SMPTE RECOMMENDED PRACTICE

RP 170-1993

Video Tape Recorder Type-Specific Messages for Digital Control Interface

1 Scope

This practice describes the type-specific messages used for the control of video tape recorder devices. Video tape recorder type-specific messages are used to provide the means for the control and monitoring of a specific type of virtual machine within a general-purpose communications channel of an interface system. This interface system transports data and digital control signals between equipment utilized in the production, post-production, and/or transmission of visual and aural information.

2 General

2.1 Virtual machine type

Video tape recorders shall be identified as a virtual machine of a type which is uniquely coded as "02," expressed as an 8-bit word, in hexadecimal form. This identification shall apply to both analog and digital video tape recorders.

2.2 Notation

This practice describes the coding of keywords and information fields (I/F) in the form shown below. The coding "NN" represents the assigned keyword or I/F code in hexadecimal form.

NN	KEYWORD or I/F NAME	Keyword or I/F descriptive text	
	Format:	<COMMAND>	
		<PARAMETER NAME 0>	[Parameter description;
		...	Parameter value coding, scale, or range;
		<PARAMETER NAME n>	Parameter definitions and explanations.]

In the practices listed in annex B, keywords are listed numerically, in hexadecimal notation. Keyword numbers are reserved as follows:

Keywords $00_h - 1F_h$: System service subset
Keywords $20_h - 3F_h$: Common message subset
Keywords $40_h - FF_h$: Virtual machine type-specific subset

NOTES
1 All tape motion commands (indicated below as "TMC") are mutually exclusive.
2 In all cases, the temporal order of entries and exits must be preserved. Thus, an entry received later in time, at the same position on the timeline, will cancel an existing exit.

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3 Summary of keywords, mnemonics, and information field names

Hex	Keyword	(mnemonic)	Hex	I/F name	(mnemonic)
40	not used		40	not used	
41	STOP	STOP	41	LTC FROM TAPE	LTFT
42	VARIABLE PLAY	VAPL	42	VITC FROM TAPE	VIFT
43	STD PLAY	STPL	43	SELECTED TAPE CODE	SETC
44	STEP	STEP	44	USERBITS FROM TAPE LTC	UFTL
45	VISIBLE FAST	VFST	45	USERBITS FROM TAPE VITC	UFTV
46	SHUTTLE	SHUT	46	TT1 (Tape Timer 1)	TTON
47	TAPE SPEED OVERRIDE	TSPO	47	TT2 (Tape Timer 2)	TTTW
48	READY SELECT	REDS	48	READY TALLY	REDT
49	SERVO REFERENCE SELECT	SRES	49	SERVO REFERENCE TALLY	SRET
4A	RECORD MODE SELECT	REMS	4A	RECORD MODE TALLY	REMT
4B	ENTRY	ENTY	4B	CHANNEL RECORD STATUS	CRES
4C	EXIT	EXIT	4C	CHANNEL RECORD MASK	CREM
4D	TAPE CODE SELECT	TACS	4D	TAPE CODE SELECTION TALLY	TACT
4E	TARGET SEARCH	TASE	4E	SYNC VELOCITY	SVTY
4F	PREROLL SEARCH	PRSE	4F	PREROLL DURATION	PRDU
50	SYNC	SYNC	50	SYNC POINT	SPNT
51	COLOR FRAMER SELECT	CFRS	51	COLOR FRAMER TALLY	CFRT
52	EDIT FIELD SELECT	EDFS	52	EDIT FIELD TALLY	EDFT
53	CHASE	CHAS	53	not used	
54	TCG LTC TIMESOURCE SELECT	TLTS	54	TCG LTC TIMESOURCE TALLY	TLTT
55	TCG VITC TIMESOURCE SELECT	TVTS	55	TCG VITC TIMESOURCE TALLY	TVTT
56	TCG LTC UB SOURCE SELECT	TLUS	56	TCG LTC UB SOURCE TALLY	TLUT
57	TCG VITC UB SOURCE SELECT	TVUS	57	TCG VITC UB SOURCE TALLY	TVUT
58	EJECT/UNTHREAD	EJCT	58	not used	
59	not used		59	not used	
5A	not used		5A	TAPELENGTH	TLTH
5B	not used		5B	PARKING ACCURACY	PARK
5C	not used		5C	SYNCHRONISM ACCURACY	SYAC
5D	not used		5D	not used	
5E	TRACKING SELECT	TRKS	5E	TRACKING SELECTION TALLY	TRKT
5F	ANTI-CLOG CONTROL	ANCC	5F	ANTI-CLOG CONTROL TALLY	ANCT
60	PRESET	PRST	60	not used	
61	not used		61	TMC TALLY	TMCT
62	not used		62	VELOCITY TALLY	VELT
63	not used		63	TIMELINE CORRECTION TALLY	TLCT
64	not used		64	not used	
65	PLAYBACK CHANNEL SELECT	PLCS	65	PLAYBACK CHANNEL TALLY	PLCT
66	CHANNEL MUTE SELECT	CMUS	66	CHANNEL MUTE TALLY	CMUT
67	TAPE/EE SELECT	TEES	67	TAPE/EE TALLY	TEET
68	not used		68	TIMECODE TO TAPE LTC	TTTL
69	not used		69	TIMECODE TO TAPE VITC	TTTV
6A	not used		6A	USERBITS TO TAPE LTC	UTTL
6B	not used		6B	USERBITS TO TAPE VITC	UTTV
6C	not used		6C	PRESETTABLE TIME SRC LTC	PTSL
6D	not used		6D	PRESETTABLE TIME SRC VITC	PTSV
6E	not used		6E	PRESETTABLE UB SOURCE LTC	PUSL
6F	not used		6F	PRESETTABLE UB SOURCE VITC	PUSV

4 KEYWORDS

Hex Keyword

40 not used

41 STOP

(TMC) Causes the controlled VTR to stop as soon as possible; indeterminate picture.

Format: <STOP>

42 VARIBLE PLAY

(TMC) Causes the controlled VTR to enter continuously variable playback mode with specified direction and speed.

Format: <VARIABLE PLAY>
<SPEED>

3-byte signed binary number: two's complement scale:
000000_h = still
010000_h = std play speed forward
$7F0000_h$ = approximately 127 times standard play speed forward
$FF0000_h$ = std play speed reverse
800000_h = 128 times standard play speed reverse

43 STD PLAY

(TMC) Causes the controlled VTR to enter field-locked real time playback mode, color framed as selected.

Format: <STD PLAY>

44 STEP

(TMC) Causes the controlled VTR to move the tape a specified number of fields forward or backward, with respect to its current position, only while in TMCs: STEP, TAPE SPEED OVERRIDE, VISIBLE FAST (STILL), or VARIABLE PLAY (STILL). Successive commands are cumulative until next TMC other than STEP.

Format: <STEP>
<FIELD NUMBER>

1-byte signal number;
range: –128 ... +127.

45 VISIBLE FAST

(TMC) Causes the controlled VTR to enter fast tape motion with visible but not necessarily broadcastable picture, with specified direction and speed.

Format: <VISIBLE FAST>
<SPEED>

3-byte signed binary number;
same format as in VARIABLE PLAY.

46 SHUTTLE

(TMC) Causes the controlled VTR to travel at specified direction and speed without necessarily reproducing picture or sound.

Format: <SHUTTLE>
<SPEED>

3-byte signed binary number;
same format as VARIABLE PLAY.

47 TAPE SPEED OVERRIDE

(TMC) Causes the controlled VTR to override instantaneous play speed for synchronizing purposes.

Format: <TAPE SPEED OVERRIDE>
<SPEED>

3-byte signed binary number;
same format as in VARIABLE PLAY.

48 READY SELECT

Establishes the VTR in a state to minimize start-up time.

Format: <READY SELECT>
<SWITCH>

Boolean value: 00_h = OFF (= default)
01_h = ON

49 SERVO REFERENCE SELECT

Selects the input switch for video reference source.

Format: <SERVO REFERENCE SELECT>
<MODE>

1-byte special binary code:
00_h = auto select (= default)
01_h = video in
02_h = external ref input
FF_h = as selected locally

4A RECORD MODE SELECT

Selects the mode of the subsequent recording(s) or edit(s).

Format: <RECORD MODE>
<MODE>

1-byte special binary code:
00_h = record disable (= default)
01_h = insert
02_h = assemble; all channels
03_h = assemble; channel selectable
04_h = rehearsal
05_h = crash record
06_h = read-before-write

4B ENTRY

In any <RECORD MODE> other than "rehearsal," causes a start of edit insertion on the specified channel(s) or track(s). When <RECORD MODE> = "rehearsal," causes a signal system monitoring switch (e.g., tape-to-EE at entry point) to occur in the specified channel(s), such as to produce visual/aural simulation of commencement of recording.

Format: <ENTRY>
<CHANNELS>

3-byte bit mask:
bit 0 (LSB) = video
bit 1 = sync track
bit 2 = VITC
bit 3 = cue audio
bit 4 = reserved
bit 5 = reserved
bit 6 = reserved
bit 7 = LTC
bits 8–23 = audios 1–16, respectively
logic: 0 = channel not affected
1 = channel turned on or stays on

NOTES
1 In "assemble/all channels" mode, the channel bits have no meaning.
2 Bits 0–7 form the least significant byte; this byte is transmitted last.

4C EXIT

In any <RECORD MODE> other than "rehearsal," causes a termination of edit insertion on the specified channel(s) or track(s). When <RECORD MODE> = "rehearsal," causes a signal system monitoring switch (e.g., EE-to-tape at exit point) to occur in the specified channel(s), such as to produce visual/aural simulation of commencement of recording.

Format: <EXIT>
<CHANNELS>

3-byte bit mask:
bit 0 (LSB) = video
bit 1 = sync track
bit 2 = VITC
bit 3 = cue audio
bit 4 = reserved
bit 5 = reserved
bit 6 = reserved
bit 7 = LTC
bits 8–23 = audios 1–16, respectively
logic: 0 = channel not affected
1 = channel turned off or stays off

NOTES
1 In "assemble/all channels" mode, the channel bits have no meaning.
2 Bits 0–7 form the least significant byte; this byte is transmitted last.

4D TAPE CODE SELECT

Selects the type of code for all succeeding messages that refer to "TAPE CODE."

NOTE – As LTC, VITC, TT1, and TT2 are also contained in an item of the VTR-specific INFORMATION FIELD, they may be accessed by a READ command at any time, even if not selected as TAPE CODE by the command TAPE CODE SELECT.

Format: <TAPE CODE SELECT>
<CODE TYPE>

1-byte special binary code:
00_h = longitudinal time code (= default)
01_h = vertical interval time code
02_h = TT1
03_h = TT2
04_h = auto TC
FF_h = as selected locally

4E TARGET SEARCH

(TMC) Causes the controlled VTR to move to a defined tape position in accordance with the TAPE CODE.

Format: <TARGET SEARCH>
<TAPE CODE> (type TIME; field referenced)

NOTE – The type of TAPE CODE is selected by the command TAPE CODE SELECT.

4F PREROLL SEARCH

(TMC) Causes the controlled VTR to move to a tape position determined by the duration of the PREROLL TIME in advance of the SYNC POINT and by the SYNC VELOCITY, in accordance with the TAPE CODE.

NOTE – PREROLL TIME, SYNC POINT, and SYNC VELOCITY are part of the VTR specific INFORMATION FIELD.

Format: <PREROLL SEARCH>

50 SYNC

(TMC) Causes the controlled VTR to start and synchronize so that after the preroll duration, the tape will be at the SYNC POINT and travelling at the SYNC VELOCITY.

NOTES
1 SYNC POINT and SYNC VELOCITY are part of the VTR-specific INFORMATION FIELD, and must be predefined by a PRESET command before execution.
2 The tape must be positioned and tallied previously by a PREROLL SEARCH command.
3 If the SYNC VELOCITY is standard play speed, the VTR reverts to STD PLAY after attaining sync.
4 In PAL, the VTR will be ADVANCED by one frame when necessary, to be in accordance with the P-phase, and the color framer will ADVANCE the VTR by as many frames as necessary.

Format: <SYNC>

51 COLOR FRAMER SELECT

Selects the color framer mode.

Format: <COLOR FRAMER>
<MODE>

1-byte special binary code:
bit 7 (msb):
0 = OFF – 2-field lock NTSC
– 4-field lock PAL/SECAM
1 = ON – 4-field lock NTSC
– 8-field lock PAL/SECAM
bit 6:
0 = normal lock
1 = inverted lock
bits 3–0:
nibble contains binary number, which specifies an offset from the lock specified above in units of fields. Exception: FF_h = as selected locally.

52 EDIT FIELD SELECT

Selects the edit field.

Format: <EDIT FIELD SELECT>
<MODE>

1-byte special binary code:
00_h = start of field 1 always
01_h = start of field 2 always
02_h = at next vertical in immediate mode, or determined by field bit of timeline if in timeline mode
FF_h = as selected locally

53 CHASE

(TMC) Maintains a given time offset between the selected tape code of the machine and the specified timeline using appropriate transport mode as determined by the timeline (usually with "external reference time" source; see common message TIMELINE SOURCE).

Format: <CHASE>
<OFFSET TIME>

(type TIME) Definition: offset = master-slave — e.g., if slave is to lead by 1 minute, send: 00 01 00 00; if slave is to lag by 1 minute, send: 23 59 00 00; i.e., "24 hours complement" notation.

54 TCG LTC TIME SOURCE SELECT

Selects the time source for the LTC time code generator of the controlled VTR.

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Format: <TCG LTC TIME SOURCE SELECT>
<TIME SOURCE>

1-byte special binary code:
00_h = hold
01_h = run independently, starting with the value contained in I/F item PRESETTABLE TIME SOURCE LTC
02_h = run with external, unspecified source
03_h = run with the regenerated value of the LTC time code as source (also contained in the I/F field LTC from tape) until a record ENTRY of the LTC track; then continue independently, running with the time value most recently read from tape, i.e., "jam-sync" function
04_h = run with regenerated VITC time code from tape as source (also contained in I/F field VITC FROM TAPE), i.e., "copy function"
05_h = run with TAPE CODE as source (also contained in I/F field TAPE CODE

55 TCG VITC TIME SOURCE SELECT

Selects the time source for the VITC time code generator of the controlled VTR.

Format: <TCG VITC TIME SOURCE SELECT>
<TIME SOURCE>

1-byte special binary code:
00_h = hold
01_h = run independently, starting with the value contained in I/F item PRESETTABLE TIME SOURCE VITC
02_h = run with external, unspecified source
03_h = run with the regenerated value of the VITC time code as source (also contained in the I/F field VITC from tape) until a record ENTRY of the VITC track; then continue independently, running with the time value most recently read from tape, i.e., "jam-sync" function
04_h = run with regenerated LTC time code from tape as source (also contained in I/F field LTC FROM TAPE), i.e., "copy function"
05_h = run with TAPE CODE as source (also contained in I/F field TAPE CODE

56 TCG LTC USERBIT SOURCE SELECT — Selects the user source for the LTC time code generator of the controlled device.

Format: <TCG LTC USERBIT SOURCE SELECT>
<USERBIT SOURCE>

1-byte special binary code:
- 00_h = no userbits; i.e., all set to zero (= default)
- 01_h = userbits from I/F item PRESET-TABLE USERBIT SOURCE LTC, which may be preset by a PRESET command
- 02_h = userbits from external, unspecified source
- 03_h = userbits continuously copied from the LTC time code from tape (also contained in I/F field USERBITS FROM TAPE LTC)
- 04_h = userbits continuously copied from the VITC time code from tape (also contained in I/F field USERBITS FROM TAPE VITC)

57 TCG VITC USERBIT SOURCE SELECT — Selects the userbit source for the VITC time code generator of the controlled device

Format: <TCG VITC USERBIT SOURCE SELECT>
<USERBIT SOURCE>

1-byte special binary code:
- 00_h = no userbits; i.e., all set to zero (= default)
- 01_h = userbits from I/F item PRESET-TABLE USERBIT SOURCE VITC, which may be preset by a PRESET command
- 02_h = userbits from external, unspecified source
- 03_h = userbits continuously copied from the VITC time code from tape (also contained in I/F field USERBITS FROM TAPE VITC)
- 04_h = userbits continuously copied from the LTC time code from tape (also contained in I/F field USERBITS FROM TAPE LTC)

58 EJECT/UNTHREAD — (TMC) Ejects cassette or unthreads tape where applicable.

Format: <EJECT/UNTHREAD>

59 not used

5A not used

5B not used

5C not used

5D not used

5E TRACKING SELECT — Selects tracking mode.

Format: <TRACKING SELECT>
<MODE>

1-byte special binary code:
- 00_h = FIXED (default)
- 01_h = AUTO
- FF_h = as selected locally

5F ANTI-CLOG CONTROL — Switches the anti-clog mechanism on/off.

Format: <ANTI-CLOG CONTROL>
<MODE>

1-byte special binary code:
- 00_h = ON (default)
- 01_h = OFF
- 02_h = extended
- 03_h = immediate tension release
- FF_h = as selected locally

60 PRESET — Presets the named information field to the given value.

Format: <PRESET>
<PERMITTED INFORMATION FIELD NAME>
<FORMAT>

Format and coding defined by the I/F NAME (see clause 5, Information fields).

Permitted information field names for VTRs are:

TT1	SYNCHRONISM ACCURACY
TT2	CHANNEL RECORD MASK
SYNC VELOCITY	PRESETTABLE TIME SOURCE LTC
PREROLL DURATION	PRESETTABLE TIME SOURCE VITC
SYNC POINT	PRESETTABLE UB SOURCE LTC
TAPELENGTH	PRESETTABLE UB SOURCE VITC
PARKING ACCURACY	

61 not used

62 not used

63 not used

64 not used

65 PLAYBACK CHANNEL SELECT — Selects the playback/monitoring channels.

Format: <PLAYBACK CHANNEL SELECT>
<CHANNELS>

3-byte bit mask:
bit 0 (LSB) = video
bit 1 = sync track
bit 2 = VITC
bit 3 = cue audio
bit 4 = reserved
bit 5 = reserved
bit 6 = reserved
bit 7 = LTC
bits 8–23 = audios 1–16 respectively

logic: 0 = playback channel
(= default for all channels)
1 = monitor channel (audio)
record channel (video)

NOTE – Bits 0–7 form the least significant byte; this byte is transmitted last.

