

Protocol Manual

software release **5.1** and later

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MODEL 2200/3000/4000
DIGITAL PRODUCTION SWITCHERS

Grass Valley Products

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Contents

Section 1 — Introduction

General Description	1-1
Manual Contents	1-1
Editor Connectivity	1-2
Editor Port Jumpers	1-3
Model 3000	1-3
Communication Standard	1-3
Termination	1-3
Model 2200/4000	1-4
Communication Standard	1-4
Termination	1-4
Serial Data Word Description	1-5
Editor Enable Pushbutton	1-6
System Performance	1-6

Section 2 — Editor Protocol

Serial Communications	2-1
Editor Protocol Access	2-1
Break Character	2-2
Address Byte	2-4
Command/Message Block Structure	2-5
Byte Count	2-5
Effects Address Byte	2-5
Command Code Byte	2-6
Read Commands	2-6
Write Commands	2-6
Status and Data Replies	2-7
Error Detection	2-8
Transmission Errors	2-8
Protocol Errors	2-9

Section 3 — Editor Interface Commands

Introduction	3-1
Editor Interface Commands	3-1
Revision History	3-3
Application Examples	3-4
Example 1: Bringing the Editor Interface into a Ready State	3-4
Example 2: How to Set Crosspoint #6, A Row, Mix/Effects 2	3-4
ALL STOP (F2) Command (Version 5.1 and Later)	3-5
Effects Addresses	3-5
Crosspoint Bus (C1) Command (PGM/BKGD A/ AUX)	3-6
Effects Addresses	3-6
Crosspoint Numbers	3-7
Crosspoint Bus (C2) Command (PST/BKGD B)	3-8
Effects Addresses	3-8
Crosspoint Numbers	3-8
Crosspoint Bus (C3) Command (KEY 1/DSK 1)	3-9
Effects Addresses	3-9
Crosspoint Numbers	3-9
Crosspoint Bus (C4) Command (KEY 2/DSK 2)	3-10
Effects Addresses	3-10
Crosspoint Numbers	3-10
Crosspoint Bus (E2) Command (PVW)	3-11
Effects Addresses	3-11
Crosspoint Numbers	3-11
Crosspoint Bus (E3) Command (MASK)	3-12
Effects Addresses	3-12
Crosspoint Numbers	3-12
Pushbutton Select and Control (C6, C7 and FB) Commands	3-13
Effects Addresses	3-13
Pushbutton Numbers	3-14
Write Wipe Pattern (C8) Command	3-21
Effects Addresses	3-21
Wipe Numbers	3-21
Write Transition Mode (CA) Command	3-23
Effects Addresses	3-23
Mode Byte	3-23
Write Transition Rate Commands	3-25
Model 3000-2 and 4000-2B	3-25
Model 2200-2	3-25
Model 3000-3 and 4000-2A	3-26
Transition Rates	3-26
Write Auto Transition Rate (CC) Command	3-27
Effects Addresses	3-27
Transition Rate	3-27

Write Key Transition Rate (CD) Command	3-29
Effects Addresses	3-29
Transition Rate	3-29
Write Recall E-MEM Register (DB) Command	3-31
Effects Addresses	3-31
Mode Byte	3-32
Registers	3-34
Bit-Mask Format	3-34
Write Learn E-MEM Register (DA) Command	3-35
Effects Addresses	3-35
Mode Byte	3-36
Registers	3-36
Bit-Mask Format	3-37
Write Split Key (E4) Command	3-38
Effects Addresses	3-38
Crosspoint Numbers	3-39
Select “Layered” Or “Standard” (E8) Command	3-40
Effects Addresses	3-40
Mode Byte	3-40
Data Transfer (5E and DE) Commands	3-41
Effects Addresses	3-41
Register Number	3-42
Sequence Number	3-42
Data	3-42
Taking a Snapshot of the Switcher	3-42
Transfer Command Examples	3-43
Scenario 1	3-43
Scenario 2	3-45
Error Detection and Handling	3-47
Software Version (6C and EC) Commands	3-50
Effects Addresses	3-50
Model Number	3-50
Version Number	3-51
Switcher Model Features	3-51
Timeline Control (4E, 4F, CE, and CF) Commands	3-52
Effects Addresses	3-52
Bit-Mask Format	3-53
Data Field Format	3-53
Examples	3-54

Section 4 — Parameter-Based Command Set

Introduction	4-1
General Discussion of the Command Set	4-2
Addressing	4-2
Timing and Latency	4-3

Crosspoint Control Command(s)	4-3
Crosspoint Query Command (V5.3)	4-3
Addressing	4-3
Data	4-4
Example	4-4
Transition Parameter Control	4-5
Transition Query Command (V5.3)	4-5
Addressing	4-5
Data	4-6
Examples	4-7
E-MEM Parameter Control	4-8
E-MEM Query Commands (V5.3)	4-8
Addressing	4-8
Data	4-9
Examples	4-10

Section 5 — Digital Effects Interface

Introduction	5-1
General Background about Switcher / DPM Integration	5-1
Switcher Configuration	5-3
DPM Type	5-3
Aux Bus Assignment	5-3
Input Mapping	5-3
Effect Send and Control Delays	5-4
Switcher Software	5-4
DPM Enables	5-4
General Protocol Notes	5-5
Message Timing	5-5
Init/Online	5-6
Source Selection	5-7
Near/Far and Front/Back	5-8
Source Hold	5-8
Tally	5-9
Activity Check	5-9
Running Effects	5-10
Subscription	5-10
Message Format	5-11
Message Tokens	5-12
Set	5-13
Subscribe	5-14
Parameter Service	5-15
Unsubscribe	5-15
Issue	5-16
Parameter Article	5-17
Send Event	5-18
Return Code	5-19

Parameters 5-19

Other Command Specifics 5-21

Transmission Media and Protocols 5-21

Examples 5-22

 Example 1 5-22

 Example 2 5-22

 Example 3 5-23

 Example 4 5-23

 Example 5 5-24

 Example 6 5-24

 Example 7 5-25

 Example 8 5-25

 Example 9 5-26

Index

1

Introduction

General Description

The first four sections of this document describe the communications protocol supported by the Model 2200, 3000, and 4000 Switchers for use by editors. This protocol is called the “editor protocol” or “editor interface” in this document. This protocol is used by Grass Valley Sabre and Super Edit Editors. The information is provided in this manual for use by other vendors wishing to interface their editors to these Grass Valley switchers.

Detailed on the following pages are the protocols, data formats, and system timing requirements for commands exchanged between an editor and the Model 2200, 3000, and 4000 Production Switchers. Although the protocol is common for all of these switcher models, the different models do differ in their capabilities. The detailed capabilities of each model are described in the pertinent Operation manual. However, in general, the switchers do for the most part provide the same functionality. From the perspective of an editor, the major differences between the models are the number of M/Es and whether or not the switcher has a DSK and PGM/PST bus.

In addition, Section 5 of this manual describes the Control-Point Language (CPL) protocol used with the Grass Valley Krystal digital picture manipulator (DPM).

Manual Contents

This manual has been revised to incorporate changes made in the software since its initial release.

Section 1 — introduces this manual and the switcher communications protocol.

Section 2 — describes the editor serial protocol.

Section 3 — lists and explains the specific commands used to control the switcher for Version 5.1 and later, and for Version 5.0 and earlier.

Section 4 — lists and explains the new parameter-based command set (PBCS) for reading, setting, and trimming the switcher state directly, introduced with Version 5.1.

Section 5 —explains the effect recall and run (including the switcher’s run lever arm), control of switcher aux busses by the DPM when used as input selectors, and on air tally involving the DPM with Version 5.1.

Editor Connectivity

An external editor controls the switcher via the EDITOR serial connector:

- Port J6 on Model 3000
- Port J3 on Models 2200 and 4000

Electrical and mechanical specifications for the port are shown in Table 1-1.

Table 1-1. Editor Port Specifications

Item	Description
Baud Rate	38,400
Word Size	8 bits, 1 start bit, 1 stop bit only
Parity	ODD only (1)
Communications	RS-422 or RS-232, depending upon the Editor
Connector	9-pin D-subminiature

(1) The switcher may initialize with a default Parity setting of NONE. If so, this parameter must be set to ODD in the Config/External IF/Editor IF menu.

The pinout for the EDITOR port is shown in Table 1-2.

Table 1-2. Editor Port Pinout

Pin	Signal	Pin	Signal
1	Common	6	Common
2	TX	7	TX+
3	RX+	8	RX-
4	Common	9	Common
5	NC		

Editor Port Jumpers

Jumper settings on the Control Processor module must be set as follows for proper operation of the EDITOR port:

Model 3000

For the Model 3000, the EDITOR port jumpers are located on the Control Processor module (068906) between the M/E 2 Processor mezzanine board (068916) and the Serial Communications mezzanine board (068918). See Figure 1-1. Jumper J71 sets the communication standard (RS-232 or RS-422); Jumper J70 sets the EDITOR port termination (IN or OUT).

Communication Standard

For **RS-422**, set the two jumpers of J71 to the **DIFF** position (RS-422) as shown in Figure 1-1. This connects pins 1 and 3 together and pins 2 and 4 together.

For **RS-232**, set the two jumpers of J71 to the **RS232** position. This connects pins 3 and 5 together and pins 4 and 6 together.

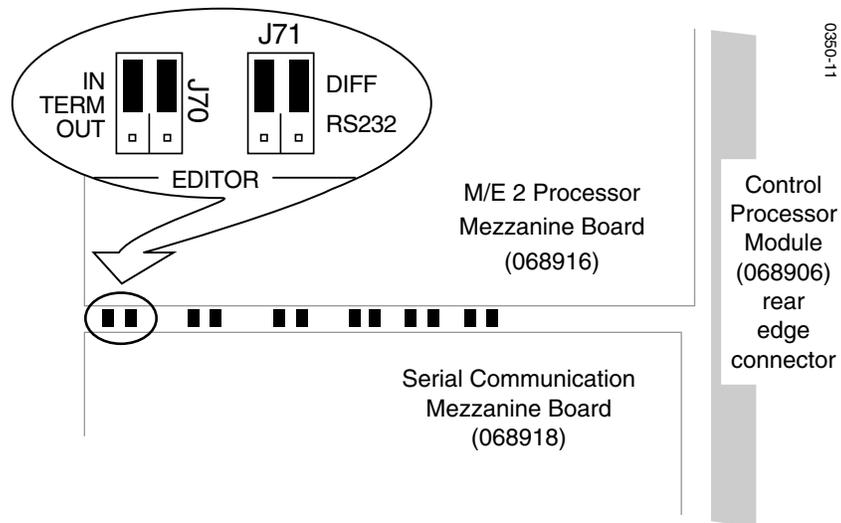


Figure 1-1. EDITOR Port Jumper Settings on Model 3000 (shown set for RS422, terminated)

Termination

Set the two jumpers of J70 to either the **IN** (terminated) position or the **OUT** (not terminated) position, depending on the requirements of your system.

If J71 is set for RS-232, Jumper J70 has no effect.

Model 2200/4000

For the Model 2200 or Model 4000, the EDITOR port jumpers are located on the Control Processor II module (064806) as shown in Figure 1-2. Jumper J15 sets the communication standard (RS-232 or RS-422); Jumpers J16, J17, and J18 set the EDITOR port termination (terminated or not terminated).

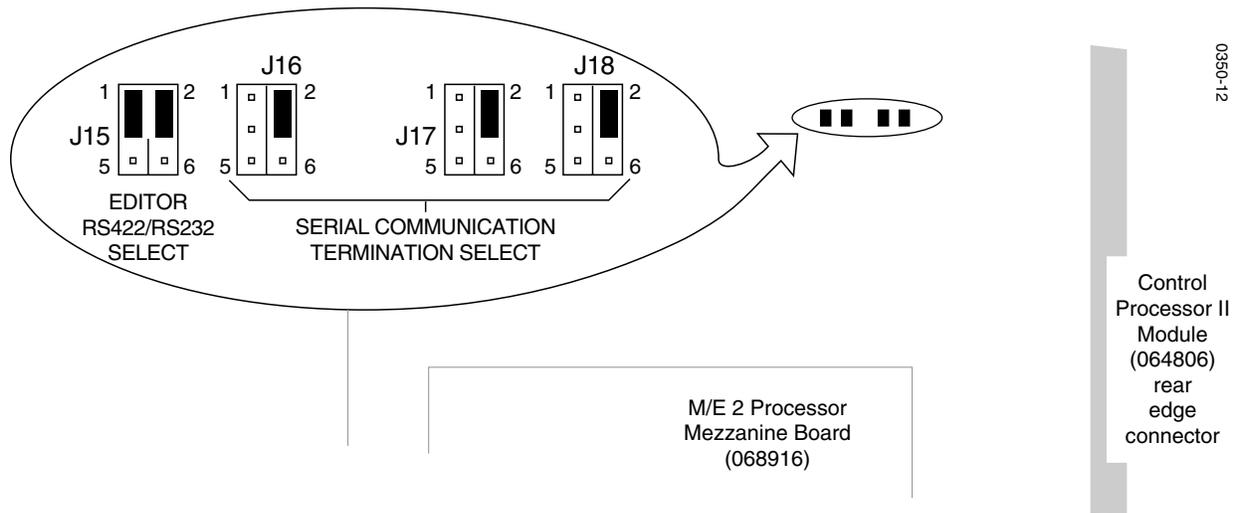


Figure 1-2. EDITOR Port Jumper Settings on Model 4000 (shown set for RS-422, terminated)

Communication Standard

For **RS-422**, set the two jumpers of J15 to the upper (RS422) position as shown in Figure 1-2. This connects pins 1 and 3 together and pins 2 and 4 together.

For **RS-232** set the two jumpers of J15 to the lower (RS232) position. This connects pins 3 and 5 together and pins 4 and 6 together.

Termination

Set jumpers J16, J17, and J18 to either the upper (terminated) or lower (not terminated) position, depending upon the requirements of your system. All three of these jumpers should be set to the same position (all up or all down). There is only one jumper for each of these jumper blocks.

If J15 is set for RS-232, Jumpers J16 through J18 have no effect.

Serial Data Word Description

The serial data word contains eleven bits, as shown in Figure 1-3:

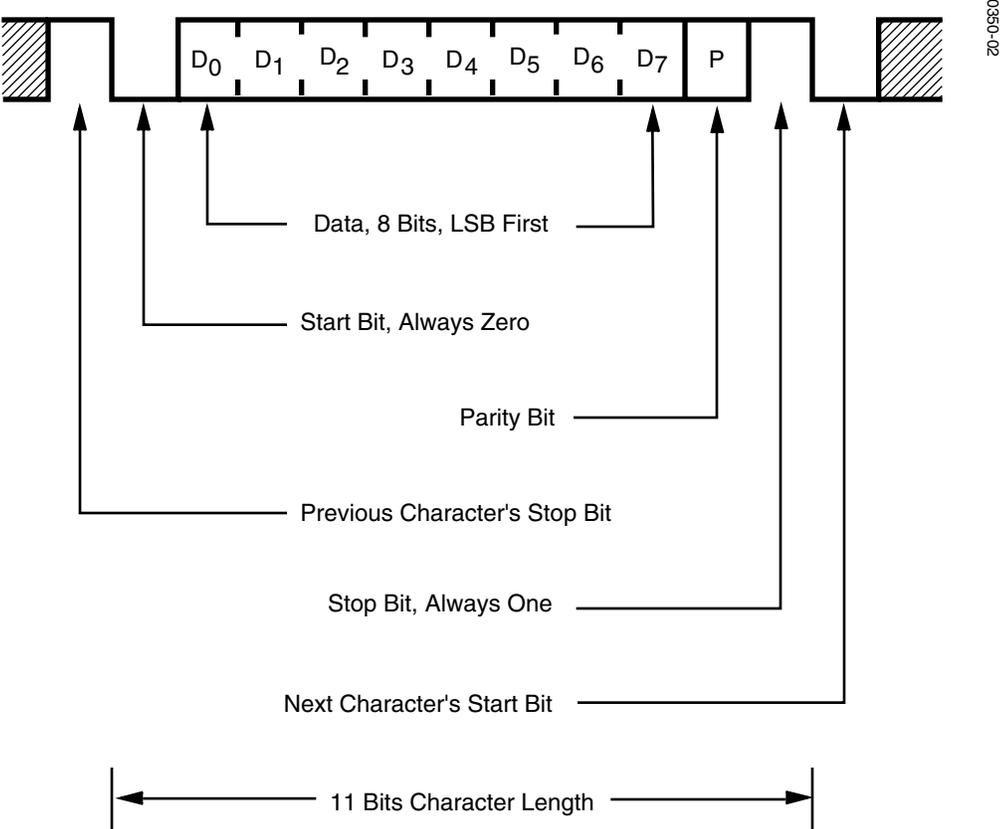


Figure 1-3. Serial Data Word

Editor Enable Pushbutton

The **EDIT** pushbutton in the External Interface area of the Control Panel (Figure 1-4) controls editor access to the switcher. When pressed, the pushbutton lights to indicate that the switcher can be controlled through the Editor Interface. Pressing **EDIT** a second time turns the lamp off and disables editor control of the switcher.

When **EDIT** is turned off, protocol messages affecting switcher parameters (as opposed to those requesting status information) are not forwarded to the switcher as they arrive from the editor. This action by the switcher does not affect the editor, which continues to send messages and function normally, even though it is being ignored.

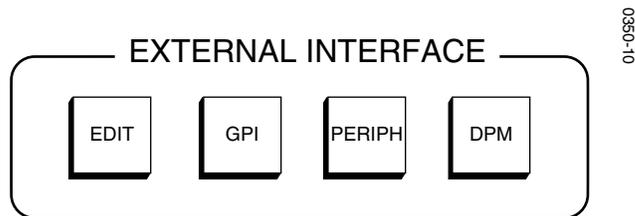


Figure 1-4. External Interface Pushbuttons

System Performance

The Editor Interface can continuously receive and process a steady stream of commands. Although all commands are received, some time may be required to act upon these commands. For example, transferring E-MEM[®] registers between the editor and the switcher may take several seconds to complete.

Any Read Command has a switcher latency of 2 fields; that is, the response will occur 2 fields after the Read Command has been received.

All other commands except E-MEM and Configuration Transfer Commands have a switcher latency of 10 fields.

E-MEM and Configuration Transfer Commands have no fixed latency in the switcher. The transfer will take place as soon as all higher-level commands have been executed.

The transfer commands have a one second timeout imposed on the time between each packet transmission.

2

Editor Protocol

Serial Communications

This section describes the communications protocol and its error handling.

A Video Editing System uses the switcher editor port to exercise real-time control over the switcher's functions. The editor is really an external computer that can input and output functions. Such functions select crosspoints, perform auto transitions, or perform E-MEM (Effects Memory) register recalls, to name just a few possibilities. Refer to the appropriate switcher Operation manual for definitions and explanations of the switcher functions and features.

Editor Protocol Access

The 2200/3000/4000 Editor Protocol is based upon, but not identical to, the proposed SMPTE (Society of Motion Picture and Television Engineers) Digital Control Interface, which establishes a means for the orderly flow of data over a serial bus.

The major components of the protocol are shown in Figure 2-1 and discussed in the following paragraphs.

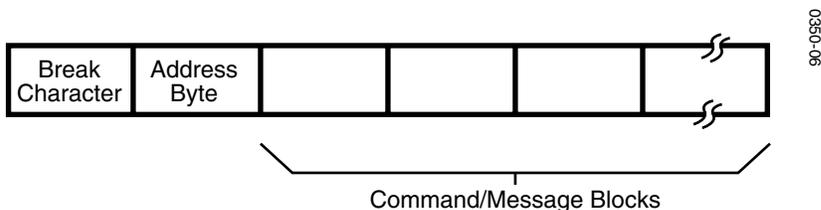


Figure 2-1. Components of the Model 2200/3000/4000 Editor Protocol Access

Break Character

The main component of the Editor Interface protocol is a 1-1/2 character-length “break.” A break consists of a spacing or logical low (0) condition on the serial bus (see Figure 2-2) followed by a minimum of two bit-times of marking (logic 1) condition. The Bus Controller (editor) transmits a break to the switcher, forewarning of an impending message.

