosspoint numbers associated with the two logical machines to be swapped. (This matches a similar exchange performed by the editing system to correctly control ESAMs without assignable logical machines.)
2. Exchange the groups of physical inputs associated with the two logical machines to be swapped.

The two data bytes in the Swap Machine command are logical machine names, *not* crosspoint numbers. The numbers used in the command to represent the logical machine names are: A = 1, B = 2, C = 3, ... Z = 1A, AUX = EF, REC = FF. The order of these two data bytes is not important. In most cases, one of them will be the REC machine (FF).

If the ESAM has more than one REC machine, the second REC will be represented by the hex value FE; the third, FD and so forth, the limit being F0. This number could be thought of as the two's complement of the REC machine number. If the ESAM has more than one AUX machine, the second AUX will be represented by the hex value EE; the third, ED and so forth, the limit being E0. This number could be thought of as the two's complement of the AUX machine number minus sixteen.

Every editing system maintains a map associating crosspoint numbers with logical machine names. An ESAM with assignable logical machines maintains a similar map. These two maps must match for the system to operate correctly[3]. The Crosspoint Assignment command allows the editing system to change the data in the ESAM's map to match its own map.

Any editing system that changes its own map (by a means other than the *swap* function) should send Crosspoint Assignment commands to the ESAM to make the maps match. Typically, this happens when the editing system's crosspoint assignment table is changed manually. It may also happen on power-up, or other reset, if the editing system reverts to a default map, especially after performing an odd number of *swaps*.

5.10 TRANSFER REGISTER

There is nothing difficult about transferring small registers (251 bytes or less) between the editing system and the ESAM–the length byte identifies the register size, and the complete register is transferred in one message. However, variable-length, multi-segment register transfers (like thoses involving a GPS D/ESAM® 800) are more complex. Conforming to the following guide-lines will optimize performance and ensure compatibility across various devices.

1. Register segments should be sent in sequence. This allows the receiving device to determine the maximum possible size of the register to be transferred before storing any data. (*Max size = (n+1) 251* where *n* is the contents of the first *segments-to-follow* field.) The exact size cannot be determined until the last segment (*n* = 0) is received.
2. A register should be transferred using the minimum number of segments possible, i.e. use a few long messages rather than a lot of short ones. This prevents excessive buffer allocation in the receiving device, and minimizes transmission overhead due to message protocol.
3. The ESAM will respond to a Transfer Register read message from the editing system with a series of Transfer Register write messages. Each message, because it is self-contained, should be preceded by a STX (02 hex) status byte.

Because of the complex nature of variable-length, multi-segment register transfers, they are more error-prone than other messages. It is recommended that the ESAM use some mechanism to verify the integrity of a received register once the transfer is complete. e.g. a checksum of the register contents embedded in the data.

[3]Both the editing system and an ESAM with assignable logical machines work with logical machines. However, they communicate via this protocol which uses crosspoint numbers. If the assignment maps in the two devices do not match, a request for VTR A may, after translation to a crosspoint number and back again, result in the selection of VTR B.

6. ADDENDUM

This section contains further extensions to the Serial II Protocol - Extended (ver 2) which have been implemented on the D/ESAM® line of Edit Suite Audio Mixers from Graham-Patten Systems.

6.1 Monitor Mutes (42 and C2)

Description

This command controls the Monitor Bus Enables in the Preview section of the control panels labeled MON1, MON2, MON3, and MON4. Each of these pushbuttons, when lit, allow audio to pass from the corresponding preview bus to the monitor mixer (monitor level controls, MONO, 2-CH, etc.). It does not, however, affect the metering of those buses.

Data

One byte of data accompanies the Write command. It is called a *bus byte* data type. The *bus byte* specifies which of the monitor outputs the command will affect. A set bit cause that monitor bus to be enabled (Audio on). A cleared bit causes that monitor bus to be disabled (Audio off). Four buses may be accessed individually or in any combination.

b7	b6	b5	b4	b3	b2	b1	b0
Bus 1	Bus 2	Bus 3	Bus 4	n/a	n/a	n/a	n/a

Read example

Report which buses are enabled (to pass audio):

Length	Bank	Command
02	01	42

The response, assuming buses 1, 2, 3, and 4 are enabled:

STX	Length	Bank	Command	Buses
02	03	01	C2	F0

Write example

Enable buses 1 and 2 while disabling buses 3 and 4:

Length	Bank	Command	Buses
03	01	C2	C0

Applicable Effects Bank

1 (Mixer).

Caveats

Will not function without a control panel on D/ESAM® mixers.

Related commands

None.

Support status

Effective with all D/ESAM® versions after 2.0.

6.2 Delay Logical Machine (34 and B4)

Description

This command sets or reports the delay for a machine. The delay remains in effect until it is set to zero. The Write has no effect if external delay control is disabled.

Data

The Read command has one byte of data. The Write command has three. The first in both cases is the crosspoint number designating which machine will be affected.

The second and third bytes specify the amount of delay in hundredths of frames (0 - 655.35 frames). The most significant byte is first.

Read example

Report the delay setting for the machine number 5:

Length	Bank	Command	Machine
03	03	34	05

The response if the delay is 1 frame (or one hundred centiframes):

STX	Length	Bank	Command	Machine	Delay
02	05	03	B4	05	00,64

Write example

Set machine number 2 to have a delay of 3 fields (1.5 frames):

Length	Bank	Command	Machine	Delay
05	03	B4	02	00,96

Applicable Effects Bank

3 (Delay).

Caveats

None.

Related commands

None.

Support status

Supported. The internal resolution of delay is set in tenths of a frame. Received delay values are rounded to the nearest tenth of a frame. Effective with all D/ESAM ® versions after 3.0.

6.3 Delay Output (3F and BF)

Description

This command sets or reports the delay offset applied to all machine selections except the RECORD machine. This delay is additive to any individual machine delay set with the Delay Machine command. The delay remains in effect until it is set to zero by another write command. The write has no effect if external delay control is disabled.

Data

The Read command has one data byte. The Write command has three. The first in both cases is a bus byte data type. This bus byte indicates to which output buses the delay should be applied.

b7	b6	b5	b4	b3	b2	b1	b0
Bus 1	bus 2	Bus 3	Bus 4	Bus 5	Bus 6	Bus 7	Bus 8

The second and third bytes specify the amount of delay in hundredths of frames (0 - 655.35 frames). The most significant byte is first.

Read example

Report the output delay on bus one:

Length	Bank	Command	Buses
03	03	3F	80

The response, assuming the output delay is set to 1 frame (or one hundred centiframes):

STX	Length	Bank	Command	Buses	Delay
02	05	03	BF	80	00,64

Write example

Turn output delay off on all buses:

Length	Bank	Command	Buses	Delay
05	03	BF	FF	00,00

Applicable Effects Bank

3 (Delay).

Caveats

Mixer makers beware! This feature must not introduce delay in the selection of inputs, the start of transitions, or edit points. The feature must be implemented in a manner such that the audio is delayed, and not the command execution points.

Because of this caveat, it is difficult to imagine how one might make the individual delay setting for each output bus work. GPS doesn't implement individual delay setting for each output bus, and it is questionable whether it should be in the protocol.

Related commands

None.

Support status

Supported. The internal resolution of delay is set in tenths of a frame. Received delay values are rounded to the nearest tenth of a frame. The bus byte is ignored by GPS mixers. All outputs are set to the specified value regardless of the bus byte. Effective with all D/ESAM ® versions after 3.0.