66 CHANNEL MUTE SELECT — Selects auto mute function.

Format: <CHANNEL MUTE SELECT>
<CHANNELS>

3-byte bit mask:
bit 0 (LSB) = video
bit 1 = sync track
bit 2 = VITC
bit 3 = cue audio
bit 4 = reserved
bit 5 = reserved
bit 6 = reserved
bit 7 = LTC
bits 8–23 = audios 1–16 respectively

logic: 0 = mute enabled
1 = mute disabled

NOTE – Bits 0–7 form the least significant byte; this byte is transmitted last.

67 TAPE/EE SELECT — Selects the tape/electronics switch.

Format: <TAPE/EE SELECT>
<MODE>

1-byte special binary code:
00_h = auto (= default)
01_h = tape
02_h = EE
03_h = as selected locally

68 not used

69 not used

6A not used

6B not used

6C not used

6D not used

6E not used

6F not used

5 Information fields

NOTE – The items of the INFORMATION FIELD are accessed by the common messages: READ, UPDATE, CYCLE, or SIMULTANEOUS READ. They are tallied by the common messages: I/F RESPONSE or SIMULTANEOUS READ RESPONSE.

These commands use the format: <KEYWORD> <PARAMETER NAME> and <KEYWORD> <PARAMETER NAME> <PARAMETER VALUE> where the PARAMETER NAME uses the FIELD NAME specified below and the PARAMETER VALUE carries the FIELD CONTENTS specified below. Several names/values may be wrapped in a BEGIN/END construct. At power-up, the content of information fields is not specified.

40 not used

41 LTC FROM TAPE — Contains the longitudinal time code value most recently read from tape.

Format: <LTC FROM TAPE>
<CODE VALIDITY>

1-byte special binary code:
00_h = valid LTC
01_h = derived LTC
FF_h = not valid LTC

<TIME VALUE>

standard "time" format

42 VITC FROM TAPE — Contains the vertical interval time code value most recently read from tape.

Format:
<LTC FROM TAPE>
<CODE VALIDITY> — 1-byte special binary code:
00_h = valid VITC
01_h = derived VITC
FF_h = not valid VITC
<TIME VALUE> — standard "time" format

43 SELECTED TAPE CODE — Contains the time value of that code (LTC, VITC, etc.) which has been most recently selected by the TAPE CODE SELECT command.

Format:
<SELECTED TAPE CODE>
<IDENTIFIER> — 1-byte special binary code:
00_h = LTC
01_h = VITC
02_h = TT1
03_h = TT2
04_h = auto TC
FF_h = invalid
<TIME VALUE> — standard "time" format

44 USERBITS FROM TAPE LTC — Contains the LTC userbit contents most recently read from tape.

Format:
<USERBITS FROM TAPE LTC>
<UB SPECIFICATION> — 1-byte special code:
bits 0, 1:
0, 0 – content of userbits unspecified
1, 0 – content of userbits is 8-bit character set conforming to ISO/IEC 646 and ISO 2022
0, 1 – unassigned
1, 1 – unassigned
bit 2:
0 – unassigned
1 – content of userbits is secondary time data in standard time format
bits 3–7:
0 – set to 0 until assigned
<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>
(MSnibble) — 4 bytes, each consisting of two 4-bit nibbles, each containing one UB group

NOTE – UB 1 is the UB group which comes first on the tape.

45 USERBITS FROM TAPE VITC — Contains the VITC userbit contents most recently read from tape.

Format:
<USERBITS FROM TAPE VITC>
<UB SPECIFICATION>
<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>
For format description, see USERBITS FROM TAPE LTC.

46 TT1 (Tape Timer 1) — Contains the instantaneous counting status of tape timer 1.

Format:
<TT1>
<TIME VALUE> — Standard "time" format.

47 TT2 (Tape Timer 2) — Contains the instantaneous counting status of tape timer 2.

Format:
<TT2>
<TIME VALUE> — Standard "time" format.

48 READY TALLY — Tallies the status set by the READY SELECT command.

Format:
<READY TALLY>
<SWITCH> — Boolean value
00_h = OFF
01_h = ON

49 SERVO REFERENCE TALLY — Tallies the status set by the SERVO REFERENCE SELECT command.

Format:
<SERVO REFERENCE TALLY>
<MODE> — 1-byte special binary code:
00_h = auto select
01_h = video in
02_h = external ref input

4A RECORD MODE TALLY — Tallies the status set by the RECORD MODE SELECT command.

Format:
<RECORD MODE TALLY>
<MODE> — 1-byte special binary code:
00_h = record disable
01_h = insert
02_h = assemble; all channels
03_h = assemble; channel selectable
04_h = rehearsal
05_h = crash record
06_h = read-before-write

4B CHANNEL RECORD STATUS — *Tallies the status of the recording channels controlled by the ENTRY and EXIT commands.*

Format: <ENTRY>
<CHANNELS> — 3-byte bit mask:
bit 0 (LSB) = video
bit 1 = sync track
bit 2 = VITC
bit 3 = cue audio
bit 4 = reserved
bit 5 = reserved
bit 6 = reserved
bit 7 = LTC
bits 8–23 = audios 1–16 respectively

logic: 0 = not recording
1 = recording

NOTE – Bits 0–7 form the least significant byte; this byte is transmitted last.

4D TAPE CODE SELECTION TALLY — Tallies the code currently selected by the most recent TAPE CODE SELECT command.

Format: <TAPE CODE SELECTION TALLY>
<CODE TYPE> — 1-byte special binary code:
00_h = longitudinal time code
01_h = vertical interval time code
02_h = TT1
03_h = TT2
04_h = auto TC

4E SYNC VELOCITY — Contains a velocity used as the synchronization velocity for the SYNC command.

Format: <SYNC VELOCITY>
<SPEED> — 3-byte signed binary number; two's complement scale:
000000_h = still
010000_h = std play speed forward
$7F0000_h$ = approximately 127 times standard play speed forward
$FF0000_h$ = std play speed reverse
800000_h = 128 times standard play speed reverse

NOTE – This is the same coding as in the argument of the VARIABLE PLAY command. Default is standard play speed.

4F PREROLL DURATION — Contains the preroll time used in advance of synchronizing processes.

Format: <PREROLL DURATION>
<TIME VALUE> — Standard "time" format.

50 SYNC POINT — Contains a TAPE CODE value used as the SYNChronization POINT for the SYNC command.

Format: <SYNC POINT>
<TIME VALUE> — Standard "time" format.

51 COLOR FRAMER TALLY — Tallies the status of the color framer selected by the COLOR FRAMER SELECT command.

Format: <COLOR FRAMER TALLY>
<MODE> — 1-byte special binary code:
bit 7 (MSB):
0 = OFF – 2-field lock NTSC
– 4-field lock PAL/SECAM
1 = ON – 4-field lock NTSC
– 8-field lock PAL/SECAM
bit 6:
0 = normal lock
1 = inverted lock
bits 3–0:
nibble contains binary number which specifies an offset from the lock specified above in units of fields

52 EDIT FIELD TALLY — Tallies the status set by the EDIT FIELD SELECT command.

Format: <EDIT FIELD TALLY>
<MODE> — 1-byte special binary code:
00_h = start of field 1 always
01_h = start of field 2 always
02_h = at next vertical in immediate mode or determined by field bit of timeline if in timeline mode
FF_h = as selected locally

53 not used

54 TCG LTC TIME SOURCE TALLY — Tallies the status of the time code generator for the longitudinal time code selected by the TCG LTC TIME SOURCE SELECT command.

Format: <TCG LTC TIME SOURCE TALLY>
<TIME SOURCE>

1-byte special binary code:
- 00_h = hold
- 01_h = running independently, starting with the value contained in I/F item PRESETTABLE TIME SOURCE LTC
- 02_h = running with external, unspecified source
- 03_h = running with the regenerated value of the LTC time code as source (also contained in the I/F field LTC FROM TAPE) until a record ENTRY of the LTC track; then continuing independently, running with the time value most recently read from tape, i.e., "jam-sync" function
- 04_h = running with regenerated VITC time code from tape as source (also contained in I/F field VITC FROM TAPE), i.e., "copy function"
- 05_h = running with TAPE CODE as source (also contained in I/F field TAPE CODE

55 TCG VITC TIME SOURCE TALLY — Tallies the status of the time code generator for the vertical interval time code selected by the TCG VITC TIME SOURCE SELECT command.

Format: <TCG VITC TIME SOURCE TALLY>
<TIME SOURCE>

1-byte special binary code:
- 00_h = hold
- 01_h = running independently, starting with the value contained in I/F item PRESETTABLE TIME SOURCE VITC
- 02_h = running with external, unspecified source
- 03_h = running with the regenerated value of the VITC time code as source (also contained in the I/F field VITC FROM TAPE) until a record ENTRY of the VITC track; then continuing independently, running with the time value most recently read from tape, i.e., "jam-sync" function

- 04_h = running with regenerated LTC time code from tape as source (also contained in I/F field LTC FROM TAPE), i.e., "copy function"
- 05_h = running with TAPE CODE as source (also contained in I/F field TAPE CODE

56 TCG LTC USERBIT SOURCE TALLY — Tallies the status of the time code generator for the longitudinal time code selected by the TCG LTC UB SOURCE SELECT command.

Format: <TCG LTC USERBIT SOURCE TALLY>
<USERBIT SOURCE>

1-byte special binary code:
- 00_h = no userbits; i.e., all set to zero (= default)
- 01_h = userbits from I/F item PRESET-TABLE USERBIT SOURCE LTC, which may be preset by a PRESET command
- 02_h = userbits from external, unspecified source
- 03_h = userbits continuously copied from the LTC time code from tape (also contained in I/F field USERBITS FROM TAPE LTC
- 04_h = userbits continuously copied from the VITC time code from tape (also contained in I/F field USERBITS FROM TAPE VITC

57 TCG VITC USERBIT SOURCE TALLY — Tallies the status of the time code generator for the vertical interval time code selected by the TCG VITC UB SOURCE SELECT command.

Format: <TCG VITC USERBIT SOURCE TALLY>
<USERBIT SOURCE>

1-byte special binary code:
- 00_h = no userbits, i.e., all set to 0 (= default)
- 01_h = userbits from I/F item PRESET-TABLE USERBIT SOURCE VITC, which may be preset by a PRESET command.
- 02_h = userbits from external, unspecified source
- 03_h = userbits continuously copied from the VITC time code from tape (also contained in I/F field USER-BITS FROM TAPE VITC)
- 04_h = userbits continuously copied from the LTC time code from tape (also contained in I/F field USER-BITS FROM TAPE LTC)

58 not used

59 not used

5A TAPELENGTH — Contains the length of the loaded tape.

Format: <TAPELENGTH>
<TIME VALUE> — Standard "time" format.

5B PARKING ACCURACY — Contains a time value that determines the accuracy of parking processes performed by certain commands, e.g., TARGET SEARCH, PREROLL SEARCH.

Format: <PARKING ACCURACY>
<FIELDS> — 1-byte unsigned number

NOTE – FF_h (as locally specified) shall be used in the PRESET command only. It shall not be used in an I/F ITEM RESPONSE.

5C SYNCHRONISM ACCURACY — Contains a time value that determines the accuracy of synchronizing processes, i.e., it specifies the maximum allowed offset error at the SYNC POINT.

Format: <SYNCHRONISM ACCURACY>
<FIELDS> — 1-byte unsigned number

NOTE – FF_h (as locally specified) shall be used in the PRESET command only. It shall not be used in an I/F ITEM RESPONSE.

5D not used

5E TRACKING SELECTION TALLY — Tallies the status set by the TRACKING SELECT command.

Format: <TRACKING SELECTION TALLY>
<MODE> — 1-byte special binary code:
00_h = FIXED (default)
01_h = AUTO

5F ANTI-CLOG CONTROL TALLY — Tallies the status of the anti-clog mechanism which is controlled by the ANTI-CLOG CONTROL command.

Format: <ANTI-CLOG CONTROL TALLY>
<SWITCH STATUS> — 1-byte special binary code:
00_h = ON (default)
01_h = OFF
02_h = extended
03_h = immediate tension release
FF_h = as selected locally

60 not used

61 TMC TALLY — Tallies the current transport motion command of the VTR and specifies its success at accomplishing the command.

Format: <TMC TALLY>
<KEYWORD> — 1-byte value that contains the keyword of the last commanded TMC from either immediate or timeline mode.

<SUCCESS LEVEL> — 1-byte special binary code:
00_h = trying; transition in process
01_h = successful
02_h = failure; this tally should be supplemented by an ERROR message as appropriate

62 VELOCITY TALLY — Tallies the current transport velocity. Note that this is the true velocity in all TMC modes.

Format: <VELOCITY TALLY>
<SPEED> — 3-byte signed binary number; two's complement scale:
000000_h = still
010000_h = std play speed forward
$7F0000_h$ = approximately 127 times standard play speed forward
$FF0000_h$ = std play speed reverse
800000_h = 128 times standard play speed reverse

NOTE – This is the same coding as in the argument of the VARIABLE PLAY command.

63 TIMELINE CORRECTION TALLY — Tallies the number of fields advanced by the machine internal clock following a TIMELINE RUN command.

Format: <TIMELINE CORRECTION TALLY>
<FIELDS> — 1-byte signed binary number

64 not used

65 PLAYBACK CHANNEL TALLY — Tallies the status of the playback channels selected by the PLAYBACK CHANNEL SELECT command.

Format: <PLAYBACK CHANNEL TALLY>
<CHANNELS> — 3-byte bit mask:
bit 0 (LSB) = video
bit 1 = sync track
bit 2 = VITC
bit 3 = cue audio
bit 4 = reserved
bit 5 = reserved
bit 6 = reserved
bit 7 = LTC
bits 8–23 = audios 1–16 respectively

logic: 0 = playback channel
1 = monitor channel (audio)
record channel (video)

NOTE – Bits 0–7 form the least significant byte; this byte is transmitted last.

66 CHANNEL MUTE TALLY — Tallies the status of the auto mute function selected by the CHANNEL MUTE SELECT command.

Format: <CHANNEL MUTE TALLY>
<CHANNELS> — 3-byte bit mask:
bit 0 (LSB) = video
bit 1 = sync track
bit 2 = VITC
bit 3 = cue audio
bit 4 = reserved
bit 5 = reserved
bit 6 = reserved
bit 7 = LTC
bits 8–23 = audios 1–16 respectively

logic: 0 = mute enabled
1 = mute disabled

NOTE – Bits 0–7 form the least significant byte; this byte is transmitted last.

67 TAPE/EE TALLY — Tallies the status of the tape/electronics switches controlled by the TAPE/EE SELECT command.

Format: <TAPE/EE>
<MODE> — 1-byte special binary code:
00_h = auto
01_h = tape
02_h = EE

68 TIME CODE TO TAPE LTC — Contains the current longitudinal time code value being generated by the time code generator.

Format: <TIME CODE TO TAPE LTC>
<TIME VALUE> — Standard "time" format.

69 TIME CODE TO TAPE VITC — Contains the current vertical interval time code value being generated by the time code generator

Format: <TIME CODE TO TAPE VITC>
<TIME VALUE> — Standard "time" format.

6A USERBITS TO TAPE LTC — Contains the current userbit contents being generated by the time code generator to go with the longitudinal time code.

Format: <USERBITS TO TAPE LTC>
<UB SPECIFICATION>
<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>
— For format description, see USERBITS FROM TAPE LTC.

6B USERBITS TO TAPE VITC — Contains the current userbit contents being generated by the time code generator to go with the vertical interval time code.

Format: <USERBITS TO TAPE VITC>
<UB SPECIFICATION>
<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>
— For format description, see USERBITS FROM TAPE LTC.

6C PRESETTABLE TIME SOURCE LTC — Contains a time value that can be PRESET and used to start the LTC time code generator by selecting it in a TCG LTC TIME SOURCE SELECT command.

Format: <PRESETTABLE TIME SOURCE LTC>
<TIME VALUE> — Standard "time" format.

6D PRESETTABLE TIME SOURCE VITC — Contains a time value that can be PRESET and used to start the VITC time code generator by selecting it in a TCG VITC TIME SOURCE SELECT command.

Format: <PRESETTABLE TIME SOURCE VITC>
<TIME VALUE> — Standard "time" format.

6E PRESETTABLE UB SOURCE LTC — Contains a userbit pattern that can be PRESET and used by the LTC time code generator by selecting it in a TCG LTC UB SOURCE SELECT command.

Format: <PRESETTABLE UB SOURCE LTC>
<UB SPECIFICATION> — For format description, see USERBITS FROM TAPE LTC.
<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>

6F PRESETTABLE UB SOURCE VITC — Contains a userbit pattern that can be PRESET and used by the VITC time code generator by selecting it in a TCG VITC UB SOURCE SELECT command.

Format: <PRESETTABLE UB SOURCE VITC>
<UB SPECIFICATION> — For format description, see USERBITS FROM TAPE LTC.
<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>

Annex A (informative)
General concepts

The following text contains a general explanation of some of the concepts used in the formulation of the VTR type-specific message set. It constitutes tutorial information and is intended to assist in the understanding of the specifications in previous portions of this document.

A.1 Transport machine states

The transport mechanism of a VTR is considered to be a separate state machine. Therefore, the commands which control transport functions form a subset within the VTR-specific message set. These commands are called tape motion commands (TMCs). Each TMC causes a transition into a transport state and cancels the previous state; i.e., these functions are mutually exclusive.

TMCs include: STOP, STD PLAY, SHUTTLE, PREROLL SEARCH, SYNC, etc.

All tape motion commands are marked as such in the command description.

A.2 Electrical machine states

Other VTR commands affect states of the electrical environment of the VTR. The functions controlled by them are not necessarily mutually exclusive.

A.3 Transport speeds

Some commands require a speed specification which is carried by the command in the form of a 3-byte parameter. This parameter is intended to define the direction and absolute value of the desired speed that should be achieved as closely as possible by the real machine.

All commands with a speed parameter use the same format and coding. This is a 3-byte signed number with a scale range defined so that:

000000_h represents still;
010000_h represents standard play speed forward;
$7F0000_h$ represents approximately 127 times standard play speed forward;
$FF0000_h$ represents standard play speed reverse;
800000_h represents 128 times standard play speed reverse.

It allows theoretically for speeds between −128 and +127 times standard speed and a resolution of 1/65,536th of standard speed.

A.4 Record control

The recording function of the tape machine is fully controlled by the command pair ENTRY/EXIT. The form of record entry or exit is predefined by the command RECORD MODE. The tracks/channels affected by the command are defined by a parameter contained within the ENTRY/EXIT command.