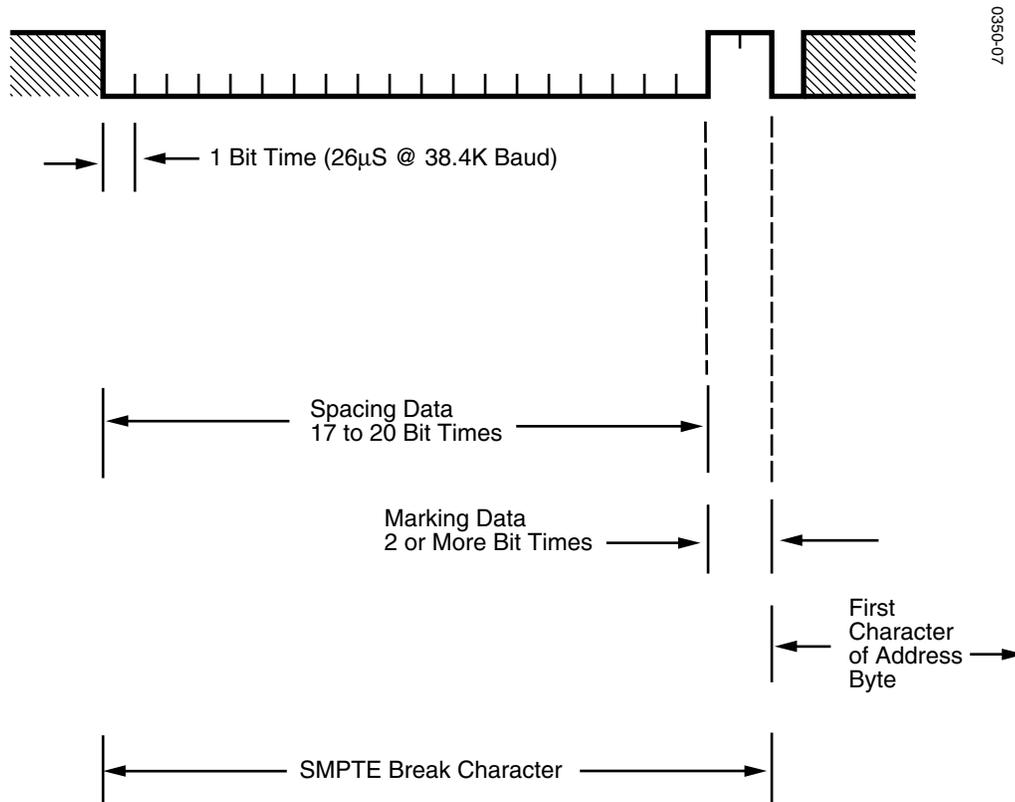


Figure 2-2. Break Character

The break forces all *tributaries*, or listeners (such as the switcher’s editor port), from the “Idle” state into the “Active” state. A break can be sent only by the Edit Controller. When the switcher receives the break, it ceases all bus communications, resets any communication error condition, and prepares to receive an address.

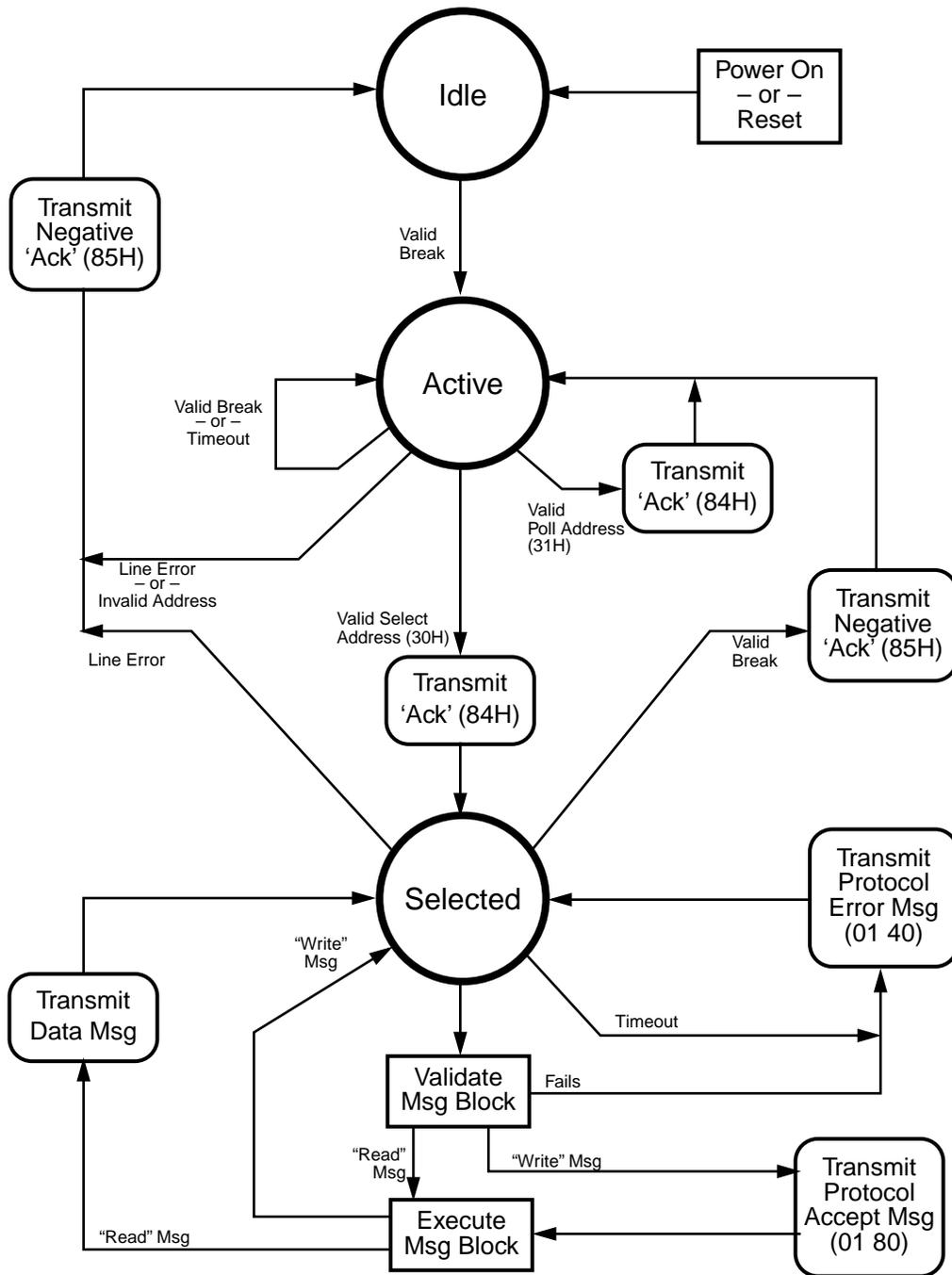


Figure 2-3. Serial Interface Protocol State Diagram

Address Byte

Once the break has been received, the Editor Interface advances to the active state and begins expecting a one-byte address. The switcher will respond to the switcher address 30H (Hexadecimal), when transmitted by the Edit controller. After receiving the address, the Editor Interface accepts command/message block transmissions containing commands, data requests, and other data directed toward the switcher. As long as communication errors do not occur, the Editor Interface can skip the break/address sequence during the remainder of the transmissions. Command/message blocks can be sent repeatedly, one after another, without break interruptions.

The address is one byte long and directed to a specific tributary. If the received address matches the tributary's assigned address, the tributary advances to the Selected state and awaits instructions. The address of the switcher is fixed as 30H. In response to the address, the 3000 transmits an acknowledgment byte of 84H to the controller, indicating the change in status to the "Selected" State. If an address of 31H is received, the switcher transmits an acknowledgment byte of 84H to the controller, but stays in the "Active" State. If the address does not match, the tributary drops off the bus (goes Idle) and awaits another break.

Note that when the switcher receives a break without an address as a result of an Editor Interface reset (**RESET** button pressed, or a warm or cold start of the Editor Interface), it returns the 84H acknowledgment byte to the controller. If the edit controller sends subsequent breaks to the switcher (when no Editor Interface reset has occurred), the switcher responds by sending 85H followed by 84H.

Command/Message Block Structure

In the Selected state, the Editor Interface receives command/message blocks that direct switcher operations. The basic message structure is shown in Figure 2-4.

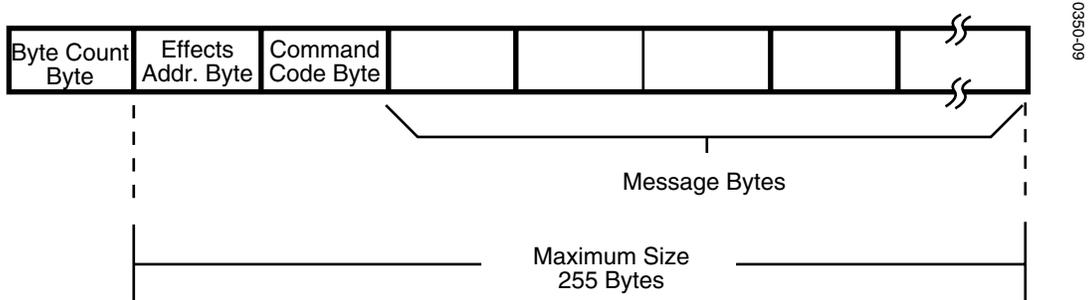


Figure 2-4. Message Structure

The maximum length of a message is 255 bytes plus the byte count byte. At a baud rate of 38,400, the maximum length command/message takes more than 4 fields to complete.

The Editor Interface can handle data continuously, receiving a contiguous stream of command/message blocks. Such an ability enables multiple switcher operations to be performed without constant cycling through the break/address sequence. Responses (handshakes or read data) are returned in the same order as the command/message blocks are received.

Byte Count

The command/message block can range in size from two to 256 bytes. The first byte of the block contains the byte count. A byte count consists of the total number of subsequent bytes in the block; valid byte count values range from 01H to FFH (1 to 255). After receiving a valid byte count (01H to FFH) and the proper number of data bytes (1 to 255), the Model 3000 executes the command.

Effects Address Byte

The second byte of the command/message block is the effects address byte, typically referred to as EX. This byte identifies the desired "effect bank" within the switcher where the associated command will go. Valid Effects Addresses for each command are specified in Section 3.

Command Code Byte

The command code is the third byte of the command/message block. Command codes fall into two broad categories: read commands and write commands. Only one command is allowed in any command/message block. Likewise, only one response is embedded in any command/message block.

Read Commands

Read commands interrogate the status of the specified operational parameter of the switcher. When the editor issues a read command/message block, the switcher responds by sending the current status of the requested operational parameter(s) back to the editor. This status information is returned in the format of the write command/message block. By echoing the write format, the editor can later send responses to a read command to the switcher and cause execution of that function.

Write Commands

Write commands are used by the editor to change operational parameter(s) or initiate a function within the switcher.

Status and Data Replies

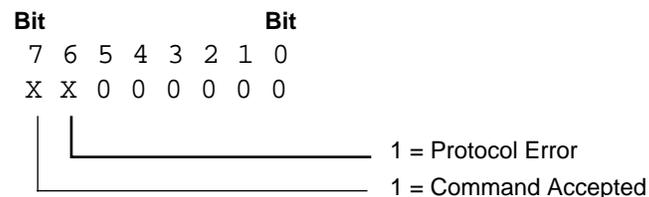
The editor interface does not respond to the controlling device upon the receipt of each and every character. It does respond to the last character of any *complete* message. The first character of any message is the “byte count” byte, specifying the number of message bytes that are to follow. A message transmission is complete when the total number of characters specified by that byte plus that byte itself have been received.

There are five possible replies in response to the complete message as outlined in Table 2-1.

Table 2-1. Possible Command Responses

Response Type	Message	In Response To:
Acknowledge	0x84	Valid Select or Poll Address
Negative Acknowledge	0x85	Invalid Select or Poll Address; Line Error
Protocol Error	0x01 0x40	Invalid Protocol Message (Read or Write); Timeout Error in Select State
Command Accepted	0x01 0x80	Valid Protocol “Write” Message
Data Message	Write Message (length varies)	Valid Protocol “Read” Message

Once the interface is placed into the Select State, the most common response is one of the two-byte status reply messages. The second byte of this message is the response to the command. The upper two bits signify whether the command was accepted or not as illustrated in the following figure:



Note that these bits are mutually exclusive; that is, both may not be set in the same message.

If Command Accept is true, the message was forwarded to its handler for execution. However, this status reply only means that the command was received with no transmission errors and passed the protocol validation test (byte count and command code) for the message structure itself. The message may still not be executed by the Switcher for failures on the Protocol Command level.

Error Detection

Transmission Errors

Error detection is a normal part of the communication process. For this Protocol Interface, error detection and reporting is limited to problems that occur at the transmission and reception level of communication. These type of errors fall into two basic categories, line and time-out errors.

Line errors include three specific types of errors that may occur with each character transmission and reception.

- Parity error
- Framing error
- Data Overrun error

These errors occur when the Serial Data Word becomes corrupted.

Time-out errors occur when too much time elapses between the reception of characters during a message transmission.

When the Editor Interface detects communication errors, it responds with a negative acknowledge of 85H and then aborts all communications. Any remaining un-executed commands are discarded after the error indication occurs and the Interface is forced back into the Idle state. Refer to Figure 2-2 on page 2-2 and Table 2-1 for details of the detection and corresponding response to each error type.

In order to resume communications, the Editor must transmit a break/address sequence to return the channel to the Select state. If the Editor Interface does not receive a valid tributary or poll address following the break, it falls back into the Idle state without transmitting the 85H Negative Acknowledge byte. Line errors that occur during an attempt to send and receive the address byte still result in a Negative Acknowledge byte being sent back to the Editor.

Protocol Errors

Errors can occur on the Protocol level itself; that is, the message may be received okay, but may not actually be executed due to problems with content or context. The only error that will be reported to the Editor as a Protocol Error (01 40) occurs if either the byte count or the command code fail the validation test when a complete message is received.

All other protocol errors go unreported back to the Editor. The only response the Editor receives to these messages is a Command Accepted message. The handler, when it uncovers a problem, will simply throw the message away and the user will see no change to the operation of the Switcher.

Some possible causes of unreported protocol errors are listed as follows:

Content Errors:

- Invalid effects address.
- Invalid data (register number, analog value, etc.)

Context Errors:

- Command is "panel-centric" and may only be executed when the Switcher is in a specific state.

3

Editor Interface Commands

Introduction

This section details the Switcher Editor Interface commands for Model 2200, 3000, and 4000 Switchers.

References to pushbuttons are shown in capital letters, using the legends as they appear on a Control Panel. Control Panel section names are shown in initial capitals.

NOTE: *All values within the tables are hexadecimal unless otherwise indicated by the notation "decimal."*

Editor Interface Commands

This section describes the traditional editor command set which bears a family resemblance to earlier generation Grass Valley switchers such as the Model 200 and the Model 300.

Editor interface commands are detailed in tables presented on the following pages. Addresses, byte counts, important names, and supporting details are listed for each command.

With Software Version 5.1, new commands are added and some existing commands enhanced. This is clearly marked for each command. Also, with Version 5.1, Grass Valley has developed a new parameter-based command set (PBCS) for advanced editing control. PBCS allows setting, trimming, and reading of all internal switcher parameters completely independent of panel operations. This is described in Section 4.

The appropriate command to use may be determined as follows:

For basic crosspoint control use:

- Crosspoint Bus (C1) Command (PGM/BKGD A/AUX) on page 3-6
- Crosspoint Bus (C2) Command (PST/BKGD B) on page 3-8
- Crosspoint Bus (C3) Command (KEY 1/DSK 1) on page 3-9
- Crosspoint Bus (C4) Command (KEY 2/DSK 2) on page 3-10
- Crosspoint Bus (E2) Command (PVW) on page 3-11
- Crosspoint Bus (E3) Command (MASK) on page 3-12
- Write Split Key (E4) Command on page 3-38

Select Wipe Patterns by using:

- Write Wipe Pattern (C8) Command on page 3-21

Control the Transition mode pushbuttons by using:

- Write Transition Mode (CA) Command on page 3-23

Set transition rates by using:

- Write Auto Transition Rate (CC) Command on page 3-27
- Write Key Transition Rate (CD) Command on page 3-29

To simulate the pressing of buttons on the transition subpanel use:

- Pushbutton Select and Control (C6, C7 and FB) Commands on page 3-13

For E-MEM learns and recalls use:

- Write Learn E-MEM Register (DA) Command on page 3-35
- Write Recall E-MEM Register (DB) Command on page 3-31

For E-MEM and Configuration Data transfer use:

- Data Transfer (5E and DE) Commands on page 3-41

To control the timeline for multiple keyframe effects use:

- Timeline Control (4E, 4F, CE, and CF) Commands on page 3-52

To simulate pressing buttons on the timeline run control subpanel use:

- Pushbutton Select and Control (C6, C7 and FB) Commands on page 3-13

For general use by an editor, the following commands are provided:

- ALL STOP (F2) Command (Version 5.1 and Later) on page 3-5
- Software Version (6C and EC) Commands on page 3-50
- Select “Layered” Or “Standard” (E8) Command on page 3-40

Revision History

The following commands were not supported prior to Version 5.1:

- ALL STOP (F2) Command (Version 5.1 and Later) on page 3-5
- Software Version (6C and EC) Commands on page 3-50
- Timeline Control (4E, 4F, CE, and CF) Commands on page 3-52

The following commands had functionality added for Version 5.1 that was not supported in Version 5.0 and earlier:

- Pushbutton Select and Control (C6, C7 and FB) Commands on page 3-13
- Write Transition Mode (CA) Command on page 3-23
- Write Auto Transition Rate (CC) Command on page 3-27
- Write Key Transition Rate (CD) Command on page 3-29
- Write Recall E-MEM Register (DB) Command on page 3-31
- Write Learn E-MEM Register (DA) Command on page 3-35
- Data Transfer (5E and DE) Commands on page 3-41

The enhancements introduced in Version 5.1 to these commands are all additions; functionality existing in Version 5.0 is still supported.

Application Examples

Several examples of serial communications using the switcher Editor Interface are provided on the following pages in the sections appropriate to the commands. In general, “Transmit” refers to communication from the editor to the switcher and “Receive” refers to communication from the switcher to the editor. Refer to specific command tables for details on these examples.

Example 1: Bringing the Editor Interface into a Ready State

Transmit:	Break	Address
	BRK	30
Receive:	Status	
	84	

Example 2: How to Set Crosspoint #6, A Row, Mix/Effects 2

Transmit:	Byte Count	Ex Address	Command	Data
	03	02	C1	06
Receive:	Byte Count	Status		
	01	80		

ALL STOP (F2) Command (Version 5.1 and Later)

The ALL STOP command is issued to set all or a specific part of the switcher to a known state. The command causes the following functions to occur:

1. An ongoing KEY 1 MIX or KEY 2 MIX is stopped.
2. An ongoing AUTO TRAN (Transition) is stopped.
3. An ongoing EFF DIS (Effects Dissolve) is stopped.
4. An ongoing SEQ (Sequence) is stopped.
5. The lever arm is set to a limit.
6. The transition type is set to MIX.
7. The transition mode is set to BKGD in Standard Mode and BKGD A in Layered Mode.
8. For Standard mode, all Keys are removed. For Layered mode, all Keys are left alone.
9. The crosspoint selections remain unchanged.

Table 3-1. All Stop Command

Function	Byte Count	Effects Address	Command Code	Message
Write	03	EX	F2	FF

Effects Addresses

Valid effects addresses for the ALL STOP command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)
05	Background (BKGD)
06	Miscellaneous (MISC)
07	DPM 1
08	DPM 2
09	DPM 3
0A	DPM 4
0B	All levels

Crosspoint Bus (C1) Command (PGM/BKGD A/AUX)

The Write Crosspoint Bus command enables the editor to select any crosspoint on a bus specified by the effects address, and the command code.

Table 3-2. Crosspoint Bus Command

Function	Byte Count	Effects Address	Command Code	Message
Write Crosspoint Bus	03	EX	C1 (Write)	Crosspoint #

Effects Addresses

Valid effects addresses for the Crosspoint Bus command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST System (PGM)
01	Mix/Effects 1 (BKGD A)
02	Mix/Effects 2 (BKGD A)
03	Mix/Effects 3 (BKGD A)
0C	Aux Bus 1A
0D	Aux Bus 1B
0E	Aux Bus 2A
0F	Aux Bus 2B
10	Aux Bus 3A
11	Aux Bus 3B
12	Aux Bus 4A
13	Aux Bus 4B
14	Aux Bus 5A
15	Aux Bus 5B
16	Aux Bus 6A
17	Aux Bus 6B
18	Aux Bus 7A
19	Aux Bus 7B
1A	Aux Bus 8A
1B	Aux Bus 8B
1C	Aux Bus 9A
1D	Aux Bus 9B

Crosspoint Numbers

Valid crosspoint numbers are as follows:

Table 3-3. Common Crosspoint Numbers for All Buses

Crosspoint Name	Number	Crosspoint Name	Number
Crosspoint 1	01H	Crosspoint 29	1DH
Crosspoint 2	02H	Crosspoint 30	1EH
Crosspoint 3	03H	Crosspoint 31	1FH
Crosspoint 4	04H	Crosspoint 32	20H
Crosspoint 5	05H	Crosspoint 33	21H
Crosspoint 6	06H	Crosspoint 34	22H
Crosspoint 7	07H	Crosspoint 35	23H
Crosspoint 8	08H	Crosspoint 36	24H
Crosspoint 9	09H	Crosspoint 37	25H
Crosspoint 10	0AH	Crosspoint 38	26H
Crosspoint 11	0BH	Crosspoint 39	27H
Crosspoint 12	0CH	Crosspoint 40	28H
Crosspoint 13	0DH	Crosspoint 41	29H
Crosspoint 14	0EH	Crosspoint 42	2AH
Crosspoint 15	0FH	Crosspoint 43	2BH
Crosspoint 16	10H	Crosspoint 44	2CH
Crosspoint 17	11H	Crosspoint 45	2DH
Crosspoint 18	12H	Crosspoint 46	2EH
Crosspoint 19	13H	Crosspoint 47	2FH
Crosspoint 20	14H	Crosspoint 48	30H
Crosspoint 21	15H	M/E 1	31H
Crosspoint 22	16H	M/E 2	32H
Crosspoint 23	17H	M/E 3	33H
Crosspoint 24	18H	PGM Out	34H (1)
Crosspoint 25	19H	M/E 1 PVW	35H (2)
Crosspoint 26	1AH	M/E 2 PVW	36H (2)
Crosspoint 27	1BH	M/E 3 PVW	37H (2)
Crosspoint 28	1CH	DSK PVW	38H (2)

(1) Accessible only on AUX buses, PVW bus, and MASK bus

(2) Accessible only on PVW bus

Crosspoint Bus (C2) Command (PST/BKGD B)

The Write Crosspoint Bus command enables the editor to select any crosspoint on a bus specified by the effects address, and the command code.

Table 3-4. Crosspoint Bus Command

Function	Byte Count	Effects Address	Command Code	Message
Write Crosspoint Bus	03	EX	C2 (Write)	Crosspoint #

Effects Addresses

Valid effects addresses for the Crosspoint Bus command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System (PST)
01	Mix/Effects 1 (BKGD B)
02	Mix/Effects 2 (BKGD B)
03	Mix/Effects 3 (BKGD B)

Crosspoint Numbers

Valid crosspoint numbers are shown in Table 3-3, “Common Crosspoint Numbers for All Buses,” on page 3-7.

Crosspoint Bus (C3) Command (KEY 1/DSK 1)

The Write Crosspoint Bus command enables the editor to select any crosspoint on a bus specified by the effects address, and the command code.

Table 3-5. Crosspoint Bus Command

Function	Byte Count	Effects Address	Command Code	Message
Write Crosspoint Bus	03	EX	C3 (Write)	Crosspoint #

Effects Addresses

Valid effects addresses for the Crosspoint Bus command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
01	Mix/Effects 1 (KEY 1)
02	Mix/Effects 2 (KEY 1)
03	Mix/Effects 3 (KEY 1)
04	DSK 1

Crosspoint Numbers

Valid crosspoint numbers are shown in Table 3-3, "Common Crosspoint Numbers for All Buses," on page 3-7.

Crosspoint Bus (C4) Command (KEY 2/DSK 2)

The Write Crosspoint Bus command enables the editor to select any crosspoint on a bus specified by the effects address, and the command code.

Table 3-6. Crosspoint Bus Command

Function	Byte Count	Effects Address	Command Code	Message
Write Crosspoint Bus	03	EX	C4 (Write)	Crosspoint #

Effects Addresses

Valid effects addresses for the Crosspoint Bus command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
01	Mix/Effects 1 (KEY 2)
02	Mix/Effects 2 (KEY 2)
03	Mix/Effects 3 (KEY 2)
04	DSK 2

Crosspoint Numbers

Valid crosspoint numbers are shown in Table 3-3, “Common Crosspoint Numbers for All Buses,” on page 3-7.

Crosspoint Bus (E2) Command (PVW)

The Write Crosspoint Bus command enables the editor to select any crosspoint on a bus specified by the effects address.

Table 3-7. Crosspoint Bus Command

Function	Byte Count	Effects Address	Command Code	Message
Write Crosspoint Bus	03	EX	E2 (Write)	Crosspoint #

Effects Addresses

Valid effects addresses for the Crosspoint Bus command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
06	PVW Bus (MISC)

Crosspoint Numbers

Valid crosspoint numbers are shown in Table 3-3, "Common Crosspoint Numbers for All Buses," on page 3-7.

Crosspoint Bus (E3) Command (MASK)

The Write Crosspoint Bus command enables the editor to select any crosspoint on a bus specified by the effects address.

Table 3-8. Crosspoint Bus Command

Function	Byte Count	Effects Address	Command Code	Message
Write Crosspoint Bus	03	EX	E3 (Write)	Crosspoint #

Effects Addresses

Valid effects addresses for the Crosspoint Bus command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
06	MASK Bus (MISC)

Crosspoint Numbers

Valid crosspoint numbers are shown in Table 3-3, “Common Crosspoint Numbers for All Buses,” on page 3-7.

Pushbutton Select and Control (C6, C7 and FB) Commands

The Pushbutton Select command (FB) is a write-only command that performs a “push” of the specified pushbutton number, just as if the button had actually been pressed at the control panel.

The Pushbutton Write commands turn the designated pushbutton either “on” (C6) or “off” (C7).

Table 3-9. Pushbutton Select and Control Commands

Function	Byte Count	Effects Address	Command Code	Message
Write PB/L# ON	04	EX	C6 (Write on)	PB/L# High, PB/L# Low
Write PB/L# OFF	04	EX	C7 (Write off)	PB/L# High, PB/L# Low
Select PB/L#	04	EX	FB (Write)	PB/L# High, PB/L# Low

Effects Addresses

Valid effects addresses for the Pushbutton Control commands are:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)
05	Background (BKGD)
06	Miscellaneous (MISC)
0B	Master E-MEM

Pushbutton Numbers

The pushbutton numbers supported by these commands cover the transition subpanels and the timeline run control subpanel. These numbers are specified in Table 3-10, “Transition Subpanel Pushbutton Numbers,” on page 3-15 and Table 3-11, “Keyframing Pushbutton Numbers,” on page 3-16.

The original intent of the switcher design team was to extend the range of these commands to cover the pressing of all buttons on the control panel. However, over time, it became clear that a better serial interface to provide for editors is the parameter-based command set (PBCS). This new command set directly sets the internal switcher state irrespective of whatever control panel may, or may not, be attached. So, for backward compatibility, a further set of pushbutton numbers is supplied for the wipe subpanel in Table 3-12, “Obsolete Pushbutton Numbers –,” on page 3-17. Although these commands do work, it is recommended that wipes be set by using the Write Wipe Pattern (C8) Command on page 3-21 or the PBCS described in Section 4.

WARNING

Specifying an invalid pushbutton number may produce an unpredictable result.

Also, please note that on the M/E Transition Panel (and DSK for 4000-2A):

- **MIX** and **WIPE** are mutually exclusive. Turning on one turns off the other.

Table 3-10. Transition Subpanel Pushbutton Numbers

Pushbutton#	Select (Press)	Write (On/Off)	Pushbutton Function	PGM/ DSK	M/E	Master E-MEM
0201H	X		CUT	X	X	
0202H	X		AUTO TRAN	X	X	
0203H	X	X	PST BLK	X	X	
0206H	X	X (3)	MIX	X (2)	X	
0207H		X	BKGD	X		
0208H	X	X (3)	WIPE	X (2)	X	
0209H		X	DSK 1	X		
020AH		X	BKGD A		X	
020BH		X	DSK 2	X		
020CH		X	BKGD B		X	
020DH		X	DSK 1 ON	X		
020EH		X	KEY 1		X	
020FH		X	DSK 2 ON	X		
0210H		X	KEY 2		X	
0212H	X	X	KEY PRI		X	
0214H		X	BKGD A ON		X	
0216H		X	BKGD B ON		X	
0218H		X	TRANS KEY 1 ON		X	
021AH		X	TRANS KEY 2 ON		X	
0222H		X	LAYERED		X	
0223H	X (1)	X (1)	KEY 1 CUT (DSK 1 CUT)	X	X	
0224H	X (1)		KEY 1 MIX (DSK 1 MIX)	X	X	
0225H	X (1)	X (1)	KEY 2 CUT (DSK 2 CUT)	X	X	
0226H	X (1)		KEY 2 MIX (DSK 2 MIX)	X	X	

(1) Not supported in Version 5.0 and earlier.

(2) Model 4000-2A only.

(3) Write On only.

Table 3-11. Keyframing Pushbutton Numbers

Pushbutton#	Select (Press)	Write (On/Off)	Pushbutton Function	PGM/ DSK	M/E	Master E-MEM
0501H	X (1)	X (1)	ENABLE PGM PST			X (2)
0502H	X (1)	X (1)	ENABLE M/E 1			X (2)
0503H	X (1)	X (1)	ENABLE M/E 2			X (2)
0504H	X (1)	X (1)	ENABLE M/E 3			X (2)
0505H	X (1)	X (1)	ENABLE DSK			X (2)
0506H	X (1)	X (1)	ENABLE BKGD			X (2)
0507H	X (1)	X (1)	ENABLE MISC			X (2)
0508H	X (1)	X (1)	ENABLE DPM 1			X (2)
0509H	X (1)	X (1)	ENABLE DPM 2			X (2)
050AH	X (1)	X (1)	ENABLE DPM 3			X (2)
050BH	X (1)	X (1)	ENABLE DPM 4			X (2)
050CH	X (1)	X (1)	ENABLE ALL			X (2)
0544H	X		PREV			X (2)
0545H	X		NEXT			X (2)
0560H	X		REWIND			X (2)
0561H	X	X (1)	HOLD INPUT			X (2)
0562H	X	X (1)	REV			X (2)
0563H	X	X (1)	AUTO RUN			X (2)
0564H	X	X (1)	STOP NEXT KF			X (2)
0565H	X		RUN			X (2)
0580H	X	X (1)	AUTO RCL			X (2)

(1) Not supported in Version 5.0 and earlier.

(2) Effects addresses are irrelevant and will be ignored. All effects addresses will be treated as 0X0B.

Table 3-12. Obsolete Pushbutton Numbers – (Sheet 1 of 4)

Pushbutton/ Lamp#	Select (Press)	Write (On/Off)	Pushbutton	PGM/ DSK	M/E	Master E-MEM
1601H	X		WIPE SOFT – PRI	X	X	
1602H	X		WIPE BORD – PRI	X	X	
1603H	X		WIPE ASPECT – PRI	X	X	
1604H	X		WIPE ROT POS – PRI	X	X	
1605H	X		WIPE ROT SPD – PRI	X	X	
1606H	X		WIPE ROT MAG – PRI	X	X	
1607H	X		WIPE DIR N ORM – PRI	X	X	
1608H	X		WIPE DIR REV – PRI	X	X	
1609H	X		WIPE DIR FLIP – PRI	X	X	
160AH	X		WIPE SPLIT – PRI	X	X	
160BH	X		WIPE H MULTI – PRI	X	X	
160CH	X		WIPE V MULTI – PRI	X	X	
160DH	X		WIPE POS NORM – PRI	X	X	
160EH	X		WIPE POS AUTO – PRI	X	X	
160FH	X		WIPE PATT MIX – PRI	X	X	
1610H	X		WIPE M/E 1 PRI	X	X	
1611H	X		WIPE M/E 2 PRI	X	X	
1612H	X		WIPE M/E 3 PRI	X	X	
1613H	X		WIPE M/E 1 SEC	X	X	
1614H	X		WIPE M/E 2 SEC	X	X	
1615H	X		WIPE M/E 3 SECI	X	X	
1616H	X		WIPE PGM PRI	X	X	
1617H	X		WIPE PGM SEC	X	X	
1618H	X		WIPE PATT 0 – PRI	X	X	
1619H	X		WIPE PATT 1 – PRI	X	X	
161AH	X		WIPE PATT 2 – PRI	X	X	
161BH	X		WIPE PATT 3 – PRI	X	X	
161CH	X		WIPE PATT 4 – PRI	X	X	
161DH	X		WIPE PATT 5 – PRI	X	X	
161EH	X		WIPE PATT 6 – PRI	X	X	
161FH	X		WIPE PATT 7 – PRI	X	X	

Table 3-12. Obsolete Pushbutton Numbers (Continued) – (Sheet 2 of 4)

Pushbutton/ Lamp#	Select (Press)	Write (On/Off)	Pushbutton	PGM/ DSK	M/E	Master E-MEM
1620H	X		WIPE PATT 8 – PRI	X	X	
1621H	X		WIPE PATT 9 – PRI	X	X	
1622H	X		WIPE PATT 10 – PRI	X	X	
1623H	X		WIPE PATT 11 – PRI	X	X	
1624H	X		WIPE PATT 12 – PRI	X	X	
1625H	X		WIPE PATT 13 – PRI	X	X	
1626H	X		WIPE PATT 14 – PRI	X	X	
1627H	X		WIPE PATT 15 – PRI	X	X	
1628H	X		WIPE PATT 16 – PRI	X	X	
1629H	X		WIPE PATT 17 – PRI	X	X	
162AH	X		WIPE PATT 18 – PRI	X	X	
162BH	X		WIPE PATT 19 – PRI	X	X	
162CH	X		WIPE PATT 20 – PRI	X	X	
162DH	X		WIPE MENU – PRI	X	X	
162EH	X		WIPE RANDOM – PRI	X	X	
162FH	X		WIPE TEXTURE – PRI	X	X	
1630H	X		WIPE UW UNDO – PRI	X	X	
1631H	X		WIPE UW LEARN – PRI	X	X	
1632H	X		WIPE USER 1 – PRI	X	X	
1633H	X		WIPE USER 2 – PRI	X	X	
1634H	X		WIPE USER 3 – PRI	X	X	
1635H	X		WIPE USER 4 – PRI	X	X	
1636H	X		WIPE USER 5 – PRI	X	X	
1637H	X		WIPE USER 6 – PRI	X	X	
1681H	X		WIPE SOFT – SEC	X	X	
1682H	X		WIPE BORD – SEC	X	X	
1683H	X		WIPE ASPECT – SEC	X	X	
1684H	X		WIPE ROT POS – SEC	X	X	
1685H	X		WIPE ROT SPD – SEC	X	X	
1686H	X		WIPE ROT MAG – SEC	X	X	
1687H	X		WIPE DIR NORM – SEC	X	X	

Table 3-12. Obsolete Pushbutton Numbers (Continued) – (Sheet 3 of 4)

Pushbutton/ Lamp#	Select (Press)	Write (On/Off)	Pushbutton	PGM/ DSK	M/E	Master E-MEM
1688H	X		WIPE DIR REV – SEC	X	X	
1689H	X		WIPE DIR FLIP – SEC	X	X	
168AH	X		WIPE SPLIT – SEC	X	X	
168BH	X		WIPE H MULTI – SEC	X	X	
168CH	X		WIPE V MULTI – SEC	X	X	
168DH	X		WIPE POS NORM – SEC	X	X	
168EH	X		WIPE POS AUTO – SEC	X	X	
168FH	X		WIPE PATT MIX – SEC	X	X	
1696H	X		WIPE PATT 0 – SEC	X	X	
1697H	X		WIPE PATT 1 – SEC	X	X	
1698H	X		WIPE PATT 2 – SEC	X	X	
1699H	X		WIPE PATT 3 – SEC	X	X	
169AH	X		WIPE PATT 4 – SEC	X	X	
169BH	X		WIPE PATT 5 – SEC	X	X	
169CH	X		WIPE PATT 6 – SEC	X	X	
169DH	X		WIPE PATT 7 – SEC	X	X	
169EH	X		WIPE PATT 8 – SEC	X	X	
169FH	X		WIPE PATT 9 – SEC	X	X	
16A0H	X		WIPE PATT 10 – SEC	X	X	
16A1H	X		WIPE PATT 11 – SEC	X	X	
16A2H	X		WIPE PATT 12 – SEC	X	X	
16A3H	X		WIPE PATT 13 – SEC	X	X	
16A4H	X		WIPE PATT 14 – SEC	X	X	
16A5H	X		WIPE PATT 15 – SEC	X	X	
16A6H	X		WIPE PATT 16 – SEC	X	X	
16A7H	X		WIPE PATT 17 – SEC	X	X	
16A8H	X		WIPE PATT 18 – SEC	X	X	
16A9H	X		WIPE PATT 19 – SEC	X	X	
16AAH	X		WIPE PATT 20 – SEC	X	X	
16ABH	X		WIPE MENU – SEC	X	X	
16ACH	X		WIPE RANDOM – SEC	X	X	

Table 3-12. Obsolete Pushbutton Numbers (Continued) – (Sheet 4 of 4)

Pushbutton/ Lamp#	Select (Press)	Write (On/Off)	Pushbutton	PGM/ DSK	M/E	Master E-MEM
16ADH	X		WIPE TEXTURE – SEC	X	X	
16AEH	X		WIPE UW UNDO – SEC	X	X	
16AFH	X		WIPE UW LEARN – SEC	X	X	
16B0H	X		WIPE USER 1 – SEC	X	X	
16B1H	X		WIPE USER 2 – SEC	X	X	
16B2H	X		WIPE USER 3 – SEC	X	X	
16B3H	X		WIPE USER 4 – SEC	X	X	
16B4H	X		WIPE USER 5 – SEC	X	X	
16B5H	X		WIPE USER 6 – SEC	X	X	
16C0H	X		WIPE POS CENTER	X	X	

Write Wipe Pattern (C8) Command

The Write Wipe Pattern command selects the specified primary or secondary wipe pattern for an M/E. Only one primary and one secondary wipe pattern can be active at a time for each M/E.

Table 3-13. Write Wipe Pattern Command

Function	Byte Count	Effects Address	Command Code	Message
Write Wipe Pattern	03	EX	C8 (Write)	Wipe #

Effects Addresses

Valid effects addresses for the Write Wipe Pattern command are:

EFFECTS ADDRESS	ASSIGNMENTS
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System

Wipe Numbers

Wipe numbers range from 00H to 41H, corresponding to decimal numbers 0 through 65 on the Wipe subpanel. Specifying an invalid wipe number can produce unexpected results.

The format of the Wipe Number byte is as follows:

Bit		Bit
7	6 5 4 3 2 1 0	
P/S	W W W W W W W	W

The seven least significant bits (W W W W W W W) represent the wipe number in hexadecimal.

When the P/S bit is a 0, the editor selects a Primary Wipe Pattern; however, when the P/S bit is a 1, the editor selects a Secondary Wipe Pattern.

Please note that Wipe Pattern number 59, "External," can be used only with a Secondary Wipe Pattern selection.