Provision is also made for the rehearsal of an impending recording operation, provided the VTR possesses a mechanism for this purpose, such as tape/EE switching. In this case, the channels affected will also be defined via the ENTRY/EXIT command, but in rehearsal mode this command should control the VTR's rehearsal mechanism rather than placing its channels into and/or out of record.

To ensure that a rehearsal always matches the recording that is to follow, it is recommended as good practice that the track selection be asserted during every rehearsal, and not just during actual recordings. This will be particularly important when the controlling device has just been placed into a different record mode, for example, if it has been switched from insert mode to assemble-all-channels mode. The required channel combination may well be different in the new mode so it must be asserted even before the first recording is made following the mode change. As another variant, when rehearsing an impending read-before-write edit recording, it may prove necessary to set all channels to the "off" condition, to prevent feedback or oscillation occurring during the interval between entry and exit points.

A.5 Track and channel selection

Some commands and information fields refer to one or more tracks (or the associated channels) of the tape machine. The format used is the same in all cases and is defined in the description of the ENTRY and EXIT commands. The format allows for up to 16 audio tracks for future applications.

A.6 VTR information fields

The VTR dialect makes extensive use of the information field concept. Some specific items of the VTR information field are described in the following sections:

A.6.1 TMC tallies

This information field indicates the current state of the transport. As all possible states are commanded by TMCs, the code of the corresponding TMC keyword is used to identify them individually.

An additional byte tallies the level of success; i.e., whether the commanded function is still in progress or already finished, and whether successfully or not.

A.6.2 Other command tallies

Commands which cause changes in any electrical machine state (non-TMCs) have a corresponding information field. When the information field is read, the response is tallied in the same format as that of the command.

Example: The command RECORD MODE is intended to preset the state of the recording electronics. The information field RECORD MODE may be read to obtain information about the record mode status, which will be tallied in the same format as that contained within the RECORD MODE command itself.

A.6.3 Tape code

There are several sources that may be used to identify a tape position, for example:

- longitudinal time code;
- vertical interval time code;
- tape timer 1;
- tape timer 2.

For tape search, editing, and other automatic procedures, one of these sources must be used. The selected source is referred to as the TAPE CODE, and can be chosen by the TAPE CODE SELECT command. The functions mentioned above then refer to the TAPE CODE rather than directly to time code.

There is a separate information field for each of the codes and timers mentioned above; the tape code actually selected, however, can also be read from the information field TAPE CODE.

A.7 Synchronization

Synchronization is one of the fundamental requirements of a tape machine. Synchronization means that the machine is programmed to pass:

- a specified point on the tape (where);
- at a specified point in time (when);
- locked to a specified speed (how).

Where: The point on the tape is called the SYNC POINT. It is specified in terms of TAPE CODE and is maintained in the information field SYNC POINT. The sync point is specified by applying a PRESET command to this information field.

When: The point in time is defined by the instant of issue of the SYNC command. At a specified time period after the arrival of the SYNC command, the SYNC POINT must be reached. This time period is called the PREROLL DURATION; it is maintained in the information field PREROLL DURATION and is specified by applying a PRESET command to this information field.

Note that the PREROLL DURATION is reserved mainly for synchronization purposes; a greater PREROLL DURATION than required by the real machine may, however, be chosen for operational reasons (e.g., extended preview time).

How: The speed at the sync point is defined by a value maintained in the information field SYNC VELOCITY; it is specified by applying a PRESET command to this information field.

As a prerequisite for the use of the SYNC command, the tape must be placed at a park position which is calculated from the SYNC POINT and the SYNC VELOCITY as follows:

SYNC POINT – (PREROLL DURATION × STD VELOCITY / SYNC VELOCITY)

To achieve this park position, the PREROLL SEARCH command is used and the VTR virtual machine must make the calculation automatically.

A.7.1 SYNC command from viewpoint of an ideal machine

A better understanding of the function of the SYNC command can be had if it is considered from the viewpoint of an "ideal" machine:

– On the arrival of a SYNC command, an ideal VTR would start immediately with no delay, fully locked and with the specified speed. Under these ideal conditions, the machine would, at the PREROLL DURATION time later, be precisely at the SYNC POINT.

– A real VTR cannot start and synchronize immediately; it is, therefore, the responsibility of the virtual machine and the virtual machine manufacturer to control the real machine in such a manner that the result is the same.

Measures taken in order to correct synchronization following the preroll duration period may include:

– on the receipt of a PREROLL SEARCH command, parking a few frames down the tape to match the average number of frames lost while coming up to play speed;

– on the SYNC command, overriding the specified velocity using the tape speed override facility of the real machine to eliminate the remaining offset from the appropriate lock condition.

A.7.2 CHASE command: alternative means of maintaining synchronism

While the PREROLL SEARCH/SYNC commands may be used to run several machines in continuous synchronism (without changing their states and/or speed), the CHASE command is used to maintain synchronism as closely as possible where dynamic changes of the machines' state and/or speed occur.

This operation, however, requires one of the synchronous machines to be the "master" while the others perform as "slaves" and emulate all the movements of the master, even when in the SHUTTLE state.

The slaves must, therefore, be given precise information about the movement of the master. Such information is, in general, transferred by means of time code, which is distributed continuously from the master to all slaves over a separate line. The bus cannot be used for this purpose due to its unpredictable delays.

The CHASE command specifies an offset between the time code of the chasing machine and a reference. The reference is the timeline which, in this case, will usually be programmed to use an "external reference time" as its source; i.e., the time code of the master. (See also the common message TIMELINE SOURCE.)

A.8 Immediate and timeline modes

All VTR commands can be used in the "immediate mode" which causes their instantaneous execution. In this way, they can be used to control even time-critical functions. As the transfer of a message over the bus within a given time slot cannot be guaranteed, however, the immediate mode is not recommended for such applications.

Wherever possible, time-critical commands should be queued on the timeline, using the command facilities provided by the common message set. Activities requiring synchronous operations between several VTRs are best suited to the "timeline mode" of operation which allows for the preprogramming of sequences of time-critical functions (e.g., SYNC, ENTRY, and EXIT commands). All time-critical functions refer to the timelines of the individual virtual machines, which themselves are synchronized by a system time transmission from the bus controller in response to a REQUEST TIME TRANSMISSION command.

For certain time-critical applications (like editing), it is essential that all machine internal clocks are synchronized to the station field phase sequence. In order to achieve this phasing, the machine internal clock will be ADVANCED by as many frames as necessary following receipt of the TIMELINE RUN command. When all virtual machines in a session achieve this in the same way (for example, when they are all VTRs), there is no difficulty.

However, a problem does arise if there are non-VTR participants within a session (ATRs for example). They would have no reason to advance the machine internal clock in accordance with a video sequence; therefore, a mixed operation of VTRs and non-VTRs would not necessarily run synchronously.

There are two approaches which might be taken to resolve this problem:

– If the bus clock which resides in the bus controller runs synchronously with the video field phase sequence, no correction of a machine internal clock following a TIMELINE RUN command need take place.

– Alternatively, if this approach is not possible, the controlling device may obtain information about correction of any of the clocks within the system by READing the information field TIMELINE CORRECTION TALLY from all virtual machines involved and comparing them with each other; if this results in differing tallies, the controlling device can take that into account when calculating events for the timeline.

In the case of a known synchronous bus clock, the TIMELINE CORRECTION TALLY may be used by the controlling device for fault diagnosis on the machine internal clocks.

A.9 Sample command sequences

The following sections show samples of typical command sequences in immediate mode as well as in timeline mode. These sequences describe only some of the applications of the command set. There is no obligation on the part of system designers to use precisely these sequences.

A.9.1 Immediate mode

A.9.1.1 Search and play

Some time before initial action:

<PRESET> <PREROLL DURATION> <time value>
<PRESET> <SYNC POINT> <time value>

Initial action:

<PREROLL SEARCH>

Final action (not earlier than when the TMC TALLY has been "SEARCHed successfully"):

<STD PLAY>

On the STD PLAY command, the VTR starts and reaches the sync point APPROXIMATELY after the preroll duration.

If the VTR is required to start at the sync point location (using no preroll), the TARGET SEARCH command should be used. Synchronization is not then guaranteed.

Note that the preroll duration and the sync point, once loaded, need not be reloaded until changed.

A.9.1.2 Search and synchronize

Some time before initial action:

<PRESET> <PREROLL DURATION> <time value>
<PRESET> <SYNC POINT> <time value>
<PRESET> <SYNC VELOCITY> <speed value>

Inital action:

<PREROLL SEARCH>

Final action (not earlier than when the TMC TALLY has been "SEARCHed successfully"):

<SYNC>

On the SYNC command, the VTR starts and reaches the sync point PRECISELY after the preroll duration.

Under control of the virtual machine, the TAPE SPEED OVERRIDE function of the VTR may be used to find the appropriate lock. Synchronization of the VTR in response to the SYNC command is guaranteed; however:

– In PAL, the VTR will be advanced by one frame when necessary to be in accordance with the P-phase;

– The color framer may advance the VTR by as many frames as necessary.

This sequence can be used for the synchronous operation of multiple VTRs only when delivery of the SYNC command can be guaranteed within a reasonable time slot (e.g., one field).

Note that the preroll duration, once loaded, need not be reloaded until changed.

A.9.1.3 Search, synchronize, and insert edit

Some time before initial action:

<PRESET> <PREROLL DURATION> <time value>
<PRESET> <SYNC POINT> <time value>
<PRESET> <SYNC VELOCITY> <speed value>
<RECORD MODE> <"insert">

Initial action:

<PREROLL SEARCH>

Final action (not earlier than when the TMC TALLY has been "SEARCHed successfully"):

<SYNC>

at ("entry point" — "record delay"):

<ENTRY> <appropriate channels>

at ("exit point" — "record delay"):

<EXIT> <appropriate channels>

The controlling virtual machine must "know" the record delays of the VTRs and correct for them.

In "assemble" mode, edits and previews differ only in the RECORD MODE parameter.

This sequence can be used for the synchronous operation of multiple VTRs only on the condition that the transfer of the SYNC, ENTRY, and EXIT commands is guaranteed within a reasonable time slot (e.g., one field).

A.9.2 Timeline mode

A.9.2.1 Search and play

Some time before initial action:

<PRESET> <PREROLL DURATION> <time value>
<CLEAR EVENT> <0>
<STOP TIMELINE> (optional)
<PRESET> <SYNC POINT> <time value>
<PRESET> <SYNC VELOCITY> <speed value>

Initial action:

<PREROLL SEARCH>

Final action (not earlier than when the TMC TALLY has been "SEARCHed successfully"):

<REQUEST TIME TRANSMISSION>
<DEFINE EVENT>
<TIMELINE> <"timeline sync point" – "preroll duration">
<STD PLAY>

Note that the "timeline sync point" is the value of the timeline when the sync point has been reached APPROXIMATELY. It must be calculated from the instantaneous timeline value transmitted by the bus controller in response to the preceding REQUEST TIME TRANSMISSION command. In this case, it is actually easier to use the immediate mode which allows for VTR PLAY at a specific time from commands given much earlier.

A.9.2.2 Search and synchronize

Some time before initial action:

<PRESET> <PREROLL DURATION> <time value>
<CLEAR EVENT> <0>
<STOP TIMELINE> (optional)
<PRESET> <SYNC POINT> <time value>
<PRESET> <SYNC VELOCITY> <speed value>

Initial action:

<PREROLL SEARCH>

Final action (not earlier than when the TMC TALLY has been "SEARCHed successively"):

<REQUEST TIME TRANSMISSION>
<DEFINE EVENT>
<TIMELINE> <"timeline sync point" – "preroll duration">
<SYNC>

Note that the "timeline sync point" is the value of the timeline when the sync point has been reached PRECISELY. It must be calculated from the instantaneous timeline value transmitted by the bus controller in response to the preceding REQUEST TIME TRANSMISSION command. For editing, it is generally desirable to introduce no unnecessary waiting times; therefore, it is suggested that:

(timeline sync point – preroll duration)

be substituted in the DEFINE EVENT command by:

(instantaneous timeline value + some frames to compensate for transmission delay).

It is the responsibility of the controlling virtual machine to ensure that the SYNC command is placed on the timeline at a point such that the SYNC POINT and the timeline SYNC POINT coincide in respect to the color framer and/or the P-phase (in PAL). If this is not done, the situation described in A.9.1.2 will occur, which may result in inexact edits. This implies preference for a system in which the system time, which presets all timelines, is synchronized to reference color frame (or in PAL, at least to P-phase).

A.9.2.3 Search, synchronize, and insert edit

Some time before initial action:

<PRESET> <PREROLL DURATION> <time value>
<CLEAR EVENT> <0>
<STOP TIMELINE> (optional)
<PRESET> <SYNC POINT> <time value>
<PRESET> <SYNC VELOCITY> <speed value>
<RECORD MODE> <"insert">

Initial action:

<PREROLL SEARCH>

Final action (not earlier than when the TMC TALLY has been "SEARCHed successfully"):

<REQUEST TIME TRANSMISSION>
<DEFINE EVENT>
<TIMELINE> <"timeline sync point" – "preroll duration">
<SYNC>
<DEFINE EVENT>
<TIMELINE> <required timeline value>
<ENTRY> <appropriate channels>

<DEFINE EVENT>
<TIMELINE> <required timeline value>
<EXIT> <appropriate channels>

The VTR virtual machine is responsible for the compensation of any inherent delays, so that the functions called for happen on the designated field. This allows the controlling virtual machine to talk to the VTR in a generic fashion. Thus, type C, type B, U-matic, and quad VTRs will all be set by exactly the same commands, and will all edit on the same field.

Split edits require multiple ENTRY and/or EXIT commands stacked on different points of the timeline by using multiple DEFINE EVENT commands.

In "assemble" mode, edits and previews differ only in the RECORD MODE parameter.

Annex B (informative)
Bibliography

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SMPTE RP 113-1992, Supervisory Protocol for Digital Control Interface

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SMPTE RP 171-1993, Type-Specific Messages for Digital Control Interface of Analog Audio Tape Recorders

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SMPTE RECOMMENDED PRACTICE

RP 171-1993

Type-Specific Messages for Digital Control Interface of Analog Audio Tape Recorders

1 Scope

This practice details and defines the type-specific messages used for the control of analog audio tape recorder devices. These type-specific messages provide the means for the control and monitoring of a specific type of virtual machine and are implemented within an architecture of a greater control message language.

2 General

2.1 Virtual machine type

Analog audio tape recorders shall be identified as a virtual machine of a type which is uniquely coded as "03," expressed as an 8-bit word, in hexadecimal form.

2.2 Notation

This practice describes the keyword coding, naming conventions and its argument constructs in a form as shown below. The coding "NN" represents the assigned keyword code, expressed as an 8-bit word, in hexadecimal form.

NN	KEYWORD or I/F NAME	Keyword or I/F descriptive text
	Format:	<COMMAND>
		<PARAMETER NAME 0> [Parameter description;
		... Parameter value coding, scale or range;
		<PARAMETER NAME n> Parameter definitions and explanations.]

In the practices listed in annex B, keywords are listed numerically, in hexadecimal notation. Keywords numbering 40_h – FF_h are reserved for the type-specific, virtual machine subsets. The type-specific messages for the ATR are contained within this subset.

2.2.1 Command classifications

All tape motion state commands are indicated by the command classification "TMS." Each TMS command causes a transition into a transport state. These states are mutually exclusive.

Tape motion process commands are indicated by the command classification "TMP." Tape motion processes are overriding control commands that cause the controlled device to automatically choose its own tape motion states to achieve the desired result. The tape motion state will be reflected in the TMS tally, as though that TMS command had been issued. TMPs are mutually exclusive.

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All audio record commands are indicated by the command classification "ARC." ARC commands affect the manner in which tracks are selected and subsequently sequenced through record entries and exits.

All audio monitor commands are indicated by the command classification "AMC." AMC commands affect the manner in which audio line output source selections are made.

2.2.2 Reserved keywords

All keyword codes listed as "reserved" are specifically retained for the expansion of the range of compatible message usage between ATR and VTR type-specific devices.

3 Index of keywords

3.1 Numerical index of keywords, mnemonics, and information field names

Commands which have a related information field for tally purposes are identified by a ">>" sign within the body of the index listing.

	Message keywords		Mnemonic	I/F field names		Mnemonic
	40	not used		40	not used	
TMS	41	STOP	STOP	41	INTERNAL LTC	INTC
TMS	42	VARIABLE PLAY	VAPL	42	not used	
TMS	43	PLAY	STPL	43	SELECTED TAPE CODE	SETC
TMS	44	STEP	STEP	44	INTERNAL LTC USERBIT	INUB
TMS	45	AUDIBLE FAST	AFST	45	not used	
TMS	46	SHUTTLE	SHUT	46	TAPE TIMER	TATI
	47	not used		47	not used	
	48	reserved		48	reserved	
	49	CAPSTAN REFERENCE SELECT	CAPS >>	49	CAPSTAN REFERENCE TALLY	CRET
ARC	4A	REHEARSE SELECT	REMS >>	4A	REHEARSE TALLY	REHT
ARC	4B	RECORD STROBE	RSTB	4B	CHANNEL RECORD STATUS	CRES
ARC	4C	RECORD EXIT	REEX	4C	not used	
	4D	TAPE CODE SELECT	TACS >>	4D	TAPE CODE SELECTION TALLY	TACT
TMP	4E	TARGET SEARCH	TASE	4E	SYNC VELOCITY	SVTY
TMP	4F	SYNC PREROLL SEARCH	SPRS	4F	PREROLL DURATION	PRDU
TMS	50	SYNC	SYNC	50	SYNC POINT	SPNT
TMS	51	LOCK	LOCK	51	LOCK TIME	LKTT
TMP	52	LOCK PREROLL SEARCH	LPRS	52	not used	
TMP	53	CHASE	CHAS	53	not used	
	54	reserved		54	reserved	
	55	reserved		55	reserved	
	56	reserved		56	reserved	
	57	reserved		57	reserved	
TMS	58	TAPE RELEASE	TARL	58	not used	
	59	FIXED SPEED SELECT	FISS	59	FIXED SPEED TALLY	FIST
	5A	not used		5A	TAPELENGTH	TLTH
	5B	not used		5B	not used	
	5C	not used		5C	SYNC LOCK ACCURACY	SLAC
	5D	not used		5D	LOCK DEVIATION	LKDE
	5E	not used		5E	not used	
	5F	not used		5F	not used	

	60	PRESET	PRST	60	TMP TALLY	TMPT
TMS	61	FAST FORWARD	FFOR	61	TMS TALLY	TMST
TMS	62	FAST REVERSE	FREV	62	VELOCITY TALLY	VELT
	63	not used		63	not used	
ARC	64	RECORD READY SELECT	RECS >>	64	RECORD READY TALLY	RECT
	65	not used		65	not used	
	66	AUTO ATTENUATE SELECT	AUAS >>	66	AUTO ATTENUATE TALLY	AUAT
	67	LIFTER DEFEAT SELECT	TLDS >>	67	LIFTER DEFEAT TALLY	TLDT
	68	not used		68	reserved	
	69	not used		69	reserved	
	6A	not used		6A	reserved	
	6B	not used		6B	reserved	
	6C	not used		6C	reserved	
	6D	not used		6D	reserved	
	6E	not used		6E	reserved	
	6F	not used		6F	reserved	
	70	LOCK MODE SELECT	LKMS >>	70	LOCK MODE TALLY	LKMT
AMC	71	GLOBAL MONITOR SELECT	MONS >>	71	GLOBAL MONITOR TALLY	MONT
AMC	72	EXCLUSIVE SYNC SELECT	ESYS >>	72	EXCLUSIVE SYNC TALLY	ESYT
AMC	73	SYNC INPUT SELECT	SYIS >>	73	SYNC INPUT TALLY	SYIT
	74	not used		74	EXTERNAL TIME CODE	EXTC
	75	not used		75	EXTERNAL USERBITS	EXUB
	76	not used		76	SLEW RATE	SLRT
	77	not used		77	REQUESTED OFFSET	ROFT
	78	not used		78	ACTUAL OFFSET	AOFT
	79	not used		79	STRIDE LENGTH	STLT
	7A	LOCAL LOCKOUT SELECT	LLOS	7A	LOCAL LOCKOUT TALLY	LLOT
	7B	not used		7B	TIME CODE ATTRIBUTES	TCAT
	7C	PLAY MODE SELECT	PLMS	7C	PLAY MODE TALLY	PLMT

3.2 Functional index of keywords, mnemonics, and information field names

Commands which have a related information field for tally purposes are identified by brackets within the body of the index listing.

Message keywords			Mnemonic	I/F field names		Mnemonic
System utility						
	7A	LOCAL LOCKOUT SELECT	LLOS	7A	LOCAL LOCKOUT TALLY	LLOT
Tape motion procedures (TMP)						
	4E	TARGET SEARCH	TASE \			
	4F	SYNC PREROLL SEARCH	SPRS >	60	TMP TALLY	TMPT
	52	LOCK PREROLL SEARCH	LPRS |			
	53	CHASE	CHAS /			

Tape motion states (TMS)

41	STOP	STOP >	61	TMP TALLY	TMST
58	TAPE RELEASE	TARL \			
43	PLAY	STPL |			
61	FAST FORWARD	FFOR |			
62	FAST REVERSE	FREV >	62	VELOCITY TALLY	VELT
44	STEP	STEP |			
42	VARIABLE PLAY	VAPL |			
45	AUDIBLE FAST	AFST |			
46	SHUTTLE	SHUT |			
51	SYNC	SYNC |			
51	LOCK	LOCK /			

Tape motion references

59	FIXED SPEED SELECT	FISS >>	59	FIXED SPEED TALLY	FIST
49	CAPSTAN REFERENCE SELECT	CAPS >>	49	CAPSTAN REFERENCE TALLY	CRET
60	PRESET	PRST	79	STRIDE LENGTH	STLT

Synchronization parameters

70	LOCK MODE SELECT	LKMS >>	70	LOCK MODE TALLY	LKMT
7C	PLAY MODE SELECT	PLMS >>	7C	PLAY MODE TALLY	PLMT
		/	51	SYNC POINT	SPNT
		|	51	LOCK TIME	LKTT
		|	4E	SYNC VELOCITY	SVTY
60	PRESET	PRST <	4F	PREROLL DURATION	PRDU
		|	77	REQUESTED OFFSET	ROFT
		|	5C	SYNC/LOCK ACCURACY	SLAC
		\	76	SLEW RATE	SLRT
			78	ACTUAL OFFSET	AOFT
			5D	LOCK DEVIATION	LKDE

Position and synchronization references

4D	TAPE CODE SELECT	TACS >>	4D	TAPE CODE SELECT TALLY	TACT
60	PRESET	PRST >	46 *	TAPE TIMER	TATI
			41 *	INTERNAL LTC	INTC
			43 *	SELECTED TAPE CODE	SETC
			74 *	EXTERNAL TIME CODE	EXTC

* = Time I/Fs which may be used as event triggers.

Position and time code utilities

60	PRESET	PRST	5A	TAPE LENGTH	TLTH
			7B	TIME CODE ATTRIBUTES	TCAT
			44	INTERNAL LTC USERBITS	INUB
			75	EXTERNAL USERBITS	EXUB

Audio record control (ARC)

64	RECORD READY SELECT	RECS >>	64	RECORD READY TALLY	RECT
4A	REHEARSE SELECT	REMS >>	4A	REHEARSE TALLY	REHT
4B	RECORD STROBE	RSTB >	4B	CHANNEL RECORD STATUS	CRES
4C	RECORD EXIT	REEX /			

Audio monitor control (AMC)

71	GLOBAL MONITOR SELECT	MONS >>	71	GLOBAL MONITOR TALLY	MONT
72	EXCLUSIVE SYNC SELECT	ESYS >>	72	EXCLUSIVE SYNC TALLY	ESYT
73	SYNC INPUT SELECT	SYIS >>	73	SYNC INPUT TALLY	SYIT
66	AUTO ATTENUATE SELECT	AUAS >>	66	AUTO ATTENUATE TALLY	AUAT
67	LIFTER DEFEAT SELECT	TLDS >>	67	LIFTER DEFEAT TALLY	TLDT

4 Keywords, definitions, and syntax

40 not used

41 STOP

(TMS) Causes the controlled ATR to stop as soon as possible; all recording tracks are automatically exited from record operation prior to execution.

Format: <STOP>

42 VARIABLE PLAY

(TMS) Causes the controlled ATR to enter capstan-controlled variable forward playback mode with specified velocity relative to the FIXED SPEED. If the controlled ATR is recording, all recording tracks will exit record mode.

Format: <VARIABLE PLAY>
<SPEED>

3-byte signed binary number: twos complement scale:
000000_h = stationary
010000_h = fixed speed forward
$7F0000_h$ = approximately 127 times standard fixed speed forward
$FF0000_h$ = fixed speed reverse
800000_h = 128 times fixed speed reverse

NOTE – Argument does not imply resolution of a controlled device.

43 STD PLAY

(TMS) Causes the controlled ATR to enter playback at the speed determined by the value in the FIXED SPEED I/F. If the controlled ATR is recording, all recording tracks will exit record mode.

Format: <PLAY>

44 STEP

(TMC) Causes the controlled ATR to move the tape a specified number of STRIDE LENGTHS forward or backward, with respect to its current position, only while in STOP or STEP. Successive commands are cumulative until next TMS or TMP (other than STEP). The number argument refers to the quantity and direction of STRIDE PERIODS of tape movement requested. The longitudinal STRIDE LENGTH is defined in the STRIDE LENGTH I/F.

Format: <STEP>
<NUMBER>

1-byte signed number:
range: –127 ... +127

45 AUDIBLE FAST

(TMS) Causes the controlled ATR to enter fast tape motion with audible but not necessarily broadcastable audio at specified direction and velocity relative to the FIXED SPEED. All recording tracks are automatically exited from record operation prior to execution.

Format: <AUDIBLE FAST>
<SPEED>

3-byte signed binary number;
same format as in VARIABLE PLAY.

46 SHUTTLE

(TMS) Causes the controlled ATR to travel at specified direction and velocity relative to FIXED SPEED without necessarily reproducing audio. All recording tracks are automatically exited from record operation prior to execution.

Format: <SHUTTLE>
<SPEED>

3-byte signed binary number;
same format as in VARIABLE PLAY.

47 not used

48 reserved

49 CAPSTAN REFERENCE SELECT

Causes the controlled ATR to select a capstan reference. This command is meaningful only when not in CHASE TMP, SYNC, or LOCK TMS. These operations will cause a return to the default selection.

Format: <CAPSTAN REFERENCE SELECT>
<MODE>

1-byte special binary code:
00_h = internal crystal (= default)
01_h = external capstan reference input
FF_h = as selected locally

4A REHEARSE SELECT

(ARC) During all subsequent record entries and exits, related line-out switching functions will mimic record operation as defined by the SYNC-INPUT SELECT I/F without actually erasing or applying bias and audio signal to tape.

Format: <REHEARSE SELECT>
<MODE>

1-byte special binary code:
00_h = rehearse true (default)
04_h = rehearse true
FF_h = as selected locally
else = record enabled

4B RECORD STROBE

(ARC) Causes record entry on the presently RECORD READY enabled track(s); causes record exit on any currently recording track(s) that are RECORD READY disabled.

Format: <RECORD STROBE>

4C RECORD EXIT

(ARC) Causes a record exit on all currently recording track(s).

Format: <RECORD EXIT>

4D TAPE CODE SELECT

Selects the source of code for all succeeding messages that refer to the SELECTED TAPE CODE.

Format: <TAPE CODE SELECT>
<CODE TYPE>

1-byte special binary code:
00_h = internal time code (= default)
01_h = reserved
02_h = tape timer
03_h = reserved
04_h = reserved
FF_h = as selected locally

4E TARGET SEARCH

(TMP) Causes the controlled ATR to move to a defined tape position in accordance with the TAPE CODE SELECT.

Format: <TARGET SEARCH>
<TAPE CODE> (type TIME)

NOTE – The SELECTED TAPE CODE reference is selected by the command TAPE CODE SELECT.

4F SYNC PREROLL SEARCH

(TMP) Causes the controlled ATR to move to the SELECTED TAPE CODE tape position determined by the PREROLL DURATION I/F minus any device-specific acceleration allowance in advance of the SYNC POINT I/F. All recording tracks are automatically exited from record operation prior to execution.

Format: <SYNC PREROLL SEARCH>

50 SYNC

(TMS) This command is styled to follow the functional intent of the VTR dialect SYNC command. When issued, causes the controlled device to immediately establish synchronism with the selected TIMELINE SOURCE.

NOTES

1 The controlled device will synchronize with the above-selected reference at the prescribed SYNC POINT with the prescribed SYNC VELOCITY precisely at the prescribed PREROLL DURATION after either the "immediate" reception or "EVENT" reception of this keycode.

2 It is essential that the selected TIMELINE SOURCE is incrementing in a real time manner at the delivery time of the command during the PREROLL DURATION and throughout the remainder of the SYNC operation.

3 PREROLL DURATION and SYNC POINT I/Fs must be predefined before both SYNC PREROLL SEARCH and SYNC command execution. The controlled device must be cued to the correct preroll position before execution.

4 This command establishes synchronism independently of any previous preset REQUESTED OFFSET, as the offset at the instant of SYNC POINT is dependent upon the time of the command's delivery and the prescribed SYNC VELOCITY. As a function of SYNC operation, REQUESTED OFFSET may continuously be changed in order to maintain SYNC VELOCITY conformance relative to the selected TIMELINE SOURCE.

Format: <SYNC>

51 LOCK

(TMS) When isssued, causes the controlled ATR to establish synchronism in a manner as defined by the LOCK MODE I/F. Causes a LOCK PREROLL SEARCH operation should the controlled device not be cued to the correct prerolled position.

Format: <LOCK>

NOTE – PREROLL DURATION, REQUIRED OFFSET, and LOCK TIME I/Fs must be predefined before LOCK execution.

52 LOCK PREROLL SEARCH

(TMP) Causes the controlled ATR to move to the SELECTED TAPE CODE tape position determined by the PREROLL DURATION I/F minus any device-specific acceleration allowance in advance of the REQUESTED OFFSET adjusted LOCK TIME I/F. All recording tracks are automatically exited from record operation prior to execution.

Format: <PREROLL SEARCH>

53 CHASE

(TMP) Causes the controlled device to attempt to follow, establish, and maintain synchronism with the EXTERNAL TIME CODE. Synchronism is established and maintained in a data-dependent manner. All recording tracks are automatically exited from record operation prior to any noncapstan servoed follow action.

Format: <CHASE>

54 reserved

55 reserved

56 reserved

57 reserved

58 TAPE RELEASE

(TMS) Releases the tape tension mechanism of the controlled ATR. All recording tracks are automatically exited from record operation prior to execution. This TMS is reset by STOP.

Format: <TAPE UNLOAD>

59 FIXED SPEED SELECT

Causes the controlled device to select the nominal tape speed.

Format: <FIXED SPEED SELECT>
<SPEED>

1-byte special binary code:

10_h =	1.875 ips	4.7625 cm/s
20_h =	3.750 ips	9.525 cm/s
30_h =	7.500 ips	19.05 cm/s
37_h =	9.606 ips	24.40 cm/s
40_h =	15.00 ips	38.10 cm/s
50_h =	30.00 ips	76.20 cm/s
FF_h =	as selected locally	

5A not used

5B not used

5C not used

5D not used

5E not used

5F not used

60 PRESET

Presets the named information field to the given value.

Format: <PRESET>
<PERMITTED INFORMATION FIELD NAME>
<VALUE>

Format and coding defined by the I/F NAME.

Permitted information field names for ATRs are:

TAPE TIMER	SYNC/LOCK ACCURACY
PREROLL DURATION	STRIDE LENGTH
SYNC POINT	SLEW RATE
LOCK TIME	REQUESTED OFFSET
TAPE LENGTH	

61 FAST FORWARD

(TMS) Causes the controlled ATR to go forward at its maximum speed without necessarily reproducing audio. All recording tracks are automatically exited from record operation prior to execution.

Format: <FAST FORWARD>

62 FAST REVERSE

(TMS) Causes the controlled ATR to rewind at its maximum speed without necessarily reproducing audio. All recording tracks are automatically exited from record operation prior to execution.

Format: <FAST REVERSE>

63 not used

64 RECORD READY SELECT

(ARC) Selects channels that will be record-enabled. These enabled tracks enter record upon receipt of a RECORD STROBE command. A track that is disabled from RECORD READY may be taken out of a recording condition through receipt of a RECORD STROBE or RECORD EXIT command.

Format: <RECORD READY SELECT>
<CHANNELS>

8-byte bitmap:
Bits 0 – 63 = audio channels 1 – 64
Logic 1 = RECORD READY TRUE

Bits 0 – 7 form the least significant byte; this byte is transmitted last.

65 not used

66 AUTO ATTENUATE SELECT

Causes the audio outputs of the controlled ATR to be attenuated. Any locally-defined time code-designated tracks may be excluded from this function.

Format: <AUTO ATTENUATE>
<MODE>

1-byte special binary code:
00_h = OFF (= default)
01_h = ON
FF_h = as selected locally

67 LIFTER DEFEAT SELECT

Defeats the tape lifter mechanism of the controlled ATR, thus allowing full tape contact with the heads at all times.

Format: <LIFTER DEFEAT SELECT>
<MODE>

1-byte special binary code:
00_h = OFF (= default)
01_h = ON
FF_h = as selected locally

68 not used

69 not used

6A not used

6B not used

6C not used

6D not used

6E not used

6F not used

70 LOCK MODE SELECT

Selects the manner in which the controlled device achieves and maintains synchronization as commanded by the lock command.

Format: <LOCK MODE SELECT>
<MODE>

1-byte special binary code:

00_h Absolute standard mode: Achieve lock to EXTERNAL TIME CODE in data-dependent mode, maintain lock in data-dependent mode. External LTC is selected as the source of EXTERNAL TIME CODE.

01_h Absolute resolve mode: Achieve lock to EXTERNAL TIME CODE in data-dependent mode, maintain lock in data-independent mode. External LTC is selected as the source of EXTERNAL TIME CODE.

02_h Absolute video mode: Achieve lock to EXTERNAL TIME CODE in data-dependent mode, maintain lock to external video reference. External LTC is selected as the source of EXTERNAL TIME CODE.

03_h Absolute VITC mode: Achieve lock to external video with VITC in data-dependent mode, maintain lock to external video reference. External video VITC signal is selected as the source of EXTERNAL TIME CODE.

11_h Free resolve mode: Achieve lock to EXTERNAL TIME CODE in data-independent mode, maintain lock in data-independent mode. External LTC is selected as the source of EXTERNAL TIME CODE.

12_h Free video mode: Achieve lock to external video signal, maintain lock to external video reference. The source of EXTERNAL TIME CODE is undefined.

FF_h = as selected locally.

NOTES

1 All LOCK commands issued in any absolute mode require predefined PREROLL DURATION, REQUIRED OFFSET, and LOCK TIME I/Fs and should be preceded by a LOCK PREROLL SEARCH command.

2 All LOCK commands issued in any free mode ignore any predefined PREROLL DURATION, REQUIRED OFFSET, and LOCK TIME I/Fs and need not be preceded by a LOCK PREROLL SEARCH command.

3 If a change in LOCK MODE from any mode to the absolute mode is performed during a successful LOCK TMS, then the ACTUAL OFFSET I/F data is automatically transferred to the REQUESTED OFFSET I/F. LOCK is maintained.

4 Smooth operation in any absolute mode is ensured only if correct framing of the EXTERNAL TIME CODE to the video reference signal is ensured; i.e., the leading edge of bit 0 must begin at the start of the appropriate line of the video.

71 GLOBAL MONITOR SELECT

(AMC) Selects all audio channels to present the signal identified below to the line output.

Format: <GLOBAL MONITOR SELECT>
<MODE>

1-byte special binary code:
01_h = playback (= default)
02_h = synchronous playback
03_h = input
FF_h = as selected locally

72 EXCLUSIVE SYNC SELECT

(AMC) Selects audio channels that will, to the exclusion of any GLOBAL MONITOR SELECTion, present synchronous playback on line output in accordance with the SYNC-INPUT I/F.

Format: <EXCLUSIVE SYNC>
<CHANNELS>

8-byte bit map:
Bits 0–63 = audio channels 1–64
Logic 1 = EXCLUSIVE SYNC TRUE

Bits 0–7 form the least significant byte; this byte is transmitted last.

73 SYNC INPUT SELECT

(AMC) Selects the conditions under which line input is presented to line output for those channels selected for synchronous playback. This function affects all audio channels exclusive of the designated time code channel.