Table 3-14. Wipe Pattern Names and Hexadecimal Numbers

Wipe Pattern Name	Hexadecimal Number	Wipe Pattern Name	Hexadecimal Number
0 VERTICAL	00H	33 DIAMOND	21H
1 T/L CORNER	01H	34 DUAL DIAGONAL	22H
2 POINT DN	02H	35 DOUBLE H SAWTOOTH	23H
3 CIRCLE	03H	36 DOUBLE V SAWTOOTH	24H
4 DIAG LT	04H	37 4 X 3 RECTANGLE	25H
5 TRIANGLE	05H	38 SMALL RANDOM	26H
6 CLOCK	06H	39 LARGER RANDOM	27H
7 ARROW	07H	40 3 PT STAR	28H
8 HEXAGON	08H	41 4 PT STAR	29H
9 SPIRAL	09H	42 6 PT STAR – Small	2AH
10 HORIZONTAL	0AH	43 6 PT STAR – Large	2BH
11 T/R CORNER	0BH	44 8 PT STAR	2CH
12 POINT RT	0CH	45 TEXTURE	2DH
13 ELLIPSE	0DH	46 SLITSCAN	2EH
14 DIAG RT	0EH	47 V ZIG ZAG	2FH
15 PENTAGON	0FH	48 V SCAN	30H
16 DUAL CLOCK	10H	49 H X-CROSS	31H
17 DIAGONAL CROSS	11H	50 V X-CROSS	32H
18 OCTAGON	12H	51 V SNOWFALL	33H
19 H ZIG ZAF	13H	52 H SNOWFALL	34H
20 V SPLIT	14H	53 V QUAD SPIRAL	35H
21 B/R CORNER	15H	54 DIAG ZIG ZAG	36H
22 POINT LT	16H	55 H QUAD SPIRAL	37H
23 SQUARE	17H	56 T/B ZIG ZAG	38H
24 CROSS	18H	57 L/R ZIG ZAG	39H
25 V SAWTOOTH	19H	58 CHECKERBOARD	3AH
26 H SAWTOOTH	1AH	59 EXTERNAL	3BH
27 5 PT STAR	1BH	60 USER 1	3CH
28 HEART	1CH	61 USER 2	3DH
29 H SCAN	1DH	62 USER 3	3EH
30 H SPLIT	1EH	63 USER 4	3FH
31 B/L CORNER	1FH	64 USER 5	40H
32 POINT UP	20H	65 USER 6	41H

Write Transition Mode (CA) Command

The Write Transition Mode command sets up the “next transition” that will occur when any transition for that level is expected (via panel or editor command) is sent.

Table 3-15. Write Transition Mode Command

Function	Byte Count	Effects Address	Command Code	Message
Write Transition Mode	03	EX	CA (Write)	Mode

Effects Addresses

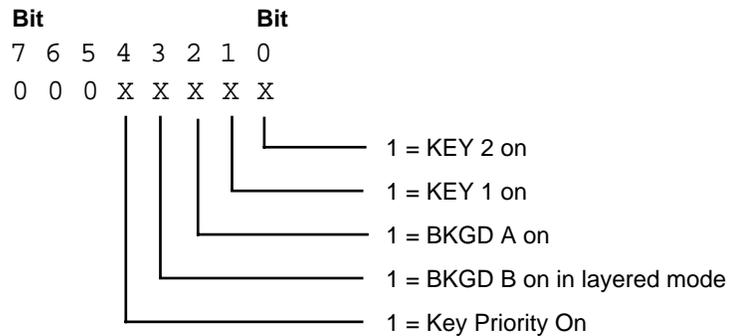
Valid effects addresses for the Write Transition Mode command are:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)

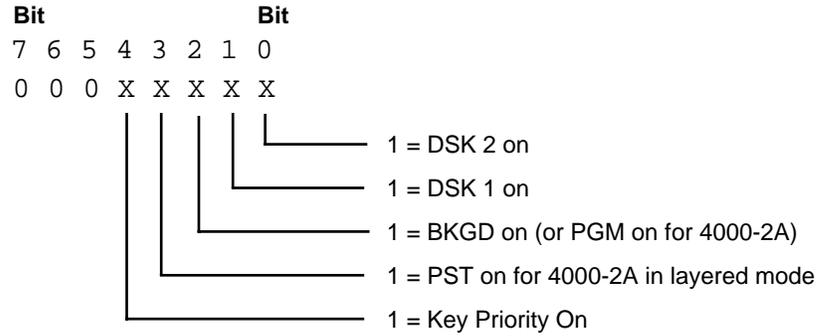
For this command, writing to the PGM-PST or the DSK has exactly the same effect.

Mode Byte

The format of the Write Transition Mode byte is as follows for an M/E:



For PGM-PST/DSK the format of the Write Transition Mode byte is as follows:



After BKGD is set to ON, the next transition will occur on the PGM-PST bus.

NOTE: Do not issue this command more than once per video field. If you do, the last command sent will be the one executed.

Write Transition Rate Commands

The Write Transition Rate commands set the rates used by the switcher to perform a transition. They can also cause a transition to take place by setting the “execute bit.” The “next transition” which will occur should have been previously selected, either manually at the panel or by sending a Write Transition Mode command.

Three transition rates may be set in the switcher:

- Auto transition rate
- Key 1 transition rate
- Key 2 transition rate

Which rate is used depends on:

- The switcher model
- The “next transition” which has been selected
- The effects address

Model 3000-2 and 4000-2B

M/E1, M/E2, M/E3

The auto transition rate is always used.

PGM-PST/DSK

The transition rate depends on the state of the “next transition.” If the next transition is set only to BKGD, then the auto transition rate is used. If the next transition is set to DSK 1, DSK 2, or both, then the Key 1 transition rate is used. If BKGD and KEY 1 or KEY 2 is selected, then the BKGD (PGM-PST) transition has precedence over the DSK transition and the auto transition rate is used.

Model 2200-2

The auto transition rate is always used.

Model 3000-3 and 4000-2A

M/E1, M/E2, (and M/E3 on 3000-3)

The transition rate depends on the state of the “next transition.” If the next transition is set only to BKGD A (or BKGD B on a 4000-2A in layered mode), then the auto transition rate is used. If the next transition is set to KEY 1, then the Key 1 transition rate is used. If the next transition is set to KEY 2, then the Key 2 transition rate is used. If a combination of BKGD, KEY 1 and KEY 2 is selected, then the order of precedence is BKGD (auto transition rate), KEY 1 (Key 1 rate), KEY 2 (Key 2 rate).

PGM-PST/DSK

Setting the transition rate is very similar to that for an M/E. If the next transition is set only to PGM (or PST on a 4000-2A in layered mode), then the auto transition rate is used. If the next transition is set to DSK 1, then the Key 1 transition rate is used. If the next transition is set to DSK 2, then the Key 2 transition rate is used. If a combination of PGM-PST, DSK 1 and DSK 2 is selected, then the order of precedence is PGM-PST (auto transition rate), DSK 1 (Key 1 rate), DSK 2 (Key 2 rate).

NOTE: *The 4000-2A and the 3000-3 have more functionality than the 3000-2, 4000-2B and 2200-2 in that Key 1 and Key 2 transition rates may be set. If the editor does not want to distinguish between Models, then it would be effective to always set the Key 1 and Key 2 rates in a Write Auto Transition Rate command.*

Transition Rates

Transition rates are specified in numbers of frames.

To translate a transition rate in seconds to number of frames, use the following formulae:

For NTSC:

$$\text{Frame Rate} = (\text{transition time in seconds}) \times (30 \text{ frames/second})$$

For PAL:

$$\text{Frame Rate} = (\text{transition time in seconds}) \times (25 \text{ frames/second})$$

As an example, take the case of a four (4) second AUTO TRAN. In such a case, the frame rate (NTSC) is 120 frames (4 seconds * 30 frames/second = 120 frames). For the PAL standard, substitute 25 frames, giving 100 frames.

Write Auto Transition Rate (CC) Command

The Write Auto Transition Rate command is primarily intended to set the auto transition rate but can also set the Key 1 and Key 2 transition rates. If the execute bit is set, the auto transition will be performed.

Table 3-16. Write Auto Transition Rate Command

Function	Byte Count	Effects Address	Command Code	Message
Write Auto Transition Rate	05	EX	CC (Write)	HD TN UN

Effects Addresses

Valid effects addresses for the Write Auto Transition Rate commands are:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK) ¹

Writing to Effects Addresses 00 (PGM-PST) and 04 (DSK) have the same effect; either can be used for this command.²

Transition Rate

The command specifies the auto transition rate in terms of frames, ranging from 000 to 999. Specify the auto transition rate in the command by supplying three data bytes:

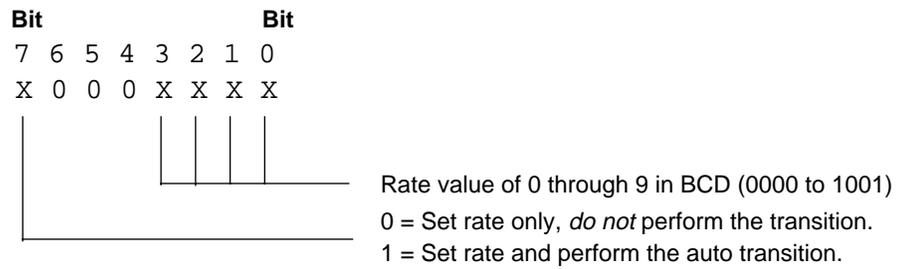
- HD — The hundreds digit in BCD. The MSB is the “execute” bit.
- TN — The tens digit in BCD.
- UN — The units digit in BCD. The two MSBs are control bits to select Key 1 and Key 2 rates in addition to the auto transition rate.³

1. Not supported in Version 5.0 and earlier

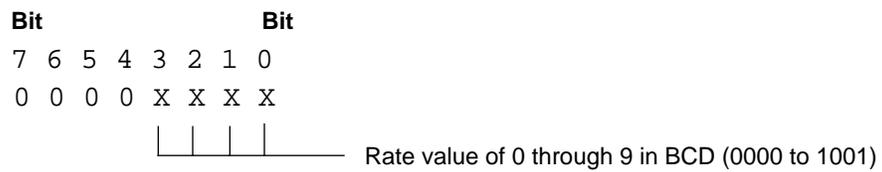
2. For Version 5.0 and earlier, writing to address 04 (DSK) was not supported

3. For Version 5.0 and earlier, using the two MSBs to control KEY 1 and KEY 2 rates was not supported.

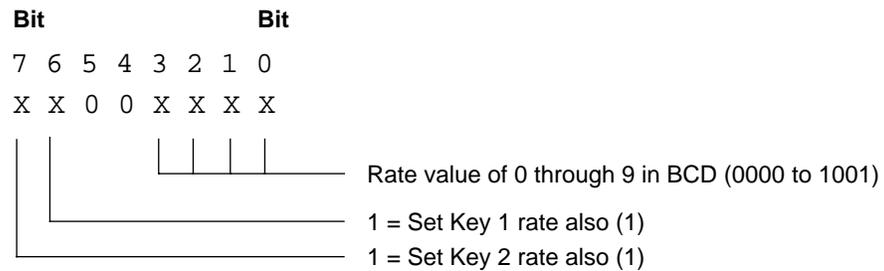
The format of the HD byte is as follows:



The format of the TN byte is as follows:



The format of the UN byte is as follows:



(1) Not supported in Version 5.0 and earlier.

Write Key Transition Rate (CD) Command

The Write Key Transition Rate command sets the Key 1 and Key 2 transition rates. If the execute bit is set, then an auto transition is performed also.

By default, both Key 1 and Key 2 rates are set¹. However, the command can be used to set either Key 1 or Key 2 rates independently on switcher models which support this.

Table 3-17. Write Key Transition Rate Command

Function	Byte Count	Effects Address	Command Code	Message
Write Key Transition Rate	05	EX	CD (Write)	HD TN UN

Effects Addresses

Valid Effects Addresses for the Write Key Transition Rate commands are:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System ²
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)

Writing to Effects Addresses 00 (PGM-PST) and 04 (DSK) have the same effect; either can be used for this command.³

Transition Rate

The command specifies the Key 1 and Key 2 rate in terms of frames, ranging from 000 to 999. Specify the transition rate in the command by supplying three data bytes:

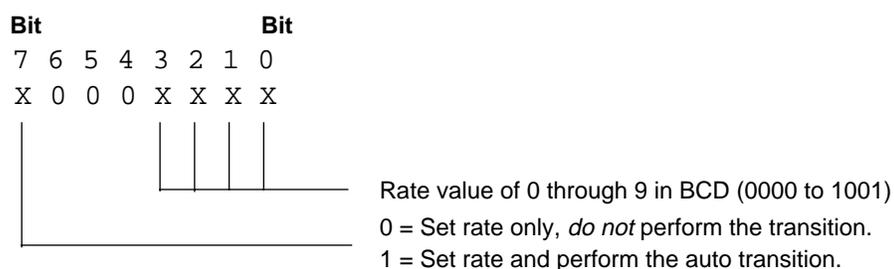
- HD — The hundreds digit in BCD. The MSB is the “execute” bit.
- TN — The tens digit in BCD.
- UN — The units digit in BCD. The two MSBs are control bits used to select only Key 1 or Key 2 rates rather than both.

1. Prior to Version 5.1, only the Key 1 rate was set by default, and it worked only for PGM-PST, not for the M/Es. The Key 2 rate was not set.

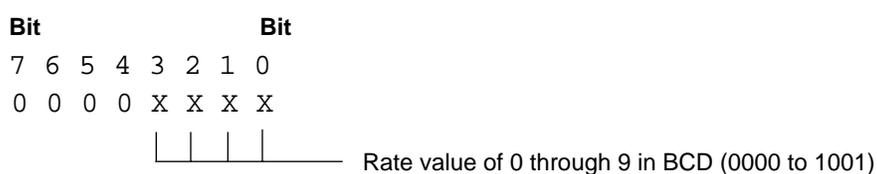
2. Not supported in Version 5.0 and earlier.

3. In Version 5.0 and earlier, writing to address 00 (PGM-PST) was not supported.

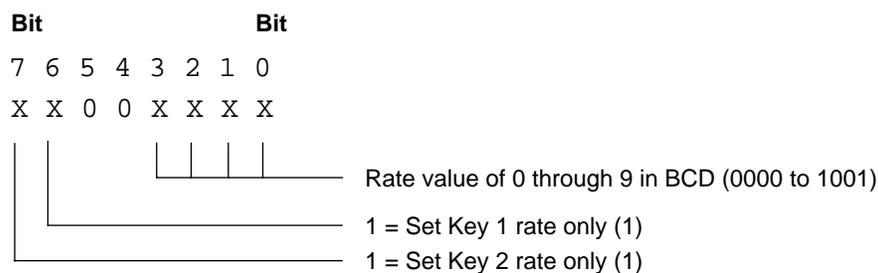
The format of the HD byte is as follows:



The format of the TN byte is as follows:



The format of the UN byte is as follows:



(1) Not supported in Version 5.0 and earlier

If bit 6 (set Key 1 rate only) and bit 7 (set Key 2 rate only) are both zero, then both the Key 1 and Key 2 rates will be set by the command.¹

If bits 6 and 7 are both set to 1, then only Key 1 rate will be set.

1. Only Key 1 rate set in Version 5.0 and earlier.

Write Recall E-MEM Register (DB) Command

Recall E-MEM is a write-only command. When sent, the command causes the state data in the specified E-MEM (Effects Memory) register to be recalled, thus changing the current state of the switcher to the stored settings for the given effects addresses. This command performs the same action as manually recalling an E-MEM register number of 0 through 99.

Control bits may be set to force or inhibit the recall of the register as an effects dissolve. Additionally, control bits may be used to force or inhibit the running of an effect which contains multiple keyframes, and the recall of learned enables prior to the recall of the register.

NOTE: Do not send this command more than once per video frame. Also note that a new recall command received by the switcher will override any recall that is still in progress for an effects address.

Table 3-18. Recall E-MEM Register Command

Function	Byte Count	Effects Address	Command Code	Message
Recall E-MEM Register	04 06	EX FF	DB (Recall) DB (Recall)	Mode, Effects Number Mode, Effects Number, 2-byte Bit-Mask (1)

(1) Not supported in Version 5.0 and earlier

Effects Addresses

Prior to Version 5.1, when an individual Effects Address was specified, the switcher disabled all but the selected E-MEM level on the panel. With Version 5.1 and later, that no longer happens. Instead, the panel is left in its current state.

Valid Effects Addresses for the Recall E-MEM to Switcher command are:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)
05	Background (BKGD)
06	Miscellaneous
07	DPM 1
08	DPM 2
09	DPM 3
0A	DPM 4
0B	All enabled levels
FF	All specified levels ¹

NOTE: Must specify **0B** effects address when recalling a 300 Style Master E-MEM effect.

The editor may recall a specific Effects Address or may recall all levels currently enabled on the control panel. If the Effects Address is FF then the levels to be recalled are specified in a 2-byte Bit-Mask

Mode Byte²

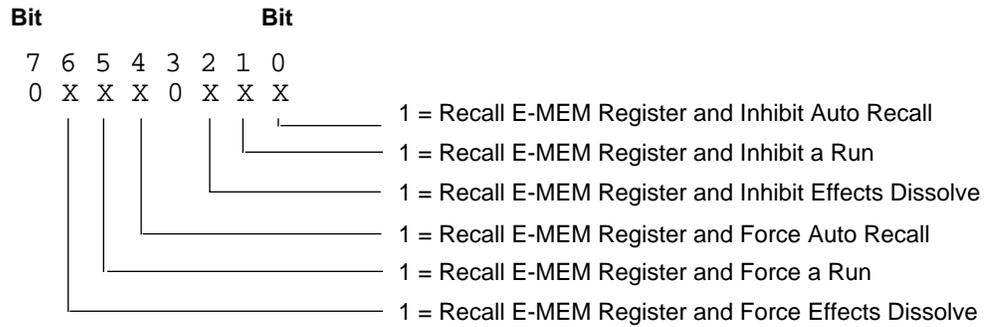
The Mode byte allows an E-MEM recall with Effects Dissolve, Auto Recall, and Run, either separately or together. The Mode byte takes precedence over the Switcher button tallies. The mode byte looks at three operations:

- Force the Auto Run/ Auto Recall/ Effects Dissolve operation
- Inhibit the Auto Run/ Auto Recall/ Effects Dissolve operation
- Operate according to current Switcher panel settings

1. Not supported in Version 5.0 and earlier

2. In Version 5.0 and earlier, the value of the mode byte was ignored and treated as though all bits were zero. That is to say, the E-MEM Register will be recalled and the action performed will be according to what was learned into the E-MEM Register and the current panel state.

The format of the Mode byte is as follows:



Effects Dissolve, Auto Recall, and Run each have a Force bit and an Inhibit bit. If the Force bit is on, the action is performed irrespective of the state of the switcher. If the Inhibit bit is on, the action is not performed, irrespective of the state of the switcher. If both bits are off, then the action is performed according to the switcher state, that is, what has been recalled from E-MEM, modified by the current state of the panel.

FORCE	INHIBIT	ACTION
1	0	Perform action
0	1	Inhibit Action
0	0	Act according to panel state and register contents
1	1	Invalid

Setting Bit 5 to one recalls an E-MEM register and runs any keyframes stored in that register. This has the same effect as pushing the AUTO RUN pushbutton and then recalling an E-MEM register from the control panel. Setting Bit 1 to one recalls an E-MEM which does not run, irrespective of the state of the AUTO RUN button. If both Bits 5 and 1 are set to zero, then the E-MEM is recalled and will run only if the AUTO RUN button is on.

Setting Bit 6 to one recalls an Effects Dissolve into an E-MEM register. This has the same effect as pushing the EFF DIS pushbutton and then recalling an E-MEM register from the control panel. Setting Bit 2 prevents the Effects dissolve from taking place irrespective of whether the effect was learned with Effects Dissolve on, or the Effects Dissolve button was pressed prior to sending the Recall E-MEM command. If both Bits 6 and 2 are zero, then the Effects Dissolve will occur if the effect was learned with Effects Dissolve on, or if the Effects Dissolve button is on (has just been pressed).

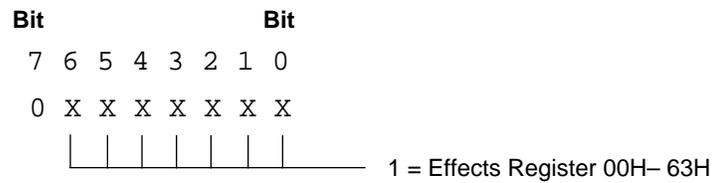
Auto Recall is controlled by the bits in the same manner as Auto Run, described above.

It is possible to combine Force bits to automatically run a register starting with an effects dissolve after the enabled levels have been recalled.

Registers

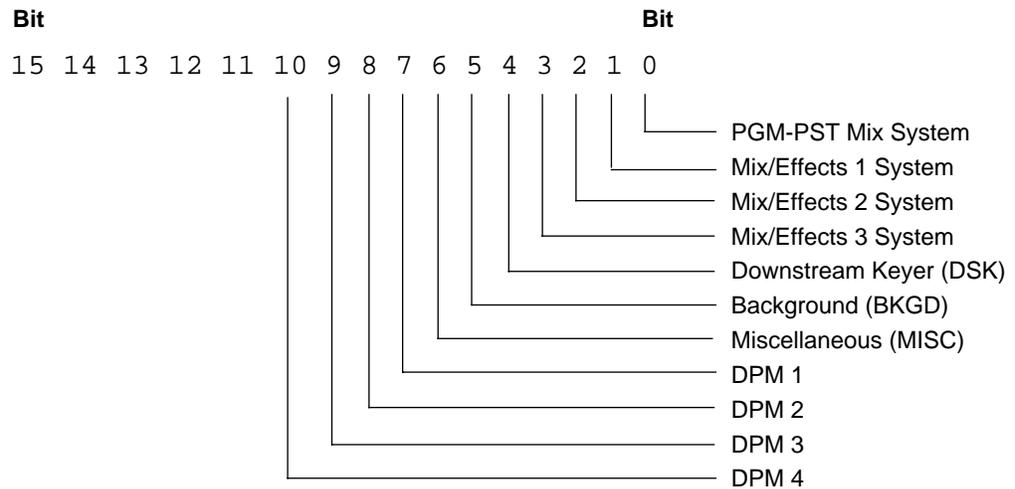
Valid E-MEM registers are 00H through 63H (0–99 decimal).

The format of the Effects Register Number byte is as follows:



Bit-Mask Format¹

The two-byte bit mask allows the editor to specify any combination of effects addresses 00 through 0A. The LSB (bit 0) represents the first address, and bit 10 represents the DPM 4 address. The top 5 bits are “don't care.”



1. Not supported in Version 5.0 and earlier.

Write Learn E-MEM Register (DA) Command

The Learn E-MEM Register command is a write-only command that causes the Effects Address state data in the specified E-MEM register to be stored or “learned” into the E-MEM register specified in the Mode byte. This command has the same effect as manually pressing the **LRN** button and then selecting an E-MEM register number (0 through 99). The command also supports learning an Effects Dissolve into a register.

Table 3-19. Learn E-MEM Register Command

Function	Byte Count	Effects Address	Command Code	Message
Learn E-MEM Register	04	EX	DA (Learn)	Mode, Effects Number
	06	FF	DA (Learn)	Mode, Effects Number, 2-byte Bit-Mask (1)

(1) Not supported in Version 5.0 and earlier

Effects Addresses

Prior to Version 5.1, when an individual Effects Address was specified, the switcher disabled all but the selected E-MEM level on the panel. With Version 5.1 and later, that no longer happens. Instead, the panel is left in its current state.

Valid Effects Addresses for the Learn E-MEM Register command are:

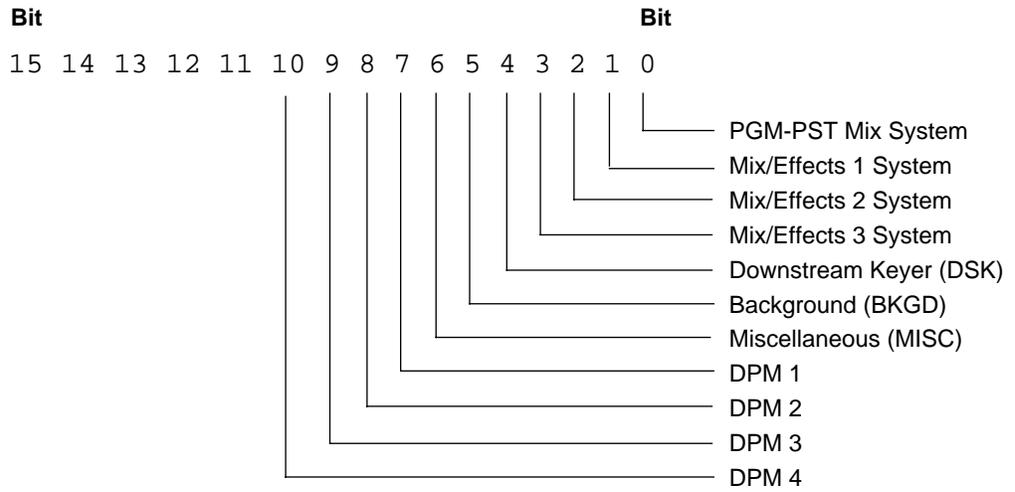
EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)
05	Background (BKGD)
06	Miscellaneous
07	DPM 1
08	DPM 2
09	DPM 3
0A	DPM 4
0B	All enabled levels
FF	All specified levels ¹

The editor may learn a specific Effects Address or may learn all levels currently enabled on the control panel. If the Effects Address is FF then the levels to be learned are specified in a 2-byte Bit-Mask.

1. Not supported in Version 5.0 and earlier

Bit-Mask Format¹

The two-byte bit mask allows the editor to specify any combination of effects addresses 00 through 0A. The LSB (bit 0) represents the first address, and bit 10 represents the DPM 4 address. The top 5 bits are “don't care.”



1. Not supported in Version 5.0 and earlier.

Write Split Key (E4) Command

This command allows an editor to use the Split Key feature of the Model 2200, 3000, or 4000 Switcher. There are two modes for selecting the key source: *Auto Select* mode uses the key source assigned to the selected fill crosspoint. *Video Select* mode uses the selected fill video as the key source.

Table 3-20. Write Split Key Commands

Function	Byte Count	Effects Address	Command Code	Message
M/E 1 A BKGD	04	01	E4 (Write)	Fill CP#, Key CP#
M/E 2 A BKGD	04	02	E4 (Write)	Fill CP#, Key CP#
M/E 3 A BKGD	04	03	E4 (Write)	Fill CP#, Key CP#
DSK 1	04	04	E4 (Write)	Fill CP#, Key CP#
DPM 1	04	07	E4 (Write)	Fill CP#, Key CP#
DPM 2	04	08	E4 (Write)	Fill CP#, Key CP#
DPM 3	04	09	E4 (Write)	Fill CP#, Key CP#
DPM 4	04	0A	E4 (Write)	Fill CP#, Key CP#
M/E 1 A BKGD	04	01	E5 (Write)	Fill CP#, Key CP#
M/E 2 B BKGD	04	02	E5 (Write)	Fill CP#, Key CP#
M/E 3 B BKGD	04	03	E5 (Write)	Fill CP#, Key CP#
DSK 2	04	04	E5 (Write)	Fill CP#, Key CP#
M/E 1 KEY 1	04	01	E6 (Write)	Fill CP#, Key CP#
M/E 2 KEY 1	04	02	E6 (Write)	Fill CP#, Key CP#
M/E 3 KEY 1	04	03	E6 (Write)	Fill CP#, Key CP#
M/E 1 KEY 2	04	01	E7 (Write)	Fill CP#, Key CP#
M/E 2 KEY 2	04	02	E7 (Write)	Fill CP#, Key CP#
M/E 3 KEY 2	04	03	E7 (Write)	Fill CP#, Key CP#

When the Mix/Effects section is in layered mode, you can use the Write split Key command on KEY 1, KEY 2, BKGD A, and BKGD B.

When the Mix/Effects is in standard mode, you can use the Write Split Key command on KEY 1 and KEY 2.

You can use the Write Split Key command on DSK 1 and DSK 2 of the DSK section.

Effects Addresses

Valid Effects Addresses for the Split Key command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)
07	DPM 1
08	DPM 2
09	DPM 3
0A	DPM 4

Crosspoint Numbers

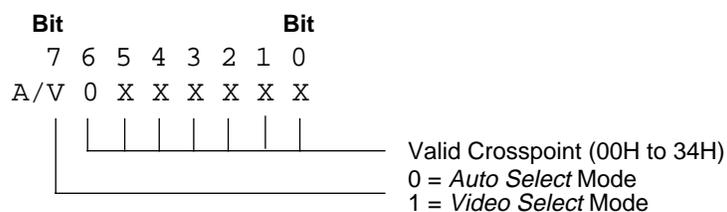
Valid crosspoints for this command are shown in the following table:

Table 3-21. Split Key Command Crosspoints

Address	Description
01H–30H = Normal Crosspoints 1 to 48	M/E 1, 2, 3 and DSK
31H = M/E 1	M/E 2 and M/E 3 and DSK
32H = M/E 2	M/E 1 and M/E 3 and DSK
33H = M/E 3	M/E 1 and M/E 2 and DSK

The fill crosspoint is a valid crosspoint in hex.

The format of the Key Crosspoint byte is as follows:



Select “Layered” Or “Standard” (E8) Command

Using this command, an editor can select for each Mix/Effects section either the *Standard* or *Layered* mode of operation.

Table 3-22. Select “Layered” or “Standard” Command

Function	Byte Count	Effects Address	Command Code	Message
Layered or Standard Mode	03	EX	E8 (Write)	Mode byte

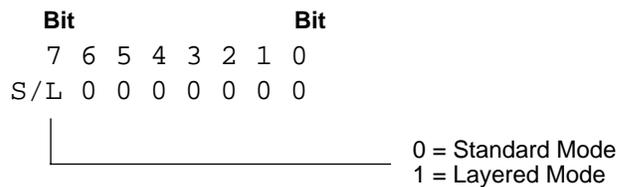
Effects Addresses

Valid Effects Addresses for the Select Layered/Standard command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System (Model 4000-2A only)
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System

Mode Byte

The format of the Mode byte is as follows:



Data Transfer (5E and DE) Commands

There are two types of data that may be transferred—switcher E-MEM data and switcher configuration data. The type of data is determined by use of the appropriate effects address (see below).

From the perspective of the editor, there are two types of data transfer—reads and writes. For example, an editor may read the contents of a specified E-MEM register from a switcher. At a later time the editor may write the contents of a specified E-MEM register back to the switcher. The switcher then stores this data back into the specified E-MEM register.

Two message types are used to perform data transfers—the Request data command and the Sending data message.

Table 3-23. Data Transfer Messages

Function	Byte Count	Effects Address	Command Code	Message
Request data	05	EX	5E	Sequence Number (2 bytes), Register Number
Sending data	06H to FFH	EX	DE	Sequence Number (2 bytes), Register Number, and up to 250 data bytes

Effects Addresses

Valid Effects Addresses for data Transfers are as follows:

EFFECTS ADDRESS	LEVELS
00	PGM-PST
01	Mix/Effects 1
02	Mix/Effects 2
03	Mix/Effects 3
04	Downstream Keyer (DSK)
05	Background (BKGD)
06	Miscellaneous (MISC)
07	DPM 1
08	DPM 2
09	DPM 3
0A	DPM 4
0B	All <u>learned</u> E-MEM levels
1E	Configuration ¹

NOTE: Effects Address **0B** deals only with the E-MEM Levels that have data learned into them, ignoring all currently enabled levels selected on the panel.

1. Not supported in Version 5.0 and earlier.

Register Number

Valid register numbers are in the range of 00H to 63H (00 to 99 decimal) for E-MEM data. When transferring configuration data, the register number is ignored.

Sequence Number

The *Sequence Number* is a two-byte value that always begins at 0 and increments to a maximum of FFFDH and is used to number successive packets of data. Please note the following:

- Each transfer must start with the sequence number reset to zero.
- A Sequence number of FFFEh indicates the end of the data
- A Sequence number of FFFFh will abort a data transfer.

Data

The length of data varies, depending on the Effects Address being used.

Taking a Snapshot of the Switcher

An editor request for effects address OBH tells the switcher to transfer all levels for that register. So to take a snapshot of the whole switcher:

- Enable all E-MEM levels
- Learn to Register x
- The editor sends a Request E-MEM Data message for Register x

Transfer Command Examples

Data transfers occur as a dialog between the editor and the switcher. One side acts as the transmitter of the data and the other as the receiver.

An editor always initiates a transfer; it acts as either the transmitter or the receiver of data depending on the direction of the transfer. A dialog proceeds as the transmitter and receiver send messages back and forth to each other requesting and sending data. Even though the editor always initiates the transfer, it is the receiver that is in charge of pacing the transfer because it specifies the sequence number of the next packet it expects the transmitter to send in the request message. So if the receiver detects an error it can abort the transfer, or ask for a retry by repeating a request for the same sequence number again. (See Error Detection and Handling, later in this section).

The following examples show scenarios of editor-to-switcher command dialogue that demonstrates how the Transfer commands work.

Scenario 1

The editor is going to read Register Number 33 (21H) from Mix/Effects 1. The editor is the receiver of the E-MEM data. The register it is going to receive contains 1450 bytes of data. The following dialogue is the result:

1. The editor sends a request to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 00H	21H	none

2. The switcher sends the first block of 250 bytes of data to the editor:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 00H	21H	250 Bytes of E-MEM data

3. The editor sends a request for the next block to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 01H	21H	none

4. The switcher sends another 250 bytes of data to the editor:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 01H	21H	250 bytes of E-MEM data

5. The editor sends a request for the next block to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 02H	21H	none

6. The switcher sends another 250 bytes of data to the editor:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 02H	21H	250 Bytes of E-MEM data

7. The editor sends a request for the next block to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 03H	21H	none

8. The switcher sends another 250 bytes of data to the editor:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 03H	21H	250 bytes of E-MEM data

9. The editor sends a request for the next block to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 04H	21H	none

10. The switcher sends another 250 bytes of data to the editor:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 04H	21H	250 bytes of E-MEM data

11. The editor sends a request for the next block to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 05H	21H	none

- The switcher sends the last 200 bytes of data to the editor and indicates that this is the last block by sending sequence number FFEH:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
CDH	01	DEH	FFH FEH	21H	200 bytes of E-MEM data

The transfer is now complete.

Scenario 2

The editor is going to write Register Number 33 (21H) to Mix Effects 1. Note that this time the editor is the transmitter of E-MEM data. The switcher is the receiver and so it controls the transfer by specifying the sequence number of the next block for the editor to send. To shorten the example, a register size of 635 bytes will be used. The following dialogue is the result:

- The editor sends the first block of data to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 00H	21H	250 bytes of E-MEM data

- The switcher requests the next block of data and supplies the sequence number of this next data block to be sent. Implicitly this acknowledges receipt of the previous block.

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 01H	21H	none

- The editor sends the next block of data to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 01H	21H	250 bytes of E-MEM data

- The switcher requests the next block of data and supplies the sequence number of this next data block to be sent:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 02H	21H	none

5. The editor sends the final block to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
8C	01	DEH	FFH FEH	21H	135 bytes of E-MEM data

6. The switcher sends a final request message to the editor, acknowledging receipt of the last block and ending the transfer:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	DEH	FFH FEH	21H	none

Error Detection and Handling

When an error of any sort is detected during a transfer, appropriate actions are to retry the last action or abort the transfer.

Only a receiver can request a retry, and it does so by sending a request to transfer a packet with the same sequence number as the last packet. If in the above example the switcher were to request a retry of sequence number 1 (after message number 3), the switcher would simply send a message to the editor asking for sequence number 1 rather than 2 as message number 4. However, the Editor or the Switcher as a Receiver will not ask for a retry after the last packet. In either case, the Switcher considers the last packet as a completion of the transfer.

The following is an example of a transfer containing an error that is detected while the switcher is receiving data. Again, a register size of 635 bytes is used:

1. The editor sends a Transfer Write command to the switcher and the first block of data:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 00H	21H	250 bytes of E-MEM data

2. The switcher requests the next block of data and supplies the sequence number of this next data block to be sent. Implicitly this acknowledges receipt of the previous block:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 01H	21H	none

3. The editor sends the next block of data to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 01H	21H	250 bytes of E-MEM data

At this point, the switcher detects an error and attempts a retry:

4. The switcher sends a request with the same sequence number to the editor:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 01H	21H	none

Section 3 – Editor Interface Commands

5. The editor re-sends a block of 250 bytes to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
FFH	01	DEH	00H 01H	21H	250 bytes of E-MEM data

6. The switcher sends a request for next block to the editor:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	5EH	00H 02H	21H	none

7. The editor sends the final block to the switcher:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
8C	01	DEH	FFH FEH	21H	135 bytes of E-MEM data

8. The switcher sends a final request message to the editor, acknowledging receipt of the last block and ending the transfer:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
05	01	DEH	FFH FEH	21H	none

NOTE: *It is not possible for the editor or the switcher to request a re-send of the last block.*

If the receiver has requested a retry several times and there is still an error, or there is some other unrecoverable error, then the transfer may be terminated by sending an abort message. Although only the receiver can request a retry, either the transmitter or receiver can send an abort message at any time during a transfer, if an error is detected.

The format of the abort message is as follows:

Byte Count	Effects Address	Command Code	Sequence Number	Register Number	E-MEM Data
06H	EX	DEH	FFH FFH	nnH	abort code (1 byte)

Switcher-supplied abort codes are:

ABORT CODE	MEANING
01	Request for an E-MEM register which is empty
02	Invalid sequence number received
03	Internal communication error
04	Bad file header
05	Bad Master E-MEM header
06	Bad individual E-MEM header
07	Bad Keyframe data
08	Invalid byte count
09	(reserved)
0A	Invalid Register number
0B	Invalid Effects Address

When the editor transfers data to the switcher, the editor should check the “Status Replies” returned by the switcher for the presence of any errors.

If the editor needs to terminate a transfer and it sends an abort message, then the switcher will acknowledge receipt of this abort message by returning an abort message also, with an abort code of 80H. This will indicate the end of the transfer.

Software Version (6C and EC) Commands

The switcher will respond with a Software Version Response message on receipt of a Read Software Version command. The response will be returned two fields after the request is received.

Table 3-24. Software Version Command

Function	Byte Count	Effects Address	Command Code	Message
Read Software Version	02	EX	6C	none
Software Version Response	07	EX	EC	Model number, Major Version number, Minor Version number, First Fix level, Second Fix Level

Effects Addresses

Valid Effects Addresses for the Software Version command are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System

Model Number

Model numbers are as follows:

MODEL NUMBER	MEANING
01	3000-2
02	3000-3
03	4000-2A
04	4000-2B
05	4000-3
06	2200-2
07	2200-2i

Version Number

The software Version number comprises a Major Version number, a Minor Version number, and two fix-level parameters. The Major Version and Minor Version are each represented as a two-byte ASCII character, and the two fix-level parameters are each represented as a one-byte ASCII character.

For example: Version 4.1a would be represented as: 30H 34H 30H 31H 61H 20H.

Version 5.0B1 would be represented as: 30H 35H 30H 30H 42H 31H.

Switcher Model Features

The following is a brief summary of the features associated with the various switcher models.

Table 3-25. Switcher Models

Model	Number of Xpoint buttons	Number of M/Es	PGM-PST/DSK	Other
3000-2	16	2	YES	Composite
3000-3	24	3	YES	Composite
4000-2B	16	2	YES	Component
4000-2A	24	2	YES	Component, layered mode on DSK
4000-3	24	3	YES	Component
2200-2	16	2	NO	Component
2200-2i	16	2	NO	Component, Krystal control

Timeline Control (4E, 4F, CE, and CF) Commands

The Timeline Control commands allow the editor to manipulate a specified effect's timeline. The controlling device may read the current position, write a new position, or trim the current position by a specified amount. All positions or trims are measured as a field count. The switcher's response to the Read Timeline command is the Write Timeline command.

Table 3-26. Timeline Control Commands

Function	Byte Count	Effects Address	Command Code	Message
Read Timeline Time (1)	02	EX	4E	None
Set Timeline Time (2)	06 08	EX FF	CE CE	4-byte write value write value + 2-byte bit-mask
Trim Timeline Time (2)	06 08	EX FF	CF CF	4-byte trim value trim value + 2-byte bit-mask
Run Timeline (2)	06 08	EX FF	4F 4F	4-byte speed value speed value + 2-byte bit-mask

(1) Response guaranteed for 2 fields.

(2) Switcher latency applies.