Format: <SYNC INPUT SELECT>
<MODE>

1-byte special binary code:
00_h = record only (= default)
01_h = record or nonplay
02_h = record or record-ready
FF_h = as selected locally

Record only: All channels that are set to monitor synchronous playback will monitor input when recording. Upon the conclusion of a record operation, those channels will return to synchronous playback.

Record or nonplay: All channels that are set to monitor synchronous playback will monitor input when recording. Upon the conclusion of a record operation, those channels will revert to synchronous playback. In addition, all record-ready channels will monitor input when not in PLAY TMS.

Record or record-ready: All channels that are set to monitor synchronous playback, and are set to record-ready (or not but still recording), will monitor input.

74 not used

75 not used

76 not used

77 not used

78 not used

79 not used

7A LOCAL LOCKOUT SELECT

Causes the controlled device to disable all local control.

Format: <LOCAL LOCKOUT SELECT>
<MODE>

1-byte special binary code:
00_h = *local control not disabled*
01_h = local control disabled

7B not used

7C PLAY MODE SELECT

Selects the manner in which the controlled device establishes its nominal, fixed speed forward operation as commanded by the PLAY command.

Format: <LOCL MODE SELECT>
<MODE>

1-byte special binary code:

00_h Normal (default): Achieve PLAY as defined by the CAPSTAN REFERENCE SELECT. No relationship with any time code or video reference is implied.

11_h *Free resolve mode*: Achieve PLAY *in a manner* that resolves with EXTERNAL TIME CODE in a data-independent mode and maintains this resolve in a data-independent mode. External LTC is selected as the source of EXTERNAL TIME CODE.

12_h Free video mode: Achieve PLAY in a manner that resolves to external video signal and maintains this resolve to external video reference. The source of EXTERNAL TIME CODE is undefined.

FF_h = as selected locally

5 Information fields, definitions, and syntax

40 not used

41 INTERNAL LTC

Contains the longitudinal time code value most recently read from tape.

Format: <INTERNAL LTC>
<CODE VALIDITY>

1-byte special binary code:
00_h = valid LTC
01_h = derived LTC
FF_h = not valid LTC

<TIME VALUE>

standard "time" format

42 not used

43 SELECTED TAPE CODE — Contains the time value of that code (LTC, TAPE TIMER, etc.) which has been most recently selected by the *TAPE CODE SELECT command*.

Format: <SELECTED TAPE CODE>
<IDENTIFIER> — 1-byte special binary code:
00_h = INTERNAL LTC
01_h = reserved
02_h = TAPE TIMER
03_h = reserved
FF_h = valid

<TIME VALUE> — standard "time" format

44 INTERNAL LTC USERBITS — Contains the LTC userbit contents most recently read from tape.

Format: <INTERNAL LTC USERBITS>
<UB SPECIFICATION> — 1-byte special code:
bits 0, 1:
0, 0 – content of userbits unspecified
1, 0 – content of userbits is 8-bit character set conforming to ISO/IEC 646 and ISO 2022 (ASCII)
0, 1 – unassigned
1, 1 – unassigned

bit 2:
0 – unassigned
1 – content of userbits is secondary time data in standard time format

bits 3–7:
0 – set to 0 until assigned

<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>
MSNibble LSNibble — 4 bytes, each consisting of two 4-bit nibbles, each containing one UB group

NOTE – UB 1 is the UB group which comes first on the tape. It is transmitted last in this format.

45 not used

46 TAPE TIMER — Contains the instantaneous counting status of the tape timer.

Format: <TAPE TIMER> — Modified standard "time" format:
MSB (80-position of hours) = sign;
tape timer count through zero technique must be monotonic:

| –4 | –3 | –2 | –1 | –0 | +0 | +1 | +2 | +3 | +4 |

47 not used

48 reserved

49 CAPSTAN REFERENCE TALLY — Tallies the status set by the CAPSTAN REFERENCE SELECT command.

Format: <CAPSTAN REFERENCE TALLY>
<MODE> — 1-byte special binary code:
00_h = internal crystal (= default)
01_h = external ref input

4A REHEARSE TALLY — Tallies the status set by the REHEARSE SELECT command.

Format: <REHEARSE TALLY>
<MODE> — 1-byte special binary code
00_h = rehearse true (= default)
04_h = rehearse true
05_h = record enable

4B CHANNEL RECORD STATUS — Contains a 64-bit map of the channels that are currently recording.

Format: <CHANNEL RECORD STATUS>
<CHANNELS> — 8-byte bit map:
bits 0–63 = audio channels 1–64

NOTE – Bits 0–7 form the least significant byte; this byte is transmitted last.

4C not used

4D TAPE CODE SELECTION TALLY

Tallies the code currently selected by the most recent TAPE CODE SELECT command.

Format: <TAPE CODE SELECTION TALLY>
<CODE TYPE>

1-byte special binary code:
00_h = longitudinal time code
01_h = reserved
02_h = tape timer
03_h = reserved
04_h = reserved

4E SYNC VELOCITY

Contains a velocity used as the synchronization velocity for the SYNC command.

Format: <SYNC VELOCITY>
<SPEED>

3-byte signed binary number; twos complement scale:
000000_h = stationary
010000_h = fixed speed forward
$7F0000_h$ = approximately 127 times fixed speed forward
$FF0000_h$ = fixed speed reverse
800000_h = 128 times fixed speed reverse direction

4F PREROLL DURATION

Prescribes the desired real-time preroll duration used in advance of the synchronizing processes.

For use with the LOCK command, the PREROLL DURATION specifies the exact real-time period between lock actuation time and the moment of encountering the LOCK POINT. It is assumed that EXTERNAL TIME CODE is presented to the device in a real-time manner during the PREROLL period. PREROLL DURATION may not be set to a value lower than the device-dependent lower limits.

For use with the SYNC command, the PREROLL DURATION specifies the exact real-time period between the receipt of the SYNC command and the moment of synchronization with the SYNC/LOCK POINT at the SYNC VELOCITY. It is assumed that the selected TIMELINE SOURCE is presented to the device in a real-time manner during this preroll period. PREROLL DURATION may not be set to a value lower than the device-dependent lower limits, which may change dependencies upon prescribed SYNC VELOCITY and other factors.

Format: <PREROLL DURATION>
<TIME VALUE>

Standard "time" format.

50 SYNC POINT

Contains the specified point on tape, as referenced to SELECTED TAPE CODE, at which synchronism with the selected TIMELINE SOURCE is ensured.

Format: <SYNC POINT>
<TIME VALUE>

Standard "time" format.

51 LOCK TIME

Contains the last specified point in time, as referenced to EXTERNAL TIME CODE, at which synchronism with the INTERNAL LTC is ensured. The manner in which the device maintains synchronous operation from this point on is defined by the LOCK MODE SELECT I/F.

Format: <LOCK TIME>
<TIME VALUE>

Standard "time" format.

52 not used

53 not used

54 not used

55 reserved

56 reserved

57 reserved

58 reserved

59 FIXED SPEED TALLY

Tallies the current nominal tape play speed.

Format: <FIXED SPEED TALLY>
<SPEED>

1-byte special binary code:

10_h =	1.875 ips	4.7625 cm/s
20_h =	3.750 ips	9.525 cm/s
30_h =	7.500 ips	19.05 cm/s
37_h =	9.606 ips	24.40 cm/s
40_h =	15.00 ips	38.10 cm/s
50_h =	30.00 ips	76.20 cm/s

5A TAPE LENGTH

Contains the length of the loaded tape.

Format: <TAPE LENGTH>
<TIME VALUE>

Standard "time" format.

5B not used

5C LOCK ACCURACY

Contains a time value that determines the accuracy of synchronizing processes; i.e., it specifies the maximum allowed error before negation of the "LOCK successful tally" (see TMS TALLY I/F).

Format: <LOCK ACCURACY>
<LTC BIT PERIODS>

1-byte unsigned number;

parameter range:
0 less than 1/80th frame period;
255 less than 3-15/80ths frame periods.

5D LOCK DEVIATION

Contains the time difference between the position of the controlled ATR and the external time code adjusted by the REQUESTED OFFSET. This is computed as follows: INTERNAL LTC minus REQUESTED OFFSET minus EXTERNAL TIME CODE.

Format: <LOCK DEVIATION>
<TIME VALUE>

High-resolution time format.

5E not used

5F not used

60 TMP TALLY

Tallies the current transport motion process of the ATR and specifies its success at accomplishing that process.

Format: <TMP TALLY>
<KEYWORD>

1-byte value that contains the keyword of the last active commanded TMP.

<SUCCESS LEVEL>

1-byte special binary code:
00_h = trying; transition in process
01_h = successful
02_h = failure; this tally should be supplemented by an ERROR message as appropriate.

61 TMS TALLY

Tallies the current transport motion state of the ATR, and specifies its success at accomplishing that process.

Format: <TMS TALLY>
<KEYWORD>

1-byte value that contains the keyword of the last active commanded TMS command.

<SUCCESS LEVEL>

1-byte special binary code:
00_h = trying; transition in process
01_h = successful
02_h = failure; this tally should be supplemented by an ERROR message as appropriate.

62 VELOCITY TALLY

Tallies the current transport velocity. Note that this is the true velocity in all modes.

Format: <VELOCITY TALLY>
<SPEED>

3-byte signed binary number; twos complement

Scale:
000000_h = stationary
010000_h = FIXED SPEED forward
$7F0000_h$ = approximately 127 times FIXED SPEED forward
$FF0000_h$ = FIXED SPEED reverse
800000_h = 128 times FIXED SPEED reverse direction

63 not used

64 RECORD READY TALLY

Contains a 64-bit map of the channels that are ready to record.

Format: <RECORD READY TALLY>
<CHANNELS>

8-byte bit map:

Bits 0–63 = audio channels 1–64;

Bits 0–7 form the least significant byte; this byte is transmitted last.

65 not used

66 AUTO ATTENUATE TALLY

Tallies the status of the AUTO ATTENUATE function selected by the AUTO ATTENUATE SELECT command.

Format: <AUTO ATTENUATE TALLY>
<MODE> 1-byte special binary code:
00_h = OFF
01_h = ON

67 LIFTER DEFEAT TALLY — Tallies the status selected by the TAPE LIFTER DEFEAT command.

Format: <LIFTER DEFEAT TALLY>
<MODE> 1-byte special binary code:
00_h = OFF
01_h = ON

68 reserved

69 reserved

6A reserved

6B reserved

6C reserved

6D reserved

6E reserved

6F reserved

70 LOCK MODE TALLY — Tallies the mode in which synchronism is established and maintained.

Format: <LOCK MODE TALLY>
<MODE> 1-byte special binary code:
00_h = absolute standard mode
01_h = absolute resolve mode
02_h = absolute video mode
03_h = absolute VITC mode
11_h = free resolve mode
12_h = free video mode

71 GLOBAL MONITOR TALLY — Tallies the status of the monitor channels selected by the GLOBAL MONITOR SELECT command.

Format: <GLOBAL MONITOR SELECT>
<MODE> 1-byte special binary code:
01_h = playback
02_h = synchronous playback
03_h = input

72 EXCLUSIVE SYNC TALLY — Tallies the status of the audio channels defined by the EXCLUSIVE SYNC SELECT command.

Format: <EXCLUSIVE SYNC TALLY>
<CHANNELS> 8-byte bit map:
Bits 0–63 = audio channels 1–64

NOTE – Bits 0–7 form the least significant byte; this byte is transmitted last.

73 SYNC INPUT TALLY — Tallies the conditions selected by the SYNC INPUT SELECT command.

Format: <SYNC INPUT TALLY>
<MODE> 1-byte special binary code:
00_h = record (= default)
01_h = record or nonplay
02_h = record or record-ready

74 EXTERNAL TIME CODE — Contains the time code value most recently read from an external time code source.

Format: <INTERNAL LTC>
<CODE VALIDITY> 1-byte special binary code:
00_h = valid TC
FF_h = not valid TC

<TIME VALUE> Standard "time" format.

75 EXTERNAL USERBITS — Contains the userbit contents most recently read from an external time code source.

Format: <USERBITS> — For format description, see INTERNAL LTC USERBITS.
<UB SPECIFICATION>
<UB GROUP 8/UB GROUP 7>
<UB GROUP 6/UB GROUP 5>
<UB GROUP 4/UB GROUP 3>
<UB GROUP 2/UB GROUP 1>

SLEW RATE — Contains the maximum rate at which the position of the controlled machine may be changed during an attempt to reestablish synchronism following a loss of same.

Format: <SLEW RATE>
<RATE> — 2-byte unsigned binary number

Scale:
0000_h = no slew
0001_h = 1/10 frame/second
$FFFF_h$ = maximum device dependent

77 REQUESTED OFFSET — Contains the desired time offset between the external time code and the internal tape time code for use with LOCK and CHASE commands.

Format: <REQUESTED OFFSET>
<OFFSET TIME> — High-resolution time code.

Definition: offset = internal minus external; e.g., if controlled device is to lead external reference by one minute, then: <OFFSET TIME> = <00 01 00 00.00 00>.

78 ACTUAL OFFSET — Contains the actual time offset between the external time code and the internal tape time code.

Format: <ACTUAL OFFSET>
<OFFSET TIME> — High-resolution time code.

Definition: offset = internal minus external; e.g., if controlled device is to lead external reference by one minute, then: <OFFSET TIME> = <00 01 00 00.00 00>.

79 STRIDE LENGTH — Contains the period of each unit in terms of LTC bits for the STEP TMS argument.

Format: <STRIDE PERIOD>
<NUMBER LTC BITS> — 1-byte unsigned binary number

7A LOCAL LOCKOUT TALLY — Tallies the status of the local control capability of the controlled device.

Format: <LOCAL LOCKOUT TALLY>
<MODE> — 1-byte special binary code:
00_h = local control not disabled
01_h = local control disabled

7B TIME CODE ATTRIBUTE — Contains the attributes of the time codes presented to the controlled device.

Format: <TIME CODE ATTRIBUTE>
<TAPE TIME CODE> — Special binary code.
<EXTERNAL TIME CODE> — Special binary code.

00_h = 24-frame count code
01_h = 25-frame count code
02_h = 30-frame count code
12_h = 30-frame count code compensated

7C PLAY MODE TALLY — Tallies the manner in which the controlled device is selected to establish its nominal, fixed speed forward operation, as commanded by the PLAY command.

Format: <LOCK MODE TALLY>
<MODE> — 1-byte special binary code:
00_h = normal (default)
11_h = free resolve mode
12_h = free video mode

Annex A (informative)
General concepts

The following text contains a general explanation of some of the concepts used in the formulation of the ATR type-specific message set. It constitutes tutorial information and is intended to assist in the understanding of the specification in previous portions of this practice. A working knowledge of the following ESbus topics is assumed:

- ESbus system overview
- Control message architecture
- Supervisory protocol
- Tributary interconnection
- Electrical and mechanical characteristics
- System service and common messages

The ATR type-specific dialect shares many conceptual constructs with the VTR type-specific dialect. However, there are significant differences between the form and function of their command structures. The reader is cautioned not to assume that a transparency of control messages between the dialects has been provided.

Conventions: Acronyms and abbreviations are shown in uppercase characters; e.g, audio tape recorder – ATR; tape motion state – TMS; information field – I/F.

Message keywords and names of information fields are shown in uppercase characters; e.g., RECORD STROBE; REQUESTED OFFSET.

These command keywords and information field names are used within the text of this document to imply requested action, information field identity, and, in turn, the information field contents of the virtual machine. To assist in readability of this document, these terms are used in the context of the presentation material; e.g.:

"There are six modes available for LOCK MODE SELECTion" [LOCK MODE SELECT is a keyword].

"This point in time is defined by the specification of the LOCK TIME I/F" [LOCK TIME I/F in this context implies the identity of an information field].

"The ACTUAL OFFSET is maintained independent of the synchronization status [ACTUAL OFFSET in this context refers to the content of an information field].

Terms with special meaning to this or related documents are shown with leading uppercase characters; e.g., Tape Motion Process; Local Lock Point.

A.1 Command keywords and information fields

ATR-specific commands affect conditions or selection of characteristics particular to the Virtual ATR Machine. Commands which direct nonmutually exclusive conditions have corresponding Information Fields. When this Information Field is tallied, the response is in the same format as that of its respective command. Commands which direct mutually exclusive conditions may share a common Information Field.

A.2 Transport motion process and state control

The transport mechanism of an ATR is considered as a separate State Machine. The commands which control transport functions are subsets within the ATR-specific message set. These are called Tape Motion Process and State commands (TMPs and TMSs). Each TMS command causes a transition into a transport state and cancels the previous state. Tape Motion Processes (indicated below as "TMP") are overriding control commands that cause the controlled device to automatically choose its own Tape Motion States to achieve the desired result. The Tape Motion State will be reflected in the TMS tally, as though that TMS had been issued.

TMP commands include: TARGET SEARCH, PREROLL SEARCH, CHASE, etc. All Tape Motion Process commands are marked "TMP" in the index list and in the command description.

TMS commands include: STOP, PLAY, SHUTTLE, LOCK, etc. All Tape Motion State commands are marked "TMS" in the index list and in the command description.

A.2.1 TMP I/F tallies

This Information Field indicates the current Tape Motion Process. As these mutually exclusive Pocesses are commanded by TMP commands, the code of the corresponding TMP keyword is used to identify them individually. An additional byte tallies the level of success; i.e., whether the commanded Process is still in progress or has already accomplished its respective goal, successfully or not.

A.2.2 TMS I/F tallies

This Information Field indicates the current State of the transport. As these mutually exclusive States are commanded by TMS commands, the code of the corresponding TMS keyword is used to identify them individually. An additional byte tallies the level of success; i.e., whether the commanded State function is still in transition or has been achieved, successfully or not.

A.3 Audio record commands (ARCs) and tallies

The recording function of the tape machine is controlled and tallied by the following Keywords and I/Fs, respectively:

REHEARSE SELECT	REHEARSE TALLY
RECORD STROBE	RECORD TALLY
RECORD EXIT	——
RECORD READY SELECT	RECORD READY TALLY

RECORD READY SELECT provides a means to identify tracks that when set will enter, and when cleared will exit a recording condition upon the receipt of a RECORD STROBE.

RECORD EXIT causes all recording tracks to exit from a recording condition.

REHEARSE SELECT provides a means of specifying that all tracks, when subsequently commanded to enter a recording condition, will mimic a record operation in regard to their respective pending Audio Monitor Commands (AMCs).