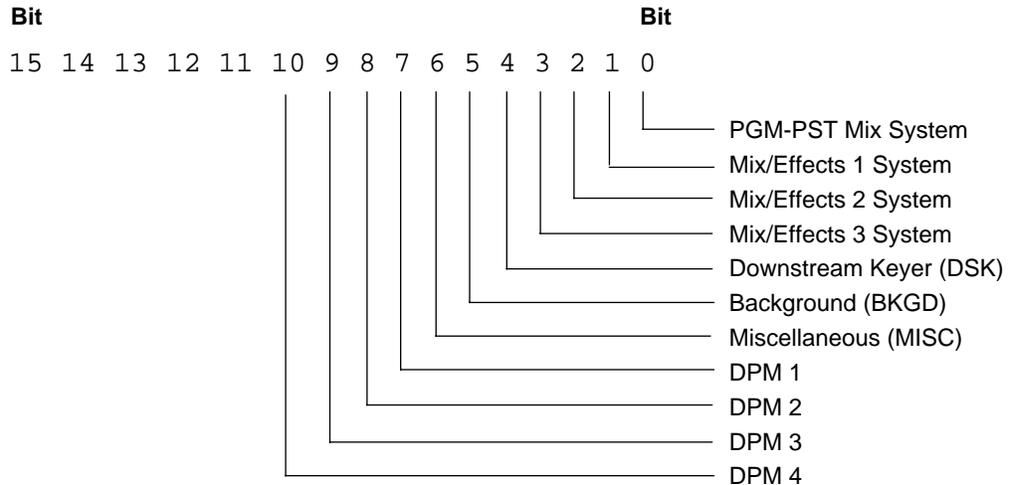
Effects Addresses

Valid Effects Addresses for the Timeline control commands are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)
05	Background (BKGD)
06	Miscellaneous (MISC)
07	DPM 1
08	DPM 2
09	DPM 3
0A	DPM 4
0B	Master Timeline (all enabled levels)
FF	All levels specified in the bit-mask

Bit-Mask Format

The two-byte bit mask allows the editor to specify any combination of effects addresses 00 through 0A. The LSB (bit 0) represents the first address, and bit 10 represents the DPM 4 address. The top 6 bits are “don't care.”



Data Field Format

All time data (field count) and speed data is specified to be binary data in S15.16 format. The lower two bytes specify a fractional field value. The topmost bit is the sign bit and the next 15 bits represent whole field values.

Note the following examples:

+1 field	==> 00 01 00 00
- 1 field	==> FF FF 00 00
+1 (unity) speed	==> 00 01 00 00
- 1/2 speed	==> FF FF 80 00

Setting the Run Time for a speed of zero is the same as sending a STOP command.

The editor is allowed to write a negative field count or to trim in a negative direction which results in a negative field count. In either case the result is to display a negative timecode in the menu and position the video at the 1st keyframe. The video will remain at that position until one of the following occurs:

- The effect runs long enough for the field count to pass zero
- The editor successively trims the field count in a positive direction until zero is passed
- The editor writes a positive, non-zero field count to the switcher

Examples

Note the following examples:

08 0C CF FF FF 00 00 07 80 ==> Trim all DPM levels by -1 field.

08 0C CE 00 1E 00 00 00 0E ==> Set the 3 M/Es to 30 fields.

08 0C 4F 00 01 00 00 00 0E ==> Run the effects for all 3 M/Es.

4 *Parameter-Based Command Set*

Introduction

This section details the addition of the Parameter-Based Command Set (PBCS), to the original switcher protocol. The PBCS consists of three commands (read, set and trim), which allows a remote controlling device the ability to query the current state of selected parameters, and to change those states as required.

Examples include:

- Ask the switcher what the current crosspoint selection is on the Key 1 bus for M/E 2.
- Query the E-MEM system for current register and enables status.
- Query the Keyers for the current On Air and Next Transitions mode status.
- Query the configuration database for information about current system setup parameters.

The initial implementation of PBCS occurs with the release of switcher software version 5.3 and contains a subset of the entire command set. Each description of a particular command that follows includes the software version in which that feature will be released.

NOTE: *Note that with software version 5.3, set and trim commands are not implemented at this time.*

General Discussion of the Command Set

The command structure is based on the same model used throughout the standard protocol already released:

- Byte Count
- Effects Address
- Command Code
- Message

For the PBCS command set, the Message contains two additional address fields and a variable 1 to 4 bytes data field (as required). The combination of the added address fields with the Effects Address produces a single address for the parameter being manipulated.

Function	Byte Count	Effects Address	Command Code	Subsystem Address	Base System Address (2)	Data (1 to 4)
Read	05	EX	45	SX	BX BX	
Set	6 to 9	EX	C5	SX	BX BX	1 to 4
Trim	6 to 9	EX	CB	SX	BX BX	1 to 4

The data field for the Read command does not exist, therefore, a shorter command length is required. The response by the switcher to a Read command is a Set command.

The data field for the Set and Trim commands varies from 1 to 4 bytes. The length of these commands varies to effect the size of the data field.

Addressing

The Effects and Subsystem addresses are 1 byte each, while the Base address is 2 bytes for a total of 4 bytes. These 4 bytes of addressing data are combined to form the parameter and its location within the switcher architecture.

Each specific implementation of the command set, as described in this document, details the possible effects and subsystem addresses available to it, as well as the relevant base addresses needed to fulfill the command's requirement. Not all possible addresses of each type can be combined with each other to form meaningful parameters.

Timing and Latency

Any PBCS read command will return a PBCS set command four fields after the command is received. The switcher takes 2 fields to fetch the data and another two fields to transmit. This means that data received by the controlling device is always two fields old.

The latency for the PBCS set and trim commands follows the same specification as the original commands in this protocol. These will be executed in the 10th field after the command is received.

Crosspoint Control Command(s)

Crosspoint Query Command (V5.3)

This command allows the editor to query a specific bus on the switcher as to the currently selected crosspoint. The response is a PBCS set command with one byte of data - the crosspoint selection.

Addressing

Valid effects address for this command are as follows:

Effects Addresses	Assignments
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System

There is only one possible subsystem address for this command:

Subsystem Address	Assignments
00	Crosspoint Busses

Valid base system addresses for this command are as follows:

Base System Addresses	Assignments
00 01	PGM or A bus
00 02	PST or B bus
00 03	DSK1 or Key1
00 04	DSK2 or Key2

Data

This data is represented as a 1 byte hex value.

The crosspoint #'s fall in the range of 1 to the maximum value based on the panel type (1 through 20 hex for a 16 source button switcher, and 1 through 30 hex for a 24 source button switcher), plus the re-entry crosspoints.

Re-entry crosspoint numbers are the same for any switcher type:

Crosspoint #	Re-entry Position
31 (hex)	Mix Effects 1
32	Mix Effects 2
33	Mix Effects 3

Example

To find out the currently selected crosspoint on the Key1 bus for M/E 2, send the following command:

05 02 45 00 00 03

The switcher returns:

07 02 c5 00 00 03 dd where dd is the crosspoint #

Transition Parameter Control

Transition Query Command (V5.3)

This command allows the editor to query a specific effects as to the state of its transition sub-panel. The response is a PBCS set command whose data is dependent on the parameter being asked for.

With this command the editor may determine:

- If the specified transition control is set to do a Mix or Wipe transition.
- What the next transition will be for the specified control; bkgd, key, or any combination thereof.
- If a key is currently On Air or not.

Addressing

Valid effects addresses for this command are as follows:

Effects Address	Assignments
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)

Valid subsystem addresses for this command:

Subsystem Address	Assignments
01	Keyer Transition sub-system

Valid base system addresses for this command are as follows:

Base System Addresses	Assignments
03 00	Transition type (mix or wipe)
03 01	Transition mode
03 02	Key 1 On Air
03 03	Key 2 On Air
03 04	Bkgd A On Air
03 05	Bkgd B On Air

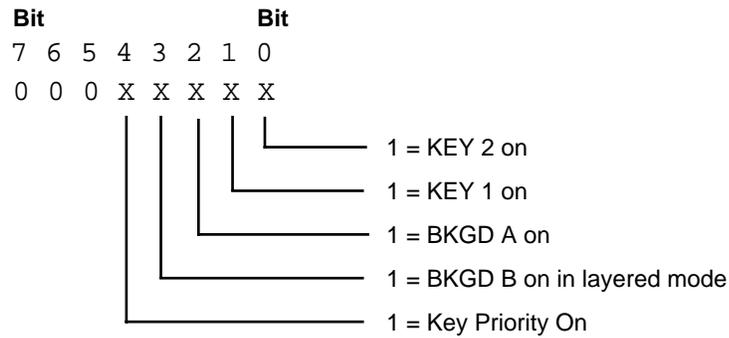
Data

Parameter Type	Data Length	Data Type
Transition Type	1 Byte	0 = Mix 1 = Wipe
Transition Mode	1 Byte	Bit Mask
On aire Stat	1 Byte	0 = No 1 = Yes

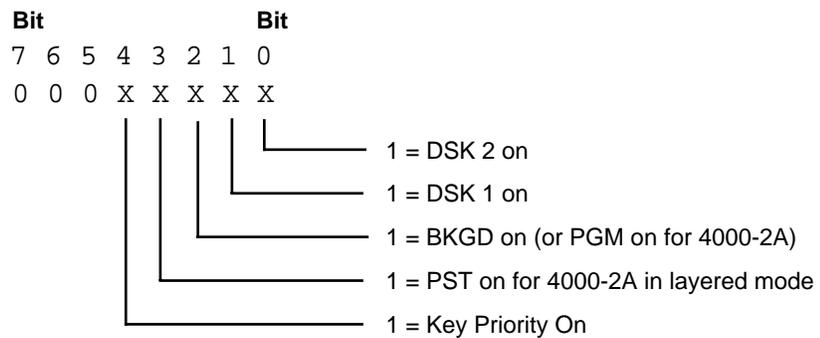
The one-byte Bit Mask uses 5 bits to describe the current state of the Transition Mode for the keyer specified. The top 3 bits are unused and will always be set to zero.

The bit definitions are identical to the mode byte implemented in the Write Transition Mode (CA) command described earlier in this document.

The format of the Transition Mode byte is as follows for an M/E:



The format of the Transition Mode byte is as follows for the DSK:



Examples

To find out what the current transition type is for M/E 3, send the following command:

05 03 45 01 03 00

The switcher returns:

06 03 c5 01 03 00 00 if currently in Mix mode

06 03 c5 01 03 00 01 if currently in Wipe mode

To find out what the current transition mode is for the DSK, send the following command:

05 04 45 01 03 01

The switcher returns:

06 04 c5 01 03 01 xx where 'xx' is the bit mask set according to the current transition mode

For example, say the bit mask is **03**. This says the next transition will involve both keyers without changing the background.

To find out if Key 1 is currently On Air for M/E 2, send the following command:

05 02 45 01 03 02

The switcher returns:

06 02 c5 01 03 02 xx where **xx = 0** Key is Off Air
or **xx = 1** Key is On Air

E-MEM Parameter Control

E-MEM Query Commands (V5.3)

These commands allow the editor to answer the following questions:

- What are all the currently enabled levels?
- Is the specified level currently enabled?
- What register is currently associated with the specified level?

Addressing

Valid effects addresses for these commands are as follows:

EFFECTS ADDRESS	ASSIGNMENTS
00	PGM-PST Mix System
01	Mix/Effects 1 System
02	Mix/Effects 2 System
03	Mix/Effects 3 System
04	Downstream Keyer (DSK)
05	Background (BKGD)
06	Miscellaneous

07	DPM 1
08	DPM 2
09	DPM 3
0a	DPM 4
0b	All Enabled Levels (enables control) – or – Master Timeline (register control)

Valid sub-system addresses for these commands are as follows:

Subsystem Addresses	Assignments
02	E-MEM sub-system

Valid base-system addresses for these commands are as follows:

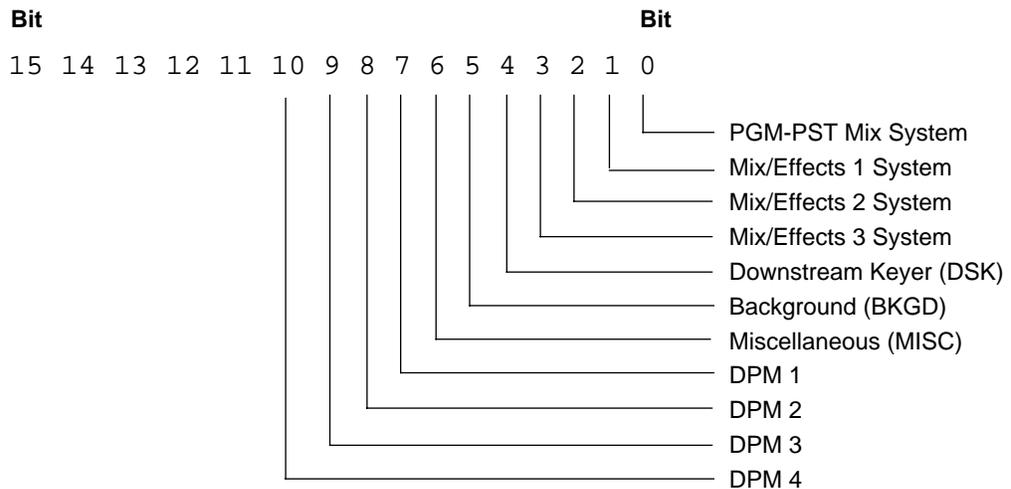
Base System Addresses	Assignments
02 00	Enables control
02 01	Register control

Data

Two byte data

Two bytes of data are returned when the base address is 02 00 (enables control) and the effects address is 0b (all enabled levels). This query is asking the switcher what are all the currently enabled levels. The data returned for this query is a 2 byte bit mask, with each of the lower 11 bits representing a distinct level. A bit ON means the associated level is ON. The top 5 bits will always be zero.

This bit mask is identical to the format outlined with the Recall E-MEM Register (0xdb) command:



Single byte data

Any query of the enables base-system for a specific individual level returns a single byte representing the ON/OFF state of that level.

0 = OFF

1 = ON

Any query of the registers base-system returns a single hex byte containing the current register number active for the requested level:

0 thru 0x63 (decimal 99)

If the effects address for this query is 0x0b, then the register number returned applies to the Master Timeline controller.

If there is NO current register associated with the requested level (Master Timeline included) then the returned value is 0xff. A typical occurrence of 'no current register' takes place right after a power-up or reset to the switcher.

Examples

To find out if level BKGD is currently enabled, send the following command:

05 05 45 02 02 00

The switcher responds with:

07 05 c5 02 02 00 00 00 if the BKGD level is NOT enabled.

07 05 c5 02 02 00 01 00 if the BKGD level IS currently enabled.

Suppose there are currently 3 levels enabled, M/E's 1 & 2, and DPM 4. Supply an effects address of 0x0b with the enable query command:

05 0b 45 02 02 00

And the switcher responds with:

07 0b c5 02 02 00 04 06

To find out what the current register associated with the Master Timeline is, send the following command:

05 0b 45 02 02 01

The switcher responds with:

07 0b c5 02 02 01 rr 00 where 'rr' is the register number in the range of 0 to 0x63 – or – 0xff.

5

Digital Effects Interface

Introduction

This section describes the interface between the Model 2200, 3000, and 4000 Switchers (“switcher”) and an external digital picture manipulator (“DPM”).

The interface supports effect recall and run (including the switcher’s run lever arm), control of switcher aux busses by the DPM when used as input selectors, and on air tally involving the DPM.

More limited DPM control is also provided via GPIs or the peripheral bus protocol. These interfaces are not covered in this section

General Background about Switcher/DPM Integration

The switcher/DPM integration involves the following functions:

- Effects on both the switcher and the DPM can be triggered and run under user control from the switcher panel. The DPM effect number can be any number in the range of DPM effects, and the number (not the effect itself) is stored in the switcher’s E-MEM register when a LEARN operation is done at the switcher. When a register is recalled at the switcher, this effect number will be sent to the DPM for effect recall.
- DPM source selection can be provided by the switcher's aux busses. One aux bus pair can be assigned to each DPM channel in a multi-channel configuration. Switcher aux busses support field accurate front/back source switching for the DPM.

NOTE: *Sources changes are synchronized to vertical interval by the switcher. Therefore this interface does not support front/back switching for nonplanar effects such as page turns.*

NOTE: *The switcher relies on the key half of an aux bus pair to be connected to the same transforming channel as its video half. This interface makes no provision for use of the key side of a switcher’s aux bus to feed a second video channel. While basic functionality can be achieved in this mode, functions such as effects send, front/back switching and tally will not function properly. Tektronix accepts no responsibility for interfaces which do not adhere to this constraint.*

- The term “Tally,” as used here, means that the switcher can receive a message from the DPM indicating whether the DPM is on-screen or not, and the switcher can use this information to tally sources feeding the DPM, providing proper panel and camera tally.

NOTE: *The DPM informs the switcher whether or not its image is **on screen** without regard to whether the DPM itself is on air. The switcher computes the on-air tally based on the on/off screen information and whether or not the DPM output is on air.*

- Distinguishing between the terms “source” and “input”: “Source mapping” provides a level of indirection between the switcher’s physical inputs and a source selection panel button. Input 20 could be mapped to button 1. “Input” would then refer to the physical entity, and “source” to the button and to what is stored as part of the switcher’s effect.

Source information exchanged with the DPM is the logical “source” form of the information that is used—not the physical input. The switcher translates this internally to a physical input.

NOTE: *The term “crosspoint” can be misleading, meaning both source and input at different times. In this documentation, the term crosspoint refers to the actual switching matrix used in routing signals.*

Switcher Configuration

In order for this interface to function as expected, the switcher must be configured properly. DPM configuration details are covered in the normal switcher documentation. The following settings should be made prior to integration testing:

DPM Type

The switcher is capable of controlling several different types of devices. A selection is made in the CONFIG/EXT IF/DPM SETUP menu. The desired setting is currently labeled DVEOUS but may be changed to be more generic in a future switcher version.

The OTHER and NONE selections deactivate the interface port. OTHER is used for simple device control via GPIs or Peripheral Bus. NONE is used when no device is controlled, but aux bus assignment and effects send are needed.

KSCOPE, KRYSTAL and INTERNAL use an extended version of this protocol, primarily to support channel sharing. Use caution: the interface may appear to partially function with these settings.

NOTE: *This protocol is only available for DEVICE 1.*

Aux Bus Assignment

A number of aux busses must be assigned to the DPM in order for the switcher to provide source selection. This assignment is performed in the CONFIG/EXT IF/DPM SETUP/MAP AUX BUSSES menu.

Input Mapping

The switcher relies on special input mapping for DPM signals returned to the switcher input. This mapping insures proper tally and effect send operation. Physical inputs are specified for every video and key signal connected from the DPM to the switcher in the CONFIG/EXT IF/DPM SETUP/MAP INPUTS menu.

Then, one or more of the switcher sources is defined as a LOGICAL input and the appropriate device and channel is specified. This is accomplished via the CONFIG/MAP INPUTS menu.

Channel 1 is handled differently than the others. The switcher assumes that channel 1's video actually contains the combined output of all channels in the system. The DPM's combiner output should feed an input configured for channel 1. This assumption affects only on-air tally.

Effect Send and Control Delays

The effect send and control delays are adjustable in the CONFIG/EXT IF/DPM SETUP menu.

The control delay compensates for the time it takes for the DPM to respond to effect recall and effect position commands.

The best way to assess the control delay is to build a combined effect of the switcher and DPM, for example, and run them together while recording on a machine. The DPM setup control delay can be adjusted to provide the correct timing, and stored in the Configuration file.

The effect send delay compensates for the time it takes the DPM to respond to a channel in video input. Essentially, this is the video delay through the DPM, typically 2 fields. When an effects send is activated, the video to the DPM is switched immediately. To avoid a flash at the output of the mix/effect bank, the M/E can't begin using the DPM's signal until the newly selected video has had time to arrive at the DPM output. The effect send delay should be adjusted so that going into effects send is clean at the output of the mix/effects bank involved in the effects send. The proper setting is the minimum setting which does not result in a flash. Too long a delay will not be noticed, but will increase the time it takes for the M/E to actually switch to the DPM video.