A.4 Audio monitor commands (AMCs) and tallies

The manner in which the Audio Line Output Source selections are made is controlled and tallied by the following Keywords and I/Fs, respectively:

GLOBAL MONITOR SELECT	GLOBAL MONITOR TALLY
EXCLUSIVE SYNC SELECT	EXCLUSIVE SYNC TALLY
SYNC INPUT SELECT	SYNC INPUT TALLY

GLOBAL MONITOR SELECT causes all audio channels to present either Playback, Synchronous Playback (sync), or Input signals to their respective Line Outputs of all audio channels.

EXCLUSIVE SYNC SELECT provides a means to select individual audio channels that will, to the exclusion of any GLOBAL MONITOR SELECTion, present synchronous playback on Line Output in accordance with the SYNC-INPUT I/F.

SYNC INPUT SELECT provides a means to choose the monitor switching methods used during record-related functions. These monitor switching functions are restricted to those channels selected for Synchronous Playback.

A.5 Velocity arguments

Some commands require a speed specification which is carried by a command in the form of a three-byte parameter. This parameter is intended to define direction and absolute value of the desired speed that should be achieved as closely as possible by the real machine. This speed is referenced in terms of the standard play speed as defined by the FIXED SPEED SELECT I/F.

All commands with a velocity parameter use the same format and coding. This is a three-byte, two's complement, signed number with a scale range defined such that:

000000_h represents a stopped condition;

010000_h represents the speed currently defined in I/F FIXED SPEED, forward direction;

$7F0000_h$ represents approximately 127 times FIXED SPEED forward;

$FF0000_h$ represents FIXED SPEED reverse;

800000_h represents 128 times FIXED SPEED reverse direction.

It allows theoretically for a resolution of 1/65,536th of standard speed. This represents an effective speed argument range from –128.00000 to +127.99998 times standard speed (rounded to five significant digits).

A.6 Track selection arguments

Some commands and Information Fields refer to one or more tracks (or channels) of the tape machine. The format used is the same in all cases and is defined as an 8-byte bit map. This allows for up to 64 tracks to be controlled. The command Keywords and I/Fs that utilize this track specific mapping are:

REHEARSE SELECT	REHEARSE TALLY
RECORD READY SELLECT	RECORD READY TALLY
EXCLUSIVE SYNC SELECT	EXCLUSIVE SYNC TALLY
	RECORD TALLY

A.7 Tape code identity

There are currently two means of referencing tape location:

– INTERNAL LTC (longitudinal time code from tape)
– TAPE TIMER

There are separate Information Fields for both the INTERNAL LTC and the TAPE TIMER. The contents of the selected TAPE CODE I/F, however, is chosen by the TAPE CODE SELECT command.

TARGET SEARCH, SYNC PREROLL SEARCH, and LOCK PREROLL SEARCH cause the Controlled Device to locate a position on the tape, referenced to the SELECTED TAPE CODE.

A.8 Achieving and maintaining synchronization

A.8.1 LOCK operations

Synchronization requires the Controlled Device to maintain a particular time relationship between its INTERNAL LTC and some External Reference. In ATRs, this relationship is usually restricted to a speed range around the nominal FIXED SPEED.

The External Reference to which synchronization is achieved and maintained may be selected from a number of alternative sources. This is done with the LOCK MODE SELECT command.

The LOCK command enables the process of synchronization. While there are facilities associated with the LOCK command that can provide for synchronization with no specification setup, the performance-critical methods of using the LOCK command require:

– a specified EXTERNAL TIME CODE ("when");
– a specified point on the tape ("where");
– a selected External Reference ("how").

When: This point in time is defined by the specification of the LOCK TIME I/F. This refers to a time, defined by the EXTERNAL TIME CODE, at which synchronism is assured between the EXTERNAL TIME CODE and the Controlled Device's INTERNAL LTC.

Where: This is a point on the tape called the "Local Lock Point." The Local Lock Point may be characterized by two independent specifications. These are the aforementioned LOCK TIME I/F and the REQUESTED OFFSET I/F.

The REQUESTED OFFSET I/F specifies the longitudinal time relationship between the EXTERNAL TIME CODE and the Controlled Device's INTERNAL LTC. This REQUESTED OFFSET is maintained during successful synchronous operation.

NOTE – A related Information Field, the ACTUAL OFFSET I/F, is provided so that tallies of INTERNAL LTC minus the EXTERNAL TIME CODE may be facilitated.

The Local Lock Point may be calculated as the sum of the LOCK TIME I/F and the REQUESTED OFFSET I/F.

A.8.2 LOCK modes ("How")

The LOCK MODE SELECT command allows a choice in the manner in which synchronization is achieved and maintained. Two different classes of synchronization may be selected: "absolute" and "free." There are four Absolute modes and two Free modes available for LOCK MODE SELECTion.

A.8.2.1 Absolute modes of LOCK

Absolute standard mode: Achieve lock to EXTERNAL TIME CODE data in dependent mode, maintain lock in data-dependent mode. External LTC is selected as the source of EXTERNAL TIME CODE.

Absolute resolve mode: Achieve lock to EXTERNAL TIME CODE in data dependent mode, maintain lock in data-independent mode. External LTC is selected as the source of EXTERNAL TIME CODE.

Absolute video mode: Achieve lock to EXTERNAL TIME CODE in data-dependent mode, maintain lock to the External video reference. External LTC is selected as the source of EXTERNAL TIME CODE.

Absolute VITC mode: Achieve lock to External video with VITC, in data-dependent mode, maintain lock to the External video reference. The External video VITC signal is selected as the source of EXTERNAL TIME CODE.

A.8.2.2 Free modes of LOCK

Free resolve mode: Achieve lock to EXTERNAL TIME CODE in data-independent mode, maintain lock in data-dependent mode. External LTC is selected as the source of EXTERNAL TIME CODE.

Free video mode: Achieve lock to External video signal, maintain lock to the External video reference. The source of EXTERNAL TIME CODE is undefined.

A.8.3 LOCK operation in absolute modes

Three important concepts must be established before any of the Absolute modes of LOCK may be represented:

PREROLL DURATION: Contains the time used or needed in advance of achieving synchronization. The PREROLL DURATION I/F specifies the exact real-time period between the start of tape movement and the moment of encountering the specified LOCK TIME. It is assumed that EXTERNAL TIME CODE is presented to the device in a real-time manner during the Preroll Duration. The PREROLL DURATION I/F may not be set to a value lower than the device-dependent lower limits.

LOCK PREROLL SEARCH: This TMP causes the controlled ATR to move to a tape position specified by the Local Lock Point minus the predefined PREROLL DURATION plus any device specific "Acceleration Allowance" (see figure A.1). This position may be described as the PREROLL SEARCH Point.

"Lock Actuation": In all Absolute modes of the LOCK command, the condition which causes the start of tape movement to achieve and maintain synchronization is always the receipt of EXTERNAL TIME CODE of a value equal to the predefined LOCK TIME I/F minus the predefined PREROLL DURATION I/F. The time (referenced to EXTERNAL TIME CODE) at which this occurs may be termed the Lock Actuation Time.

The source of the EXTERNAL TIME CODE that triggers the Lock Actuation may be either LTC or VITC. This choice is specified by the LOCK MODE SELECT.

All LOCK commands issued in any Absolute mode require predefined PREROLL DURATION, REQUESTED OFFSET, and LOCK TIME I/Fs, and must be preceded with a LOCK PREROLL SEARCH command.

After establishing a PREROLL DURATION, DESIRED OFFSET, and commanding a LOCK PREROLL SEARCH, a LOCK command of the ABSOLUTE class may be issued. When the EXTERNAL TIME CODE equals the Lock Actuation Time, the Controlled Device will accelerate and synchronize its INTERNAL LTC with the EXTERNAL TIME CODE. For a LOCK to be successful, synchronism must be achieved prior to the LOCK TIME. Synchronous operation will be maintained from the LOCK TIME on, with the LOCK MODE SELECT I/F specified External Reference.

A.8.4 LOCK operation in FREE modes

All LOCK commands issued in any Free mode ignore any predefined PREROLL DURATION, REQUESTED OFFSET, and LOCK TIME I/Fs and need not be preceded with a PREROLL SEARCH command. These LOCK facilities provide the means to synchronize immediately without an absolute reference to EXTERNAL TIME CODE.

If a change in LOCK MODE from any mode to the Absolute Standard Mode is performed during a successful LOCK TMC, then the ACTUAL OFFSET I/F data is automatically transferred to the REQUESTED OFFSET I/F.

A.8.5 SYNC operations

The External Reference to which SYNC synchronization is achieved and maintained is prescribed by the TIMELINE SELECT common message. The SYNC command actuates the process of synchronization. To do this, the SYNC command requires:

- a specified instant in time ("when");
- a specified point on the tape ("where");
- a specified velocity ("how").

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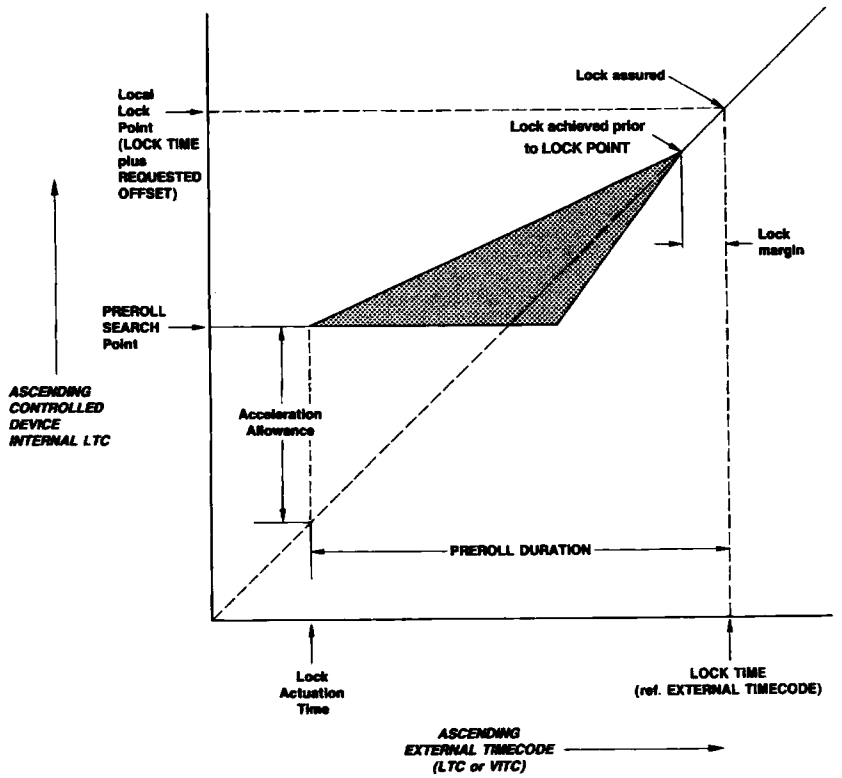


Figure A.1 – Lock operation diagram (absolute modes)

When: This is a specified instant in time defined as the PREROLL DURATION after the receipt of the SYNC command. As the ESbus by nature may not be deterministic in the delivery timing of commands, it is advisable to use the Common Message Event construct to define the actuation timing of this command.

Where: This point in time is defined by the specification of the SYNC POINT I/F. This refers to a tape position, relative to the SELECTED TAPE CODE, at which synchronism is ensured between the selected TIMELINE and the Controlled Device's SELECTED TAPE CODE.

How: The speed at the LOCK POINT is defined by the SYNC VELOCITY I/F. The SYNC command requires that the Controlled device be parked at a position such that the Controlled device will accelerate from its PREROLL SEARCH Point to the SYNC POINT at the prescribed SYNC VELOCITY during a precisely prescribed PREROLL DURATION.

If the Controlled device were to be "Ideal," it would have no latency in response to the SYNC command, and would have an infinite acceleration capability from its PREROLL SEARCH Point. Given an "Ideal" Controlled device, this PREROLL SEARCH Point would be characterized as follows:

"Ideal" PREROLL SEARCH Point =

$$\text{SYNC POINT} - \frac{\text{PREROLL DURATION} \times \text{SYNC VELOCITY}}{\text{STANDARD VELOCITY}}$$

As "Ideal" performance is unlikely in the real world, the Controlled Device would be required to park at a "Real" PREROLL SEARCH Point, which would be some distance in advance of the "Ideal" PREROLL SEARCH Point. The magnitude of this advance may be termed the "Acceleration Allowance." This "Acceleration Allowance" would most likely be proportional to the SYNC VELOCITY (see figure A.2).

After establishing a PREROLL DURATION and commanding a SYNC PREROLL SEARCH, a SYNC command may be issued. The Controlled Device will accelerate and synchronize its SELECTED TAPE CODE to the TIMELINE reference.

For a SYNC to be successful, SYNC VELOCITY must be achieved relative to the TIMELINE reference, at the SYNC POINT precisely the PREROLL DURATION after the receipt of the SYNC command.

A.8.6 CHASE command

An alternative means for maintaining synchronism. While the PREROLL SEARCH and LOCK commands may be used to run several machines in synchronism continuously (without changing their states and/or speed), the CHASE command is used to maintain synchronism during changes of the machine's state and/or velocity in a dynamic manner.

This operation, however, requires one of the synchronously running machines to be a "Master," while the others have to act as "slaves," which follow the movement of the Master, even in SHUTTLE.

For this purpose, the slaves must have information about the movement of the Master. This information is distributed as the Master Device's Time Code. This Time Code stream would be continuously distributed to all Slaves over a separate line. (The ESbus cannot be used for this purpose due to its nondeterministic delay characteristics.)

The CHASE command utilizes the REQUESTED OFFSET I/F to establish any required longitudinal position relationships between the Master and the Controlled Device. Synchronism is always established and maintained in a data dependent manner, independently of the current LOCK MODE TALLY I/F.

A.9 TIMELINE and other EVENT triggers

All ATR commands can be used in an "Immediate" manner in which their receipt causes their execution. As the timely transfer of traffic over the ESbus may not be deterministic, some of the more time-critical applications may not occur in an acceptable manner. In these cases, an Immediate command method would not be recommended.

Wherever possible, therefore, time-critical commands should be prepared using the EVENT command facilities provided by the Common Message Set. The DEFINE EVENT Common Message allows any Type-Specific Keyword or the Common Message READ to be executed by the Virtual Machine at a specified Trigger Time. This Trigger Time may be the Common TIMELINE I/F, or a Type-Specific Time I/F.

It should be noted that the temporal order of EVENTS should be preserved. Commands actuated by the EVENT construct that are placed on the EVENT cue at the same trigger point will execute as requested, preserving the temporal order of the delivery of the commands. The ATR Type-Specific Time I/Fs that may be used as EVENT Triggers are: INTERNAL LTC, SELECTED TAPE CODE, TAPE TIMER, and EXTERNAL TIME CODE. ATR Type-Specific Time I/Fs that are not permitted for use as EVENT Triggers are: TAPE LENGTH, LOCK DEVIATION, REQUESTED OFFSET, and ACTUAL OFFSET.

The Common Message TIMELINE SOURCE may be selected to be an internal clock or an External Reference Time. There is no restriction as to the source of this External Reference Time. Should the External Reference Time be chosen as the intended TIMELINE SOURCE, it might be conceivable to locally configure a Controlled Device to use an External LTC signal or an External video signal with the VITC signal as the TIMELINE TIME. Alternatively, when the Internal Clock is the intended TIMELINE SOURCE, the External "tick" which increments the Internal Clock, might be locally configured to be the sync-word of an External LTC signal or an External video signal.

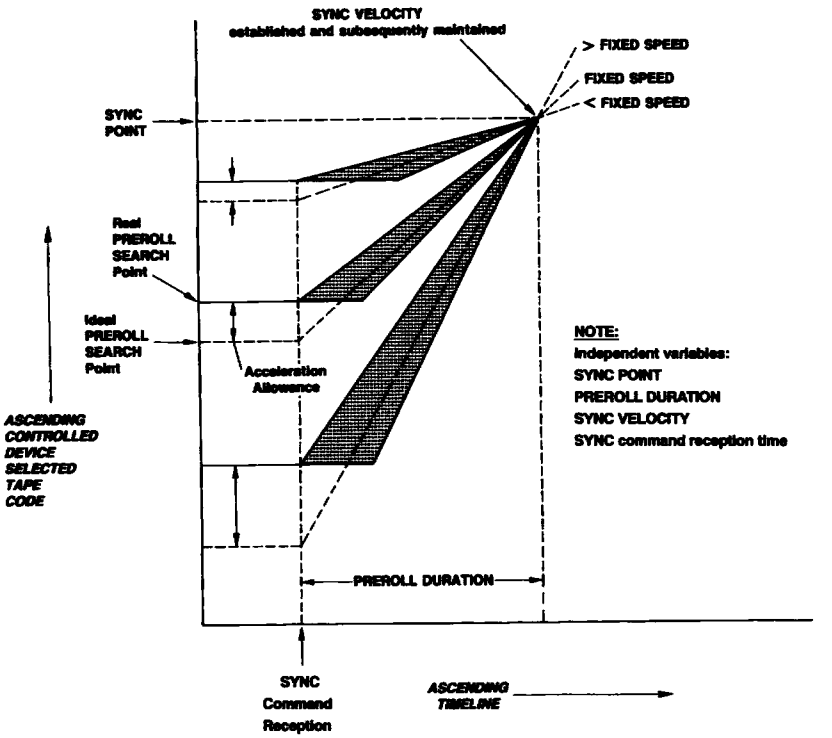


Figure A.2 – Sync operation diagram

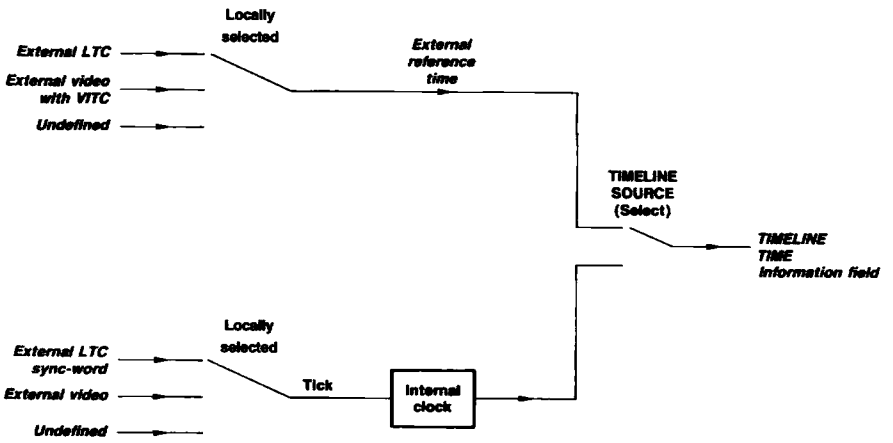


Figure A.3 – Selections of TIMELINE source

Activities requiring simultaneous operations between several Controlled Devices may be best suited to the EVENT mode of command delivery, which allows for the pre-programming of sequences of time-critical functions (e.g., RECORD STROBE).

EVENTS may refer to the TIMELINE of the individual virtual machines. These individual TIMELINE TIMEs are synchronized by a System Time transmission from the Bus Controller in response to the System Service REQUEST TIME TRANSMISSION command.

A.10 Sample command sequences

The following sections show samples of typical command sequences including time deferred EVENT constructs. These sequences describe only some of the applications of the command set. There is no obligation on the part of system designers to use precisely these sequences. READ commands of the related I/Fs for system confidence are not shown and should be an integral part of any reasonable Controlling Tributary's typical sequence.

A.10.1 Selective record entries and exits

Some time before initial record action:

<RECORD READY SELECT>
<00000000> (64-bit map)
<00000000>
<00000000>
<00000000>
<00000000>
<00000000>
<00000000>
<00000000>
<01010101>
(tracks 1,3,5,7 are record-enabled)
<PLAY>

Some time later:

<RECORD STROBE>
(above selected tracks enter recording condition)

Some time later:

<RECORD READY SELECT>
<00000000> (64-bit map)
|
<10101010>
(tracks 1,3,5,7 are record-disabled; tracks 2,4,6,8 are record-enabled; no change is made to the recording status of these tracks)

Some time later:

<RECORD STROBE>
(tracks 1,3,5,7 exit record; tracks 2,4,6,8 enter record)

Some time later:

<RECORD EXIT>
(the remaining record tracks 2,4,6,8 exit record)

A.10.2 EVENT-triggered record entries and exits

Exactly the same actions as above may be accomplished through the use of the EVENT construct, albeit with more precise control of the RECORD STROBE times:

<RECORD READY SELECT>
<00000000> (64-bit map)
|
<01010101>
(tracks 1,3,5,7 are record-enabled)
<PLAY>

Any time before the required record action sequence:

<DEFINE EVENT>
<event name #1> (user assigned)
<INTERNAL LTC> (I/F name of trigger)
<TRIGGER VALUE #1> (standard "time" value)
<RECORD STROBE>

<DEFINE EVENT>
<event name #2> (user assigned)
<INTERNAL LTC> (I/F name of trigger)
<TRIGGER VALUE #2> (standard "time" value)
<RECORD READY SELECT> <00000000>
|
<01010101>
(tracks 2,4,6,8 are record-enabled)

<DEFINE EVENT>
<event name #3> (user assigned)
<INTERNAL LTC> (I/F name of trigger)
<TRIGGER VALUE #3> (standard "time" value)
<RECORD STROBE>

<DEFINE EVENT>
<event name #4> (user assigned)
<INTERNAL LTC> (I/F name of trigger)
<TRIGGER VALUE #4> (standard "time" value)
<RECORD EXIT>

NOTES
1 The above TRIGGER VALUEs 1–4 are assigned with suitable ascending values respectively. These EVENTS are established with the assumption that the Controlled Device will encounter these INTERNAL LTC Triggers in ascending order.
2 The controlling virtual machine need not "know" the Device Specific record initiation delays of the ATRs. It is the job of the Virtual Machine to resolve any internal, time dependent idiosyncrasies.

Example: An IEC center-track format ATR is required to simultaneously enter record on track #1 and exit record on track #2 at an INTERNAL LTC of 12:26:00:02. The TIME CODE ATTRIBUTE I/F of the INTERNAL LTC indicates "30-frame count code compensated."

Given an INTERNAL LTC I/F Triggered RECORD STROBE EVENT, and working with an SMPTE Compensated (drop frame) Time Code, the machine must:

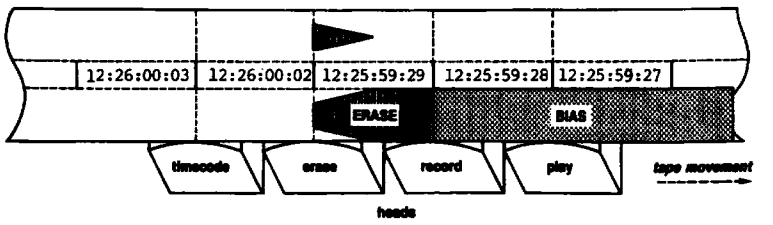
– anticipate the two missing frame codes in the INTERNAL LTC;

– compensate for any longitudinal offsets of the Controlled Device's Time Code Playback head;

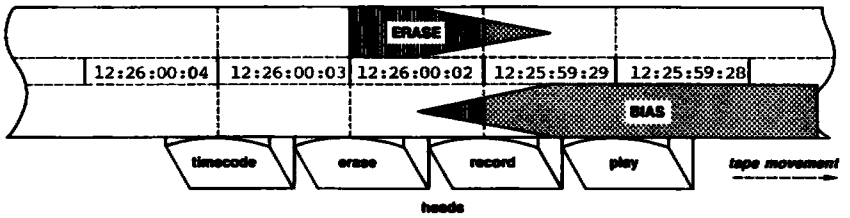
– transition the erase signal in advance of the Virtual Machine's INTERNAL LTC Trigger point to ensure that the erase signal starts and stops its process at the correct point on the tape.

Graphically represented:

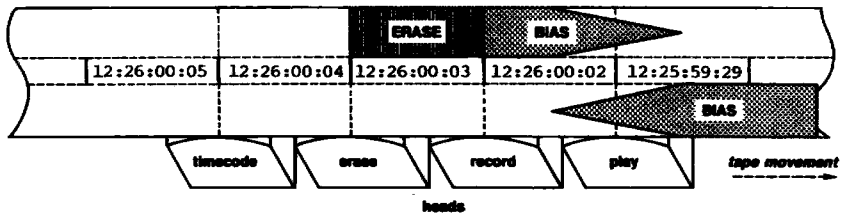
EVENT Time	<VIRTUAL MACHINE INTERNAL LTC>
minus one	< 12:25:59:29 >
frame	< the RECORD sequence begins >
	< tk #1 Erase begins ramp up >
	< tk #2 Erase begins ramp down >



EVENT Time <VIRTUAL MACHINE INTERNAL LTC>
< 12:26:00:02 >
< RECORD sequence in process >
< tk #1 Record begins ramp up >
< tk #2 Erase exit completed >



EVENT Time plus one frame <VIRTUAL MACHINE INTERNAL LTC>
< 12:26:00:03 >
< RECORD sequence completed >



If the above example were to consider a TIMELINE TIME I/F or EXTERNAL TIME CODE I/F triggered RECORD STROBE EVENT, the requirements of the Virtual Machine would be basically unchanged. The record EVENT must occur at the EVENT time, regardless of any Device-dependent precursive process.

Search and synchronize:

Some time before required synchronization action:

<PRESET> <PREROLL DURATION> (time value)
<PRESET> <LOCK POINT> (time value)
<PRESET> <REQUIRED OFFSET> (high resolution time value)
<LOCK MODE SELECT> <ABSOLUTE STANDARD MODE>

NOTE – The PREROLL DURATION, LOCK POINT, REQUIRED OFFSET, and LOCK MODE SELECT, once chosen, need not be reloaded until a change is required.

<LOCK PREROLL SEARCH>

(Not earlier than when a TMP TALLY has indicated that the LOCK PREROLL SEARCH has been successfully accomplished.)

<LOCK>

On receipt of the LOCK command, the ATR will monitor the Longitudinal EXTERNAL TIME CODE. When the EXTERNAL TIME CODE equals the Controlled Device calculated "Lock Actuation Time," the Controlled Device will accelerate and synchronize its INTERNAL LTC with the EXTERNAL TIME CODE. For a LOCK to be successful, synchronism must be achieved prior to the LOCK TIME.

Annex B (informative)
Bibliography

ANSI/SMPTE 207M-1992, Television — Digital Control Interface — Electrical and Mechanical Characteristics

SMPTE RP 113-1992, Supervisory Protocol for Digital Control Interface

SMPTE RP 138-1992, Control Message Architecture

SMPTE RP 139-1992, Tributary Interconnection

SMPTE RP 163-1992, Television — System Service Messages

SMPTE RP 170-1993, Video Tape Recorder Type-Specific Messages for Digital Control Interface

SMPTE RP 172-1993, Common Messages for Digital Control Interface

ISO/IEC 646:1991, Information Technology — ISO 7-Bit Coded Character Set for Information Interchange

ISO 2022:1986, Information Processing — ISO 7-Bit and 8-Bit Coded Character Sets — Code Extension Techniques

SMPTE RECOMMENDED PRACTICE

RP 172-1993

Common Messages for Digital Control Interface

1 Scope

This practice details and defines the control message subset common messages. Common messages are used to perform certain functions common to all equipment types within a general-purpose communications channel of an interface system. This interface system shall transport data and digital control signals between equipment utilized in the production, post-production, and/or transmission of visual and aural information.

2 Notation

This practice describes the coding of keywords and information fields (I/F) in the form as shown below. The coding "NN" represents the assigned keyword or I/F code, in hexadecimal form.

NN	KEYWORD or I/F NAME	Keyword or I/F descriptive text
	Format:	<COMMAND>
		<PARAMETER NAME 0> [Parameter description;
		... Parameter value coding, scale or range;
		<PARAMETER NAME n> Parameter definitions and explanations.]

In the practices listed in annex B, keywords are listed numerically, in hexadecimal notation. Keyword numbers are reserved as follows:

Keywords $00_h - 1F_h$: System service subset;
Keywords $20_h - 3F_h$: Common message subset;
Keywords $40_h - FF_h$: Virtual machine type-specific subset.

Approved July 1, 1993

3 Summary of keywords, mnemonics and information field (I/F) names

Hex	Keyword	(Mnemonic)	Hex	I/F name	(Mnemonic)
20	CNOP	(CNOP)	20		
21	CRESET	(CRST)	21	VIRTUAL MACHINE TYPE	(VTYP)
22	READ	(READ)	22	EQUIPMENT TYPE	(ETYP)
23	I/F ITEM RESPONSE	(IFRE)	23	TIME STANDARD	(TIME)
24	TIMELINE SOURCE	(TSCE)	24	TIMELINE TIME	(TTIM)
25	STARTUP RESPONSE	(STRE)	25	HIGH-RES TIMELINE TIME	(HTIM)
26	EXECUTE PROCEDURE	(EXPR)	26	EVENT BUFFER STATUS	(EBST)
27	DEFINE EVENT	(DEEV)	27	VIRTUAL MACHINE STATUS	(VMST)
28	CLEAR EVENT	(CLEV)	28		
29	ERROR	(CERR)	29	FAULT STATUS	(FTST)
2A			2A		
2B			2B		
2C			2C		
2D	FAILURE	(FAIL)	2D		
2E			2E		
2F	TIMELINE STOP	(TSTP)	2F		
30	TIMELINE RUN	(TRUN)	30		
3E	USER DEFINED	(UDEF)	3E	USER DEFINED	(UDND)
3F	EXTENSION	(CEXT)	3F	EXTENSION	(CIEX)

NOTE – The ability to perform command 29_h (ERROR) is mandatory for every virtual machine.

EXTENSION SET

Hex	Keyword	(Mnemonic)
00		
01		
02		
03	FUNCTION POLL	(FNPL)
04	FUNCTION RESPONSE	(FNRE)
05	FIELD POLL	(FDPL)
06	FIELD RESPONSE	(FDRE)
07	UPDATE	(UDAT)
08	CYCLE	(CYCL)
09	MUTE	(MUTE)
0A	SIMULTANEOUS READ	(SIRD)
0B	DEFINE PROCEDURE	(DEPR)
0C	DELETE PROCEDURE	(DLPR)
0D	RECALL PROCEDURE	(REPR)
0E	PROCEDURE RESPONSE	(PRRE)
0F	RECALL EVENT	(REEV)
10	EVENT RESPONSE	(EVRE)
11	SIMULTANEOUS READ RESPONSE	(SRDR)
FF	EXTENSION	(EXEX)

4 Keywords

Hex Keyword

20 CNOP — Virtual machine no operation.

Format: <CNOP>

21 CRESET — Directs the destination virtual machine to assume standard values of all preselectable functions. (Same status as power up).

Format: <CRESET>

22 READ — Directs the virtual machine to transmit the instantaneous content of the specified information field.

Format: <READ>
<I/F NAME>

NOTE – Several <I/F NAMES> may be wrapped in a BEGIN/END construct.

23 I/F ITEM RESPONSE — Response to READ, UPDATE, or CYCLE commands.

Format: <I/F ITEM RESPONSE>
<I/F NAME>
<I/F VALUE> (Length varies according to the I/F NAME)

NOTE – Several <I/F NAME> AND <I/F VALUE> pairs may be wrapped in a BEGIN/END construct.

24 TIMELINE SOURCE — Directs the virtual machine to select the source of the timeline.

Format: <TIMELINE SOURCE>
<SOURCE IDENT>

00_h INTERNAL – Internal clock incremented by an unspecified source ("tick")

01_h EXTERNAL – External reference time

25 STARTUP RESPONSE — Indicates that the controlled device has been started up.

Format: <STARTUP RESPONSE>
<MODE>

1-byte special binary number:
00_h = coldstart
01_h = warmstart

NOTES
1 This response is generated automatically whenever the controlled device is powered up.
2 "Coldstart" means that all internal stores are cleared; all functions are set to their default conditions.

26 EXECUTE PROCEDURE — Directs the virtual machine to execute immediately the procedure name.

Format: <EXECUTE PROCEDURE>
<PROCEDURE NAME> NAME is in the range 01_h to FF_h. 00_h is reserved.

27 DEFINE EVENT — Prepares an event; i.e., a function which shall be executed at the instant of coincidence of a specified trigger time with the content of a specified I/F time.

Format: <DEFINE EVENT>
<EVENT NAME> 8-bits
<I/F NAME OF TRIGGER SOURCE>
<TRIGGER VALUE>
<COMMAND> Specifies the function.

NOTES
1 In order to implement a procedure in an event, EXECUTE PROCEDURE shall be used for the COMMAND, and the procedure shall have been predefined.
2 The TRIGGER SOURCE I/F NAME is a TIMELINE or a type-specific time information field.
3 All functions contained within a procedure defined as an event must be executed by the virtual machine at the trigger time specified by the event.
4 The virtual machine shall clear an event on execution.
5 The EVENT NAME is unique for each event.
6 Where mutually exclusive commands are given inadvertently at the same time through the use of events constructs, such events shall be cleared by the virtual machine and an error message returned.

28 CLEAR EVENT — Clears one or all events previously established.

Format: <CLEAR EVENT>
<EVENT NAME> ($<00_h>$ is all events)

29 ERROR — Advises the controlled virtual machine that the previous string has not been understood by or cannot be performed by the controlled virtual machine.

Format: <ERROR>
<EXEC CODE> 8-bits:
00 = Parse error.
01 = Cannot do by design.
02 = Insufficiently equipped.
03 = Buffer overflow.
04 = Invalid keyword.
05 = Invalid keyword argument.
FE = See FAULT STATUS information field for more information.
FF = Unspecified
<BYTE COUNT> 8-bits, not including the byte count.
<OFFENDING STRING> Truncated not to exceed an overall ERROR message length of 256 bytes.

2D FAILURE

Warns of a catastrophic failure of the specific machine; i.e., a failure which requires intervention by the local operator.

Format: <FAILURE>

2F TIMELINE STOP

If the timeline is internal, stops the timeline from incrementing.

Format: <TIMELINE STOP>

30 TIMELINE RUN

If the timeline is internal, starts the timeline incrementing from the time indicated.

Format: <TIMELINE RUN>
<TIMELINE VALUE> (type TIME)

3E USER DEFINED

Identifies USER DEFINED commands.

Format: <USER DEFINED>
<BYTE COUNT> 16-bit binary unsigned number. Specifies the length of the command, in bytes, not including the byte count itself.
<RAW DATA> (Length varies according to the byte count.)

3F EXTENSION

Directs the virtual machine to enter the common message extension set for the following single command only. The virtual machine shall then resume execution of the basic command set.

Format: <EXTENSION>
<EXTENSION SET COMMAND> (1 or more bytes)

EXTENSION SET

00
01
02
} RESERVED

03 FUNCTION POLL

Directs the virtual machine to indicate which of the keywords contained in the command set are supported by its type-specific machine. BEGIN and END are excluded from the keywords. The existence of the function poll command assumes the existence of the BEGIN/END construct.

Format: <FUNCTION POLL>
<BEGIN>
<KEYWORD 1>
<KEYWORD 2>
<KEYWORD ...>
<END>

04 FUNCTION RESPONSE

Contains the list of supported keywords in response to a FUNCTION POLL command.

Format: <FUNCTION RESPONSE>
<BEGIN>
<KEYWORD 1>
<KEYWORD 2>
<KEYWORD ...>
<END>

05 FIELD POLL

Directs the virtual machine to indicate which I/F names contained in the parameter list are supported by the type-specific machine information field.

Format: <FIELD POLL>
<BEGIN>
<I/F NAME 1>
<I/F NAME 2>
<I/F NAME ...>
<END>

06 FIELD RESPONSE

Contains the list of supported I/F names from those indicated in a FIELD POLL command.

Format: <FIELD RESPONSE>
<BEGIN>
<I/F NAME 1>
<I/F NAME 2>
<I/F NAME ...>
<END>

07 UPDATE — Directs the virtual machine to respond immediately with the contents of the information field, and then automatically whenever its contents change.

Format:
<UPDATE>
<I/F NAME> (Hex)

NOTES
1 The single <I/F NAME> may be replaced by several names wrapped into a BEGIN/END construct.
2 The default condition is MUTEd.
3 When an information field value has changed a number of times in the period between bus-controller polls, only the most recent value is transmitted at the next poll.

08 CYCLE — Directs the virtual machine to transmit periodically, as specified, the instantaneous contents of the specified information field.

Format:
<CYCLE>
<TIME INTERVAL> (type TIME)
<I/F NAME> (Hex)

NOTES
1 The single <I/F NAME> may be replaced by several names wrapped in a BEGIN/END construct.
2 The default condition is MUTEd.
3 When an information field value has changed a number of times in the period between bus-controller polls, only the most recent value is transmitted at the next poll.