Once the delay values have been determined, they should be published in the DPM's configuration documentation. The user may simply set the delays to those values.

Switcher Software

Switcher must be running standard software version 5.2 or later in order for the interface to function as described in this document.

DPM Enables

The switcher provides a selection for disabling the DPM interface. The DPM button in the EXTERNAL INTERFACE section of the control panel must be lit in order for the switcher to communicate with the DPM.

General Protocol Notes

The protocol used for this interface is designed around setting values and receiving status (values). A subscription mechanism provides for status updates when changes occur providing more timely delivery of information without constant and frequent polling.

The interface is not designed as a pure master/slave relationship; both the switcher and DPM have responsibility for part of the communications and function more as peers: The switcher forwards source selection button presses to the DPM and orchestrates running effects; the DPM sends video, key, and front/back information to the switcher to control aux busses.

This protocol is derived from one used for internal communications between the Grass Valley Krystal™ Digital Picture Manipulator control panel and effect manager via an ethernet connection. Much of the message structure is to support communications between multiple panels and multiple effect managers but was retained for consistency. The Krystal panel to effect manager communications is not described in this document.

The format of messages is described in “Message Format” on page 5-11.

Message specifics are described in “Parameters” on page 5-19 and “Other Command Specifics” on page 5-21.

Data communications specifics are described in “Transmission Media and Protocols” on page 5-21.

Communications examples are contained in “Examples” on page 5-22.

Message Timing

The timing of some messages is critical in order for the switcher and DPM to perform in lock step. These are considered real time messages.

The run control messages sent by the switcher to the DPM must be acted on in a fixed number of video fields from when they are sent by the switcher. A delay adjustment is provided to compensate for variations in devices.

Source changes sent by the DPM to the switcher will be processed so that the video will change at the beginning of the next field.

All other messages do not have a deterministic requirement and are processed differently within the switcher.

Transmission of real time messages should be given priority over the nondeterministic ones. The maximum packet size was chosen to allow for interleaving high priority messages when several low priority messages are awaiting transmission.

NOTE: The last packet containing real time messages sent by the DPM in a field must complete transmission 3 milliseconds before the end of the field. (13.6 mS from the start of the field for 525/60 or 22 mS for 625/50.) No real time messages should be sent to the switcher during this end-of-field period. Transmissions during this time can disturb critical processes within the switcher and cause the program video output of the switcher to glitch randomly.

Init/Online

This section describes the sequence used on start up communications. A DPM must respond and perform the indicated steps in order to achieve a reliable connection with the switcher.

If the **Switcher** is reset, or its DPM port configuration is changed:

1. The switcher sends out the message:
SEND_EVENT, EID_ONLINE (15)
This tells the DPM that the switcher just came on-line.
2. The DPM acknowledges this message with the RETURN_CODE message echoing the return ID from the switcher's SEND_EVENT message:
val = OK (0). (The switcher ignores the return value.)
3. The switcher then requests the DPM system name (by subscribing to it):
SUBSCRIBE, IMMEDIATE, PID_SYSTEM_NAME
4. The DPM sends its name:
ISSUE, PARAMETER_ARTICLE, PID_SYSTEM_NAME
5. Once the switcher receives the system name message (can be any name text) the switcher sends subscription messages for all of the parameters listed below Appendix B.

NOTE: Other subscriptions may be solicited as well, but may be safely ignored. Their status is used only for Krystal and Kaleidoscope interfaces.

6. The DPM returns ISSUE messages containing the values for all of the subscribed parameters. From then on, any changes to any of these parameters will result in new issue messages being sent to the switcher.

NOTE: The switcher does not poll for changes. It relies on the subscriptions registered during initialization to provide it with timely updates to parametric changes.

If the **DPM** is reset or its switcher interface is reconfigured, the sequence is:

1. The DPM sends out the message:
 SEND_EVENT, event EID_ONLINE
 This tells the switcher that the DPM just came on-line.
2. The switcher acknowledges receiving the on-line message by sending the RETURN_CODE message:
 (the message header's return ID is set to 0)
 val = EID_ONLINE (15).
 then sends out a message cancelling all subscriptions:
 UNSUBSCRIBE, CLEAR_SUBSCRIPTIONS
3. The switcher then takes over the initialization process with step 3 above.

Source Selection

There are multiple parts to the source selection part of the interface.

When the operator makes a selection on the aux row of the control panel (or via a remote aux panel), the switcher sends a message to the DPM with the video *or* key source, never both. The switcher relies on the DPM's use of source memory to select the appropriate key source. Essentially, the switcher is simply telling the DPM that an operator pressed a button. It is up to the DPM to process this information in an expected manner.

The switcher will send a selection for the front source, the back source or both depending on the near/far selection made from the switcher's AUX BUS menu.

The following SET commands communicate this information to the DPM. These messages include front/back information in the device ID field. The channel bit is set in the upper 16 bits. The lower 16 bits indicate if the front or back side is being set (1 = back). These fields are defined as bit maps so that multiple channels may be set at once. However in practice, a source set command applies to only one channel at a time.

PID_VIDEO_SOURCE

PID_KEY_SOURCE

NOTE: *The switcher does not make aux bus selections as a direct result of an aux row button press. If the DPM does not respond to the source message, the aux bus output and aux row lamp indication will not change.*

As an independent mechanism, the DPM sends messages with the video and key sources, and the front/back status per channel. They are separate SET messages, with the content of these parameters:

PID_FRONT_VIDEO_SOURCE_LIST (for 8 channels)

PID_BACK_VIDEO_SOURCE_LIST

PID_FRONT_KEY_SOURCE_LIST

PID_BACK_KEY_SOURCE_LIST

PID_FRONT_BACK_SELECT_LIST

The DPM must send source information on changes. Sending at regular intervals (e.g., every-field) is acceptable and can improve recovery should the link be interrupted.

Near/Far and Front/Back

The switcher differentiates between sides of a planar transform in two different, but related ways:

“Front” is the side of the picture plane which would be visible if no rotation is applied to the transformation; “back” is the opposite side.

“Near” is the side which is visible; “far” is the side which is not visible.

When no rotation is applied, Near = Front and Far = Back.

Use of near and far allow the operator to change sources and insure the change is either seen (near) or not seen (far) regardless of the picture’s rotation amount.

In order for the switcher to sort out near and far, it must be provided with front/back information from the DPM. Front/Back information tells the switcher which side is visible, that is, which is the near side.

Selections in the switcher’s AUX BUS menu allow delegation of the aux selector row to either near or far or both. The row will change and display the selected side. If BOTH is selected, the near side is displayed and a selection will cause a change in both the front and back sides.

The AUX BUS menu displays both the DPM’s front and back sources, the current aux selector row delegation (near/far) and which side the DPM has reported as the near side (front/back).

If the DPM does not fully implement the front and back source selection and front/back flag, the switcher will not be able to properly resolve near/far. While the system will still function, the information displayed to the user may be incorrect.

Source Hold

On the switcher, holding down a source selection button overrides normal source selections as effects are recalled or run. Aux busses assigned to the DPM are actually controlled by the DPM, not the switcher and any hold down override must be handled by the DPM.

The switcher provides the DPM with the source button hold down indication via SET, PID_HOLD_INPUT_CROSS_PT.

The switcher also provides a user selection to prevent all source changes when an effect is recalled or run. This HOLD INPUT button affects all busses of the switcher, and in the case of Krystal also all channels of digital effects.

PID_HOLD_INPUT_OVERRIDE is used to communicate the global hold input state.

Tally

The switcher subscribes for PID_VIDEO_ON_AIR and PID_KEY_ON_AIR information from the DPM. The DPM must compute whether a channel's image is on screen or not and update these subscriptions when necessary.

NOTE: *The parameter ID used for on screen information is the same as the one used to communicate on air information from the switcher to the DPM. This can easily lead to confusion since the same PID is used for different meanings.*

In determining on/off screen, the following information should take into consideration:

- location relative to the output raster of the DPM (e.g., off screen)
- image size (e.g., reduced to zero size)
- rotation (e.g., exactly on edge)
- transparency
- any other processing or transform which may affect visibility

Additional factors include actual use of the incoming signal.

If the video signal is replaced by a matte fill, its incoming video is not on screen.

If the key input is not used it is not on screen.

If instead, the video signal is used in a self key, then the video is on screen even if the video is a matte.

Other factors may exist depending on the functionality of the DPM.

In addition, the DPM may subscribe to the DPM's on air status. This information tells the DPM whether or not the switcher has the DPM video or key on air. The DPM should *not* incorporate this information in the on screen status it sends to the switcher.

Activity Check

The activity check provides a mechanism for the switcher to detect a link failure (disconnected cable, etc.) or a patching/routing a different DPM to the switcher.

The switcher periodically tests for link activity by sending out a Subscribe Immediate command for the DPM's ethernet address. If no response is received, the switcher notes the time-out. When a response is received after a timeout, the switcher assumes that subscription issues or other updates could have been missed and reestablishes communications as if the switcher had been reset.

If link activity is present, the switcher looks at the value returned from the DPM. If it is different than the last response, the switcher assumes a different DPM is now connected and reestablishes communications as if it had been reset.

The value which the DPM returns is unimportant. However, if multiple DPMs exist in a facility it is a good idea to report different values from each one to allow the switcher to detect a change in DPM connections.

The activity check is optional. The interface behaves normally even if the DPM never responds to the switcher's query. However, the switcher will not be able to recover from link failures, patching or routing without a reset from one of the two devices.

The switcher queries the DPM approximately every 20 seconds.

Running Effects

During initialization, the switcher subscribes for the DPM's current effect number. When a switcher effect is learned, the DPM's current effect number is stored as part of the effect.

When that effect is recalled at the switcher (DPM 1 level enabled), the switcher will send out a command to recall the DPM effect. (SET, PID_CURRENT_EFFECT).

At the time of the recall, the switcher also issues a SET, PID_EFFECT_POSITION. The time value sent is zero if REVERSE on the switcher E-MEM effect memory system is turned off; or to the ending time of the switcher's effect if REVERSE is on.

As an effect is running, the switcher sends out commands every field to the DPM to SET the effect position (PID_EFFECT_POSITION). This same mechanism supports runs via the RUN button as well as the switcher's run lever arm. Other time positioning controls on the switcher panel (PREV KF, NEXT KF, REWIND, etc. also result in the sending of a new effect position to the DPM. In this way, the DPM exactly follows the timeline of the switcher's effect.

Subscription

Status information is gathered indirectly as a result of a "subscription" request. The request tells the other device where to send changes to the specified parameter. The changes are delivered to the requestor in an "issue" message which may contain several parameter "articles". Many articles may be contained in one subscription. Consider a magazine subscription: The reader subscribes to the magazine and whenever new information is available, a new issue is delivered to the readers home. The reader does not have to specifically request each new issue of the magazine. The "subscribe immediate" mechanism is like requesting a trial magazine issue - you only get one. Subscriptions may be canceled at any time. The requestor can also modify the terms of delivery at will.

The switcher subscribes to information using several request IDs. It is important for the DPM to include the proper request ID in the status update issue messages. Different parameter articles may be sent in the same issue as long as the subscriptions for all the data had the same request ID. Articles destined for different request IDs must be placed in separate issue messages.

It is also important to limit issue messages to less than 256 bytes or the message will be discarded by the switcher.

Message Format

A binary protocol with variable-length messages is used. Multiple messages may be delivered in a single packet. To accommodate a packet that may contain multiple variable-length messages, each message is preceded by a message header. As shown in Figure 5-1, the message header is comprised of five fields.

The Version field is used to identify the protocol version and allows changes in the protocol while providing compatibility with older implementations. Currently, only version 1 has been specified.

The Token field identifies the message.

The Return ID is a unique command identifier, that is used in conjunction with the Return Code message. If a control point desires to know the result of issuing a command, it places a non-zero value in the Return ID field. The Return ID and the command return code are sent back to the control point, in the form of a Return Code status message. The sender should manage the return ID's value to avoid receiving multiple return code messages with the same return ID.

NOTE: *The switcher violates this utilization of the return ID. The switcher does not respond with Return Code messages even if the return Id is nonzero. The switcher always responds to a Send Event On-line messages with a Return Code message even if the return ID is zero. It inserts a zero return ID into that Return Code message and sets the data value to EID_ONLINE (= 15) instead of OK or FAILURE. The switcher does specify a nonzero return ID in its Send Event On-line message and expects the DPM to echo that return ID in a Return Code message, however the switcher ignores the data value.*

Only commands may request a Return Code message via the Return ID field. Status messages must insert a null return ID.

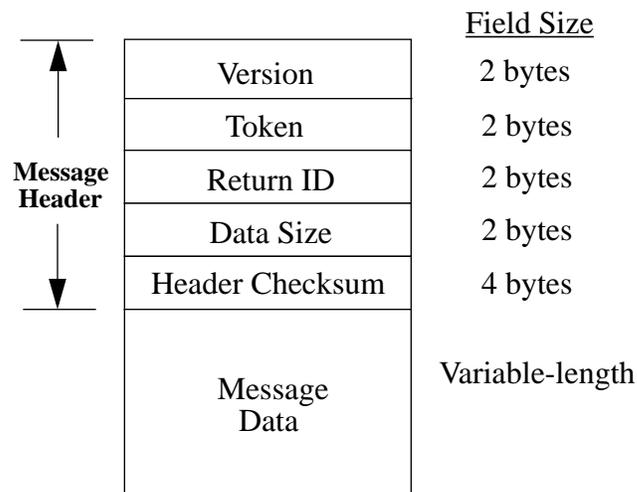


Figure 5-1. Message Format

The Data Size field specifies the size of the Message Data in bytes. It is this field which allows variable-length messages to be passed. The Header Checksum provides the mechanism by which message integrity and alignment can be verified. This is extremely important when parsing packets with multiple messages. The algorithm used with version 1 of the protocol is a simple summation of the message header information. This algorithm is shown below.

$$\text{Header Checksum} = \text{Version} + \text{Token} + \text{Return ID} + \text{Data Size}$$

All messages are network-byte ordered (i.e. most significant byte transmitted first) with a maximum packet size of 256 bytes. All messages will fit within this packet size, although care must be taken to insure subscription response issues are packed based on this maximum.

When constructing packets (HDLC frames) which contain multiple messages, each message must be padded to guarantee 32-bit alignment.

Message Tokens

The values assigned to each message token are enumerated in Table 5-1. Other message values are treated as an error by the switcher.

Table 5-1. Message Tokens

Token	Value
Send Event	5
Set	6
Subscribe	8
Unsubscribe	10
Issue	16
Return Code	17

The following sections identify the messages used for the switcher/DPM interface. It provides a brief overview of each message, as well as details the contents of each message.

Set

The Set command is used to set a parameter to a specific value. As shown on the following page, the Set command data consists of four fields.

The parameter ID (“PID”) is used to uniquely identify the parameter which is to be set.

The flags field specifies how a parameter is to be set. A zero in this field indicates that an absolute set is to be performed (i.e. the parameter is set to the specified value) and is the only valid value for this parameter.

The device field contains a four byte identifier that further qualifies the parameter to be set. Typically, the device field identifies which channel is to be modified.

Table 5-2. Set Command Data

Field	Size	Value
Parameter ID	2 bytes	refer to Appendix B
Flags	2 bytes	0 = Absolute
Device	4 bytes	refer to Appendix B
Value	variable	refer to Appendix B

Refer to Parameters for a complete parameter list that includes each parameter ID and parameter type (short, long, float, string, etc.), as well as the devices associated with each parameter.

Subscribe

The subscribe command is used to solicit information from a device. This information is delivered in the form of a subscription issue¹. A subscription issue is sent after receiving a subscription request and thereafter when the requested information changes. As shown below, the Subscribe command data consists of a request address, a request ID, a serial number, a service ID, subscribe flags, and optional service specific data.

Table 5-3. Subscribe Command Data

Field	Size	Value
Request Address	16 bytes	(not used)
Request ID	2 bytes	any (requestor's choice) echoed in Issue message
Serial Number	2 bytes	any (requestor's choice)
Service ID	2 bytes	3 = Parameter Service
Flags	2 bytes	0 = normal service 1 = Subscribe Immediate 2 = Replace Service 3 = combination of 1 & 2
Service Data	variable	refer to Parameter Service below

The request address field specifies where the requested information is to be delivered. This field is only used when subscribing to information via Krystal's ethernet interface and is unused for HDLC communications.

The request ID is a user-defined subscription request identifier. It is used in conjunction with the request address to uniquely identify a subscription. Because the request ID is sent back as part of the subscription issue, it is commonly used for subscription issue routing within a control point. The serial number is also sent back to a control point as part of a subscription issue. A control point can use this field to qualify a subscription issue. For example, when a control point changes a subscription, it should modify the serial number from its previous state. If a subscription issue is received that contains the old serial number, then that issue should be discarded.

The service ID identifies the desired subscription service. Only parameter service is supported for the switcher/DPM interface. The parameter service is used to obtain and/or monitor the present value of one or more parameters.

The flags field modifies the behavior of the Subscribe command. When the subscribe immediate flag is set, the requested information is returned immediately. In essence, the information is returned once upon request without further updates. The replace service flag is used to replace a current service subscription (identified by request address, request ID, and service ID) with a new request. For example, one could replace an existing parameter service subscription with a new group of parameters.

1. Refer to "Issue" on page 5-16 for a complete description of a subscription issue.

NOTE: *Subscribe immediate results in only one issue with the current value(s). A subscription for changes is not activated.*

Parameter Service

Table 5-4. Parameter Service Data

Field	Size	Value
Parameter ID	2 bytes	refer to Appendix B
alignment pad	2 bytes	any
Device	4 bytes	refer to Appendix B

The parameter ID field identifies the parameter of interest¹. This is followed by a pad field which 32-bit aligns the Device field. The Device field further qualifies the parameter or group of parameters being requested. In some instances, the device field contains a mask which may be used to request the parameter value of each device specified in the mask. For other parameters, a separate parameter service request is necessary².

Unsubscribe

The unsubscribe command cancels all or part of a subscription. As one might expect, the same command data necessary to subscribe to a service, is also needed to unsubscribe from it. The primary difference between the Subscribe and Unsubscribe command data is the value that the flags field may assume. As shown below, the Unsubscribe command flags may be set to one of four values.

Table 5-5. Unsubscribe Command Data:

Field	Size	Value
Request Address	16 bytes	(not used)
Request ID	2 bytes	any (requestor's choice) echoed in Issue message
Serial Number	2 bytes	any (requestor's choice)
Service ID	2 bytes	3 = Parameter Service
Flags	2 bytes	1 = Cancel Service 2 = Cancel Subscription 4 = Clear Subscriptions 8 = Clear All Subscriptions

1. Refer to "Parameters" on page 5-19 for a complete list of parameters used for this interface.
2. Refer to "Parameters" on page 5-19 for the device types associated with each parameter.

With no flags set, the Unsubscribe command cancels the specified service information. For example, when unsubscribing from a select group of parameters, only those parameters identified in the parameter service data will be cancelled. When the cancel service flag is set, the subscription associated with the specified request address, request ID, and service ID is cancelled. It should be noted that a control point can have more than one subscription to the same service. This can be accomplished by using a different request ID with each service request. The cancel service flag will not cancel all subscriptions to the specified service, but only the one associated with the given request address and request ID. The cancel subscription flag is used to cancel all subscription services associated with the specified request address and request ID. The clear subscriptions flag is used to clear all subscriptions associated with a control point. Finally, the clear all subscriptions flag is used to clear out all control point subscriptions, including those for other control points. If any one of the Unsubscribe flags is set, the service specific data is ignored.

Issue

An Issue status message is sent to a control point as the result of a subscription request (a subscribe command) or a change in the value of a parameter with an active subscription. When a request is received, an issue is delivered to the subscribing control point. Another issue is not delivered until the requested information changes. As shown on the following page, there are five fields of data associated with the Issue status message.

Table 5-6. Issue Message Data:

Field	Size	Value
Request ID	2 bytes	matches Request ID of Subscribe message
Serial Number	2 bytes	any (requestor's choice)
Service ID	2 bytes	3 = Parameter Article
alignment pad	2 bytes	any
Service Data	variable	refer to Parameter Article section below

The request ID is a user defined request identifier. It is passed in the data portion of the Subscribe command and is sent back to a control point as part of the Issue. The request ID is typically used by a control point to route issue data to the correct handler.

The serial number field provides the mechanism by which unwanted issue data can be ignored¹. This field is followed by the service ID field. The service ID specifies the type of issue. Only parameter issues are supported for the switcher / DPM interface.

The service ID is followed by a pad field which 32-bit aligns the service data. The service data itself contains service specific information.

1. Refer to the Subscribe command for more information.

Parameter Article

The parameter subscription service data consists of one or more parameter articles. Each article contains the value of one parameter. Multiple articles may be included in the same issue as long as the request address and request ID for all articles are the same. Remember that the request address and ID are provided by the requesting control point and must be returned with the issue.

The data associated with each parameter article is shown below.

Table 5-7. Parameter Article Data

Field	Size	Value
Parameter ID	2 bytes	refer to Appendix B
alignment pad	2 bytes	any
Device	4 bytes	refer to Appendix B
Parameter value	variable	refer to Appendix B

The parameter ID field identifies which parameter is contained in the article. The pad field 32-bit aligns the device field. The device field itself identifies the device associated with the specified parameter. The last field contains the parameter value. In order to accommodate parameters of varying size, the value field is variable length. When parameter service issue contains more than one parameter article, each article is 32-bit aligned within the packet.¹

To maximize link bandwidth, articles should be combined into a single issue whenever possible. However, this practice should not delay delivery of an article. That is, if no more articles require delivery, send a partially filled issue.

When a large number of subscriptions are active and many parameters are simultaneously changing value, it is easy to exceed the maximum packet size. When adding an article to an existing issue would exceed the maximum packet size, the article must be added to a new issue message.

1. Refer to "Parameters" on page 5-19 for more information concerning parameters.

Send Event

This command sends an event to the other device. An event is an input, without lasting state, which is used to trigger some action. As shown below, there are three Send Event command data fields.

The event ID (“EID”) field uniquely identifies the event.

The pad field 32-bit aligns the device field.

The last field contains a four-byte device identifier which further qualifies the event to be triggered.

The only Send Event used for the switcher/DPM interface is to instruct the other device to activate communications.

Table 5-8. Send Event Command Data

Field	Size	Value
Event ID	2 bytes	15 = On Line
alignment pad	2 bytes	any
Device	4 bytes	any
Value	variable	any

NOTE: *The switcher violates this utilization of the return ID.*

The switcher does not respond with Return Code messages even if the return Id in the command sent by the DPM is nonzero.

The switcher always responds to a Send Event On-line messages with a Return Code message even if the return ID is zero. It inserts a zero return ID into that Return Code message and sets the data value to EID_ONLINE (= 15) instead of SUCCESS or FAILURE.

The switcher does specify a nonzero return ID in its Send Event On-line message and expects the DPM to echo that return ID in a Return Code message, however the switcher ignores the data value.

Return Code

The Return Code message returns the result of a command. All commands return an OK or ERROR status. A return code message is sent to a control point only if the return ID field, in the message header, contains a non-zero value.

As shown below, there is one field of data associated with the Return Code message. This field contains the return code itself.

Also, the return ID sent with the command is returned in the message header of the Return Code message. This is particularly important if a control point is sending multiple commands and needs the return ID to match a Return Code message to its command.

Table 5-9. Return Code Message Data

Field	Size	Value
Return code value	4 bytes	0 = OK / Success 0xFFFFFFFF = Error / Failure

NOTE: Refer to the note under Send Event above

Parameters

This appendix outlines those parameters supported for the switcher/DPM interface. A parameter is a value that may be modified and has lasting state. Parameters are sent via the SET command. When building a Set command, the parameter ID, its associated device, and the parameter value must be specified.

In addition, a parameter's value may be obtained via the subscription/issue mechanism.

Below, is a complete list of the parameters in tabular form. This list includes the name of each parameter used in this document, the PID's numeric value, its associated devices, and the type of each parameter with its acceptable range. Bytes and chars are 8-bit values, shorts are 16-bit values, longs are 32-bit values. "s15.16" is a signed 32-bit fixed point value where 1.0 = 0x00010000 (0.0 = 0x00000000, -1.0 = 0xFFFF0000, 0.5 = 0x00008000, etc.). Boolean is a 16-bit value where true or on = 1 and false or off = 0. Values are in decimal unless preceded by 0x indicating hexadecimal. The last two columns indicate who sends and receives which commands associated with each PID. "Tx" means the device transmits the message; "Rx" means that device receives the message. "SUB" indicates subscribe append or replace messages. "SUB-I" indicates subscribe immediate messages.

Table 5-10. Switcher/DPM Parameters

Parameter Name	ID	Device	Type/Range	Switcher	DPM
PID_FRONT_VIDEO_SOURCE_LIST	810	Channel bit map: 0x00000001 = Chan 1 0x00000002 = Chan 2 0x00000004 = Chan 3 0x00000008 = Chan 4 0x00000010 = Chan 5 0x00000020 = Chan 6 0x00000040 = Chan 7 0x00000080 = Chan 8 (typically ORed to address several channels at once)	8 bytes Chan 1 first 1 - 48 all 8 bytes must be sent even if bit not set in device map	Rx SET	Tx SET
PID_VIDEO_BACK_SOURCE_LIST	813				
PID_FRONT_KEY_SOURCE_LIST	811				
PID_BACK_KEY_SOURCE_LIST	814				
PID_FRONT_BACK_SELECT_LIST	816		8 bytes (as above) Chan 1 first 0 = front 1 = back		
PID_VIDEO_SOURCE	2642	Channel bit map: 0x00010000 = Chan 1 0x00020000 = Chan 2 0x00040000 = Chan 3 0x00080000 = Chan 4 0x00100000 = Chan 5 0x00200000 = Chan 6 0x00400000 = Chan 7 0x00800000 = Chan 8 ORed with Back side bit map: 0x00000001 = Chan 1 0x00000002 = Chan 2 0x00000004 = Chan 3 0x00000008 = Chan 4 0x00000010 = Chan 5 0x00000020 = Chan 6 0x00000040 = Chan 7 0x00000080 = Chan 8 (refer to text)	short 1 - 48	Tx SET	Rx SET
PID_KEY_SOURCE	2643				
PID_HOLD_INPUT_OVERRIDE	2357	Channel bit map (refer to source list parameters above)	1 boolean (applies to all channels specified in device field)	Tx SET	Rx Set
PID_HOLD_INPUT_CROSS_PT	2358				
PID_VIDEO_ON_SCREEN	819			Tx SUB Rx ISSUE	Rx SUB Tx ISSUE
PID_KEY_ON_SCREEN	820				
PID_VIDEO_ON_AIR (optional)	819			Rx SUB Tx ISSUE	Tx SUB Rx ISSUE
PID_KEY_ON_AIR (optional)	820				
PID_CURRENT_EFFECT	886	0 = Effect Manager	short any value	Tx SUB Rx ISSUE Tx SET	Rx SUB Tx ISSUE Rx SET
PID_EFFECT_POSITION	875	0 = Effect Manager	s15.16 in frames	Tx SET	Rx SET
PID_SYSTEM_NAME	917	0 = Effect Manager	exactly 16 chars no terminating null pad with spaces	Tx SUB Rx ISSUE Rx SUB-I Tx ISSUE	Rx SUB Tx ISSUE optional: Tx SUB-I Rx ISSUE
PID_ETHERNET_ADDRESS (optional - refer to Activity Check description)	3047	0 = Effect Manager	long (refer to text)	Tx SUB-I Rx ISSUE	Rx SUB-I Tx ISSUE

Other Command Specifics

The bulk of the communications used for the switcher/DPM interface is via parametric interchange, as indicated in Appendix B. This section tabulates other commands used by the switcher/DPM interface.

Currently, the only other communications is the exchange of an on line event while communications are initiated. The DPM must transmit an on-line event and respond to one sent by the switcher with an appropriate return code message.

Transmission Media and Protocols

The switcher/DPM interface is designed as a point-to-point link. Messages are delivered in an HDLC-like frame consisting of an 8-bit opening flag, a variable-length data field, a 16-bit CRC, and an 8-bit closing flag. Within the transmission frame, messages are delivered via the data field.

A 307.2K baud FM0 synchronous serial link with imbedded clock is used for deterministic communications. Data rate and frame format are not adjustable. HDLC is a synchronous protocol with built-in mechanisms for error detection and packet detection.

Not all UARTs support this protocol. Those that do handle the packetization, zero stuffing and CRC insertion/detection. A Motorola 68302 along with a 68195 are used in the switcher for this interface. A Motorola 68360 or Zilog 8030 or 8530 also support this protocol.

Unlike asynchronous protocols, communications is frame (packet) based. A transmit underrun is not permitted in a synchronous protocol and will abort the transmission of the frame and the receiver will discard it.

The physical connection between the switcher and the digital effect device (DPM) is point to point with two RS-422 pairs, one for each direction.

The connector provided for this interface is a female DB-9. It is located on the rear of the switche frame and labeled "A1". The pinout is shown below.

Table 5-11. Return Code Message Data

Function	Pin
Tx + (switcher to DPM)	3
Tx -	8
Rx + (DPM to switcher)	7
Rx -	2
Ground	1, 4, 6, 9

Examples

The following are examples of switcher messages to and from the DPM. All values are in hex. The semi-colon after 2 or more bytes is just used as a separator to give the name of that field and any other explanatory information. (Values are in hexadecimal)

Example 1

DPM -> switcher, RETURN_CODE:

```
00 01      ; Version
00 11      ; Msg token, RETURN_CODE
00 00      ; Return Id
00 04      ; Data Size
00 00 00 16 ; Header checksum
00 00 00 0F ; Return code
```

Example 2

Switcher -> DPM, UNSUBSCRIBE

```
00 01      ; Version
00 0a      ; Msg token, UNSUBSCRIBE
00 00      ; Return Id
00 18      ; Data Size
00 00 00 23 ; Header checksum
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 16 bytes rqstAddr
00 00      ; Rqst Id
00 00      ; Serial number
00 03      ; Service Id, PARAMETER_SERVICE
00 04      ; flags, CLEAR_SUBSCRIPTIONS
```

Example 3

Switcher -> DPM, SUBSCRIBE

```

00 01      ; Version
00 08      ; Msg token, SUBSCRIBE
00 00      ; Return Id
00 20      ; Data Size
00 00 00 29    ; Header checksum
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 16 bytes rqstAddr
00 00      ; Rqst Id
00 00      ; Serial number
00 03      ; Service Id, PARAMETER_SERVICE
00 02      ; flags, REPLACE_SERVICE
03 95      ; Param Id, PID_SYSTEM_NAME
00 00      ; padding
00 00 00 00    ; Device, EFFECT_MANAGER

```

Example 4

DPM -> Switcher, SET front video source

```

00 01      ; Version
00 06      ; Msg token, SET
00 00      ; Return Id
00 10      ; Data Size
00 00 00 17    ; Header checksum
03 2A      ; Param Id, PID_FRONT_VIDEO_SOURCE_LIST
00 00      ; flags, ABSOLUTE
00 00 00 05    ; Device, logical channel 1 and logical channel 3
07 00 09 00 00 00 00 00    ; 8 channels worth of source information;
                           ; only channel 1 and channel 3 are relevant.

```

Example 5

DPM -> Switcher, SET front key source

```
00 01      ; Version
00 06      ; Msg token, SET
00 00      ; Return Id
00 10      ; Data Size
00 00 00 17 ; Header checksum
03 2B      ; Param Id, PID_FRONT_KEY_SOURCE_LIST
00 00      ; flags, ABSOLUTE
00 00 00 05 ; Device, logical channel 1 and logical channel 3
0F 00 09 00 00 00 00 00 ; 8 channels worth of source information;
                        ; only channel 1 and channel 3 are relevant.
```

Example 6

DPM -> Switcher, SET front/back select

```
00 01      ; Version
00 06      ; Msg token, SET
00 00      ; Return Id
00 10      ; Data Size
00 00 00 17 ; Header checksum
03 30      ; Param Id, PID_FRONT_BACK_SELECT_LIST
00 00      ; flags, ABSOLUTE
00 00 00 05 ; Device, logical channel 1 and logical channel 3
00 00 01 00 00 00 00 00 ; 8 channels worth of source information;
                        ; only channel 1 and channel 3 are relevant.
                        ; 00 = front visible
                        ; 01 = back visible
```

Example 7

DPM -> Switcher, ISSUE

```

00 01      ; Version
00 10      ; Msg token, ISSUE
00 00      ; Return Id
00 20      ; Data Size
00 00 00 31 ; Header checksum
00 00      ; Rqst Id
00 00      ; Serial Number
00 03      ; Service Id, PARAMETER_SERVICE
00 00      ; padding
03 95      ; Param Id, PID_SYSTEM_NAME
00 00      ; padding
00 00 00 00 ; Device, EFFECT_MANAGER
16-byte system name in ASCII

```

Example 8

Switcher -> DPM, SUBSCRIBE to more than one Param Id in one message

```

00 01      ; Version
00 08      ; Msg token, SUBSCRIBE
00 00      ; Return Id
00 28      ; Data Size
00 00 00 31 ; Header checksum
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 16 bytes rqstAddr
00 01      ; Rqst Id
00 00      ; Serial number
00 03      ; Service Id, PARAMETER_SERVICE
00 00      ; flags, APPEND_SERVICE
03 33      ; Param Id, PID_VIDEO_ON_AIR
00 00      ; padding
00 00 00 FF ; Device, 8 channels
03 34      ; Param Id, PID_KEY_ON_AIR
00 00      ; padding
00 00 00 FF ; Device, 8 channels

```

Example 9

Switcher -> DPM, SET a new video source

```
00 01      ; Version
00 06      ; Msg token, SET
00 00      ; Return Id
00 0C      ; Data Size
00 00 00 13 ; Header checksum
0A 52      ; Param Id, PID_VIDEO_SOURCE
00 00      ; flags, ABSOLUTE
00 01 00 01 ; Device, logical channel 1, visible side (source memory
              device uses mask to indicate side)
00 0B      ; Source 11
00 00      ; padding
```



Index

A

Abort 3-47, 3-49
Activity check, Digital Effects I/F 5-9
Address Byte 2-4, 2-5, 4-2
ALL STOP Command 3-5
AUTO RUN pushbutton 3-33
Auto Transition Rate 3-25
 Command 3-27
AUX Crosspoint Bus Command 3-6

B

Baud Rate 1-2
BKGD A Crosspoint Bus Command 3-6
BKGD B Crosspoint Bus Command 3-8
Break Character 2-2
Bus Controller 2-2
Byte Count 2-5

C

Code Byte Command 2-6
Command
 ALL STOP 3-5
 Auto Transition Rate 3-27
 Aux Xpoint Bus 3-6
 BKGD B Crosspoint 3-8
 Code Byte 2-6
 Crosspoint Bus 3-6
 Crosspoint Query 4-3
 Data Transfer 3-41
 Dialogue, Editor 3-43
 DSK 1 Crosspoint Bus 3-9
 DSK 2 Crosspoint Bus 3-10
 Editor Interface 3-1
 E-MEM Query 4-8

KEY 1 Crosspoint Bus 3-9
KEY 2 Crosspoint Bus 3-10
Key Transition Rate 3-29
Lamp Select 3-13
Learn E-MEM Register 3-35
MASK Crosspoint Bus 3-12
PGM Crosspoint Bus 3-6
PST Crosspoint Bus 3-8
Pushbutton Select 3-13
PVW Crosspoint Bus 3-11
Recall E-MEM Register 3-31
Select
 Layered 3-40
 Standard 3-40
Software Version 3-50
Split Key 3-38
Timeline Control 3-52
Transition
 Mode 3-23
 Rate 3-25
Transition Query 4-5
Wipe Pattern 3-21

Command/Message Block Structure 2-5
Communication Standards 1-3
Configuration Transfer Command 1-6
Crosspoint Bus Commands 3-6
Crosspoint Commands 3-6 to 3-12
Crosspoint Query Command 4-3

D

Data Transfer Command 3-41
Dialogue, Editor Command 3-43
Digital Control Interface 2-1
Digital Effects Interface
 Activity Check 5-9
 Effect Send and Control Delays 5-4

- Examples 5-22 to 5-26
- General Background 5-1
- General Protocol Notes 5-5
- Input Mapping 5-3
- Message Format 5-11
 - Issue 5-16
 - Parameter Article 5-17
 - Return Code 5-19
 - Send Event 5-18
 - Set 5-13
 - Subscribe 5-14
 - Parameter Service 5-15
 - Unsubscribe 5-15
- Message Timing 5-5
- Other Command Specifics 5-21
- Parameters 5-19
- Running Effects 5-10
- Source Selection 5-7
 - Near/Far Front/Back 5-8
 - Source Hold 5-8
- Subscription 5-10
- Tally 5-2, 5-9
- Transmission Media and Protocols 5-21

DSK 1 Crosspoint Bus Command 3-9

DSK 2 Crosspoint Bus Command 3-10

E

Editor

- Interface Commands 3-1
- Specifications 1-2

Editor Interface, Section 3

Editor to Switcher Command Dialog 3-43 to 3-46

EFF DIS pushbutton 3-33

Effects

- Address Byte 2-5
- Dissolve into an E-MEM register 3-33
- Memory 2-1
- Registers 3-34

E-MEM

- Learn Register Command 3-35
- Parameter Control 4-8
- Query Command 4-8
- Recall 3-32
- Register Commands 3-31 to 3-34
- Register Transfers 1-6

Error Detection Handling 3-47

Examples, Digital Effects Interface 5-22 to 5-26

External Interface 1-6

F, G

Frame Rate 3-26

H, I, J

Handshaking, Error Detection 2-5

K

KEY 1 Crosspoint Bus Command 3-9

KEY 2 Crosspoint Bus Command 3-10

Key Transition Rate Command 3-29

Keyframes 3-31, 3-33

Keyframing Pushbutton Numbers 3-16

L

Lamp Select Command 3-13

Layered mode, Split Key 3-38

Learn E-MEM Register Command 3-35

M, N

M/E Transition Panel 3-14

MASK Crosspoint Bus Command 3-12

Message Format

- Digital Effects I/F 5-11
- Issue 5-16
 - Parameter Article 5-17
- Return Code 5-19
- Send Event 5-18
- Set 5-13
- Subscribe 5-14
- Unsubscribe 5-15

O

Other Command Specifics, Digital Effects I/F 5-21

P, Q

Parameter-Based Command Set 4-1

- Address Byte 4-2
- E-MEM Parameter Control 4-8
- Timing and Latency 4-3

Parameters, Digital Effects I/F 5-19

Parity 1-2

PGM Crosspoint Bus Command 3-6
Protocol
 messages 1-6
 Overview 1-2
PST Crosspoint Bus Command 3-8
Pushbutton Select command 3-13
PVW Crosspoint Bus Command 3-11

R

Read Commands 1-6, 2-6
Ready State 3-4
Recall E-MEM
 Register Command 3-31
 To Switcher Command 3-31
Retry 3-43, 3-47, 3-49
Rewind 3-16
RS-232 1-2 to 1-4
RS-422 1-2 to 1-4
Run Control Subpanel 3-2, 3-14
Running Effects, Digital Effects I/F 5-10

S

Select
 Layered Command 3-40
 Standard Command 3-40
Serial Communication Defined 2-1
Serial Data Word Description 1-5
Serial Interface Protocol Diagram 2-3
Software Version Command 3-50
Source Selection
 Hold 5-8
 Near/Far Front/Back 5-8
Specifications, Editor 1-2
Split Key Command 3-38
Status Replies 2-7
Subscription, Digital Effects I/F 5-10
Super Edit 2-1
Switcher Configuration DPM Type 5-3

T, U

Tally, Digital Effects I/F 5-9
Timeline Control Command 3-52
Timing and Latency 4-3
Transfer Command Examples 3-43
Transfer Example 3-47
Transition

Mode Command 3-23
Query Command 4-5
Rate 3-26
Rate Command 3-25
Transmission Media and Protocols, Digital
 Effects I/F 5-21

V

VPE-Series Protocol 2-1

W, X, Y, and Z

Wipe Pattern Command 3-21
Wipe Pattern Names and Numbers 3-22
Word Size 1-2
Write Commands 2-6, 3-21 to 3-38