09 MUTE — Directs the virtual machine to switch off all responses previously initiated by CYCLE or UPDATE commands.

Format:
<MUTE>

0A SIMULTANEOUS READ — Directs the virtual machine to read simultaneously the contents of the specified information fields.

Format:
<SIMULTANEOUS READ>
<BEGIN>
<I/F NAME>
<I/F NAME>
.
.
<END>

0B DEFINE PROCEDURE — Directs the virtual machine to assemble a block of virtual machine commands for subsequent execution.

Format:
<DEFINE PROCEDURE>
<PROCEDURE NAME> (Hex) in the range 01_h – FF_h. 00_h is reserved.
<BYTE COUNT> 16-bits, not including the byte count.
<COMMAND 1>
<COMMAND 2>
<COMMAND ...>
} The procedure.

NOTES
1 All functions contained within a procedure which is used within an event must be executed by the virtual machine at the trigger time specified by the event, even if actions must be taken in advance.
2 Procedures are retained until receipt of a DELETE PROCEDURE or CRESET command.

0C DELETE PROCEDURE — Directs the virtual machine to delete a command block previously defined.

Format:
<DELETE PROCEDURE>
<PROCEDURE NAME> (Hex) (00_h deletes all procedures)

0D RECALL PROCEDURE — Directs the virtual machine to transmit, but not execute or delete, the specified procedure for checking purposes.

Format:
<RECALL PROCEDURE>
<PROCEDURE NAME> (Hex) (00_h recalls all procedures)

0E PROCEDURE RESPONSE — Response to RECALL PROCEDURE command.

Format:
<PROCEDURE RESPONSE>
<PROCEDURE NAME>
<BYTE COUNT> 16-bits, not including the byte count.
<COMMAND 1>
<COMMAND 2>
<COMMAND ...>

0F RECALL EVENT — Causes an EVENT RESPONSE from the controlled virtual machine containing the data of an event already established.

Format:
<RECALL EVENT>
<EVENT NAME> (00_h recalls all events)

10 EVENT RESPONSE — Contains the data of an event already established.

Format:
<EVENT RESPONSE>
<EVENT NAME>
<I/F NAME of TRIGGER SOURCE>
<TRIGGER VALUE> (type TIME)
<COMMAND> Function caused by trigger condition.

11 SIMULTANEOUS READ RESPONSE — Response to SIMULTANEOUS READ with all specified information fields.

Format:
<SIMULTANEOUS READ RESPONSE>
<BEGIN>
<I/F NAME 1>
<I/F VALUE 1>
<I/F NAME 2>
<I/F VALUE 2>
.
.
.
<END>

FF EXTENSION — Directs the virtual machine to enter the further extension set for the following single command only. The virtual machine shall then resume execution of the basic set.

Format:
<EXTENSION>
<EXTENSION SET COMMAND>

5 Information fields

20 RESERVED

21 VIRTUAL MACHINE TYPE — Contains the virtual machine name and hence defines the type-specific machine command set.

Format:
<VIRTUAL MACHINE TYPE>
<VIRTUAL MACHINE NAME> (8-bit binary unsigned number)

NOTE – The content of VIRTUAL MACHINE NAME shall be defined explicitly in each virtual machine dialect; the virtual machine name for a wholly USER-DEFINED virtual machine is 01_h.

22 EQUIPMENT TYPE — Contains the data to identify the specific product, including hardware/software revision level.

Format:
<EQUIPMENT TYPE>
<BYTE COUNT> 8-bits; not including the byte count itself.
<ISO/IEC 646 printing characters>

NOTE – The ISO/IEC characters shall contain three fields: (1) manufacturer identification, (2) product identification, and (3) revision level (in that order). Each field shall be terminated by OD_h.

23 TIME STANDARD — Contains the nominal field rate to be used, or in use.

Format:
<TIME STANDARD>
<NAME> 8-bit binary unsigned number:
00_h is undefined
01_h is "48"
02_h is "50"
03_h is "60"

24 TIMELINE TIME — Contains the timeline time value.

Format:
<TIMELINE TIME>
<TIMELINE TIME VALUE> Standard "time" format.

25 HIGH-RES TIMELINE TIME — Contains the time of a high-resolution timeline where applicable.

Format:
<HIGH-RES TIMELINE TIME>
<TIME VALUE> 6-byte expression in "high-resolution time" format.

26 EVENT BUFFER STATUS — Tallies the event buffer status.

Format: <EVENT BUFFER STATUS>
<STATUS REPORT> — Space remaining in bytes. 16-bit number.

27 VIRTUAL MACHINE STATUS — Tallies the virtual machine status.

Format: <VIRTUAL MACHINE STATUS>
<STATUS REPORT> — 00_h = OFF; 01_h = not available; 02_h = available

29 FAULT STATUS — *Tallies faults in the system* and their reasons where detected by internal diagnostics (as applicable).

Format: <FAULT STATUS>
<PARAMETER GROUP COUNT> — 1-byte number specifying the number n of parameter groups following:

<ERROR CODE> — 1-byte code
<FAULTY ITEM #> — 1-byte number — 1st detected fault
...
<ERROR CODE> — 1-byte code
<FAULTY ITEM #> — 1-byte number — nth detected fault

NOTES
1 Parameter group count = 0 means: no fault.
2 The error codes and faulty item numbers are user-defined.

3E USER DEFINED — Identifies USER DEFINED information fields.

Format: <USER DEFINED>
<BYTE COUNT> — 16-bit binary unsigned number. Specifies the length of the information field in bytes, not including the byte count itself.
<RAW DATA> — (Length varies according to the byte count.)

3F EXTENSION — Directs the virtual machine to enter the common message I/F name extension set for the following single I/F name only. The virtual machine shall then resume access to the basic I/F name set.

Format: <EXTENSION>

Annex A (informative)
General concepts

The following text contains a general explanation of some of the concepts used in the formulation of the common message set. It constitutes tutorial information and is intended to assist in the understanding of the specifications in previous portions of this practice.

A.1 Commands and responses

The message language is subdivided into two varieties of message which differ only in the direction of information flow between controlling and controlled virtual machines.

– COMMANDS are messages from a controlling to a controlled virtual machine;

– RESPONSES are messages from a controlled to a controlling virtual machine; responses are generally transmitted in reaction to a command.

A.2 State machine and information transfer

The virtual machine controlled by the message language is considered to be a STATE MACHINE. The message set can be regarded as being of two types:

– Messages which change the state of the virtual machine (e.g., the VTR messages STOP and PLAY). These commands reside mainly in the type-specific message set and comprise commands which are mutually exclusive (e.g., the tape motion commands [TMCs] in the VTR set);

– Messages (commands and responses) which do not change the state, but which only carry information to or from the virtual machine. As information transfer is a general requirement of all types of virtual machines, general principles are applied to these tasks; therefore, these messages reside mainly in the common message set.

A.3 Information fields (I/F)

Items of information which are maintained by and held within a controlled virtual machine, and which may be needed by its controlling virtual machine, are arranged in a virtual array of INFORMATION FIELDS, in a manner similar in concept to a data base.

Each information field is identified by a unique descriptor called the INFORMATION FIELD NAME. This name, coded as a binary value, is used as an address within all commands referencing the field. Therefore, the information field name *is used as a parameter name in these commands.*

The format of information field data within each message, as transmitted over the remote control system, is predefined for each item by the information field name. Each message set requires its own array of information fields. The complete field array of a specific virtual machine comprises the field array specified in the common message set, together with that of the type-specific message set.

A typical example of a command requiring an information field is READ, which directs the virtual machine to transmit the content of one or more information fields, as specified *within the command. The SIMULTANEOUS READ com*mand directs the virtual machine to read simultaneously the instantaneous values of a number of specified information fields. In response to this command, all specified fields will be read as a "snapshot" and will, therefore, be "frozen" during the read period.

It is essential to be able to PRESET the values of certain items held within information fields. However, since the preset function could indirectly change the state of the virtual machine (e.g., presetting a tape-timer), the PRESET command is contained within the type-specific command set; information fields to which it relates are then individually specified.

A.4 Error and failure messages

An ERROR message advises a controlling virtual machine that the command as identified cannot be performed. The reason for the inability to perform the action is contained within an EXEC CODE transmitted as a parameter to the ERROR keyword. The string which caused the error message is then appended to the EXEC CODE preceded by a byte count.

A special EXEC CODE is available which directs that an information field (FAULT STATUS) should be read to obtain more information on the error. In the event of failure of the specific machine (i.e., a failure requiring the attendance of an operator), a single byte FAILURE message is transmitted.

A.5 Inquiry concept

Although ideally every virtual machine should respond to the complete message set, it is the responsibility of each manufacturer to determine the degree of conformance of his product. To enable a controlling virtual machine to determine the facilities supported by a remote-controlled virtual machine, two inquiry commands are provided:

– FUNCTION POLL to identify supported commands;
– *FIELD POLL to identify supported information fields.*

The associated responses are FUNCTION POLL RESPONSE and FIELD POLL RESPONSE. Virtual machines that do not support these inquiry commands must respond to any unknown command with ERROR.

A.6 Standard and extension keywords

Because of the limited code space available, each message set (system service, common, type-specific) contains an extension keyword which opens an additional code space of 256 additional keywords.

Frequently used keywords will preferably reside in the standard set. For keywords that are used less frequently, the additional overhead of one byte is acceptable; such keywords have been put in the extension set from the beginning, thus making room in the standard set for future applications.

A.7 Procedures

A group of commands which are to be executed in sequence on one or more occasions may be combined into a procedure using the command DEFINE PROCEDURE. Once defined, a procedure can be called simply by the command EXECUTE PROCEDURE as often as wanted until cancelled by the DELETE PROCEDURE command. It is possible to define more than one procedure at a time using different procedure names coded as binary numbers.

The command RECALL PROCEDURE and the associated response PROCEDURE RESPONSE may be used to inspect currently-defined procedures.

A.8 Timeline concept

In order to allow for synchronous processes in and among several virtual machines, a timescale common to all virtual machines is provided which may be referenced by certain commands. This timescale is called the TIMELINE. The default resolution of the timeline shall be frames. As an *option, a higher resolution may be specified* using the ESbus high-resolution time format.

The timeline may be derived externally by a locally defined reference time (e.g., derived from a central time code generator and distributed over separate lines), or it may *be generated internally by a built-in clock, the "machine* internal clock," that gets only its "ticks" from an external source available to all machine internal clocks of the system (e.g., the vertical pulse in television applications). Either one of the two possibilities may be selected by the TIMELINE SOURCE command.

When the machine internal clock is selected as the timeline source, the timeline may be stopped by the TIMELINE STOP command and restarted by the TIMELINE RUN command which also specifies the start value. The TIMELINE RUN command is also issued by the bus controller *in response* to the system service command REQUEST TIME TRANSMISSION; this allows for exact synchronization of all timelines of the system. The current status of the timeline may be accessed through the information fields TIMELINE TIME or HI-RES TIMELINE TIME.

A.9 Events

An event specifies a command that will be executed on occurrence of a specified trigger condition. The trigger condition arises when a specified trigger value coincides with the content of a specified trigger source. Any information field of the specific virtual machine may serve as a trigger source. However, the most important trigger source is the timeline. This allows for time-synchronous events in different virtual machines; e.g., synchronizing the transports of several VTRs.

The command DEFINE EVENT is used to specify an event. The event is cleared by the occurrence of the trigger condition or by a CLEAR EVENT command.

The command RECALL EVENT and the associated response EVENT RESPONSE may be used to inspect pending events.

Using EXECUTE PROCEDURE as the command within an event specification allows for a sequence of commands to be programmed for execution on a trigger condition. The accuracy with which an event is defined and executed shall depend on the type of timeline in use (default or high-resolution).

It is important to note that the controlled virtual machine, once programmed with an event, is responsible for taking care of all necessary actions for the correct execution of that event. This is the case even if actions have to be taken in advance of the occurrence of the trigger condition. For example, when executing an event that programs an edit entry on the timeline, the virtual machine (in this instance, a VTR) must apply the necessary switch commands for the erase head a certain number of frames in advance of the trigger time.

A.10 Tasks with repeated responses

In order to reduce overhead on the remote control system, commands are provided which may be used to instruct a controlled virtual machine to transfer the content of an information field repeatedly, either whenever the content changes (UPDATE command) or when a specified time period is over (CYCLE command).

However, caution must be exercised in the use of multiple UPDATE commands where the values of the specified information fields are changing rapidly; bus congestion may occur. Additionally, when an information field value has changed a number of times in the period between bus controller polls, only the most recent value is transmitted at the next poll in response to either the UPDATE or CYCLE commands. *This will minimize the risk of bus congestion.*

NOTE – Repeated transmissions must be consistent with the requirements of the supervisory protocol (i.e., a transmission can take place only following a tributary poll and a subsequent service request to the bus contoller).

A.11 Dialect identification

The information field VIRTUAL MACHINE TYPE of the common message set contains a code which defines the type of the type-specific message set. Every dialect has an associated code which is defined in the specification of that message set. The type of virtual machine and the dialect understood by it can be interrogated by READing this information field.

Annex B (informative)
Bibliography

ANSI/SMPTE 207M-1992, Television — Digital Control Interface — Electrical and Mechanical Characteristics

SMPTE RP 113-1992, Supervisory Protocol for Digital Control Interface

SMPTE RP 138-1992, Control Message Architecture

SMPTE RP 139-1992, Tributary Interconnection

SMPTE RP 163-1992, Television — System Service Messages

SMPTE RP 170-1993, Video Tape Recorder Type-Specific Messages for Digital Control Interface

SMPTE RP 171-1993, Type-Specific Messages for Digital Control Interface of Analog Audio Tape Recorders

ISO/IEC 646:1991, Information Technology — ISO 7-Bit Coded Character Set for Information Interchange

ISO 2022:1986, Information Processing — ISO 7-Bit and 8-Bit Coded Character Sets — Code Extension Techniques

SMPTE ENGINEERING GUIDELINE

EG 29-1993

Remote Control of Television Equipment

1 Introduction

This guideline provides a guide to the architecture of the SMPTE/EBU ESbus digital control interface and related interfaces, which were developed for the purpose of standardizing the control of television equipment. The digital control interface was developed jointly by the SMPTE and the European Broadcasting Union (EBU).

The referenced documents define the technical specification and system characteristics required to allow the control of television production and distribution equipment.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this guideline. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this guideline are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI/SMPTE 207M-1992, Television — Digital Control Interface — Electrical and Mechanical Characteristics

SMPTE RP 113-1992, Supervisory Protocol for Digital Control Interface

SMPTE RP 138-1992, Control Message Architecture

SMPTE RP 139-1992, Tributary Interconnection

SMPTE RP 163-1992, Television — System Service Messages

SMPTE RP 170-1993, Video Tape Recorder Type-Specific Messages for Digital Control Interface

SMPTE RP 171-1993, Type-Specific Messages for Digital Control Interface of Analog Audio Tape Recorders

SMPTE RP 172-1993, Common Messages for Digital Control Interface

3 Application

3.1 Introduction

The ESbus and associated interfaces establish the system characteristics required for the remote control of television equipment, from any location, by the employment of an intelligent processor which should ideally be an integral part of the controlled equipment.

This digital control interface is based on the ESbus developed and documented by the SMPTE and EBU and is, therefore, made available by a multitude of manufacturers.

Both SMPTE and EBU are continuing to develop specifications for additional applications. This guideline will be updated to reference the appropriate documents as they are completed.

3.2 Overview

A function of any remote control system is to establish a connection between operational controlling and controlled devices. The ESbus system is based on the concept of distributed intelligence whereby each device is attached to the system by means of an intelligent interface that will carry out the majority of local calculations and logical operations required by the device. The intelligent equipment will be called a tributary of the remote control system.

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The use of distributed intelligence within the control system offers a number of advantages:

– the ability to modify elements of the configuration without affecting other users;

– high resilience, the majority of failures can be contained within a single tributary;

– the number of time-critical messages needing to be transferred between tributaries is minimized;

– the control system is independent of the type of device.

The basic functional unit of the remote control system is the local network which comprises an interface bus, a bus controller, and a number of tributaries as required by the user. The number of tributaries on any one local network may range from one to a practical maximum of up to 32, although typically the number will probably be in single figures. The configuration may be either multipoint in which one controller and more than one tributary share a common interface bus or, alternatively, point-to-point in which more than one interface bus radiates from the bus controller and only one tributary connects to each bus.

Where larger systems are required, there is provision for local networks to be interconnected via a separate interconnection bus accessed through a gateway. This gateway may be integral with the bus controller.

3.3 System architecture

The system architecture conforms largely to the International Organization for Standardization (ISO) architecture. This is the logical model used by the IEEE 802 Committee in its recommendations on local area networks (LAN). Progress in communications over several years has led to the development of a structured technique to describe communication systems. The systems are viewed as logically composed of layers.

Layering divides the whole service offered by the system in such a way that each layer adds value to the service provided by the lower layers. The layers and service referred to are logical in nature as distinct from a physical entity or software implementation. The logical functions are carried out in software residing in hardware, but the implementation is carried forth using these logical entities to represent the software elements of the final program. This added value contributed by each layer is established by the characteristics of an entity residing in the layer.

Two entities operating in the same layer but in different parts of the network are called peer entities. The aim is to permit communication between peer entities; this communication is governed by a protocol. The route between peer entities using a protocol is only a virtual one; in reality, the communication path passes through lower layers and is completed over a physical medium, such communication being effected transparently.

In software terms, the **interface** is the logical line separating two layers. It is not necessarily a physical reality.

The point where a communication path crosses an interface is called a service access point (SAP). The point within a SAP that provides a real connection is called a connection end point (CEP).

3.4 International Organization for Standardization (ISO) Model OSI

The ISO has established a model consisting of seven layers and specified the function of each. This is called open system interconnection (OSI) architecture.

The OSI reference model defines the following seven layers:

Layer 7 serves the user directly by defining his **application** tasks in abstract terms. An application process performs a function such as playing a tape. Each applications entity serves a physical device and is device-specific, varying according to the characteristics of the device.

Layer 6 gives a **presentation** of those abstract terms in coded and strictly formatted forms. The presentation layer contains the **virtual machine** which responds to defined data, the control language in a defined manner using a distinct **dialect** within the control language.

Layer 5 is concerned only with **session** involving more than one participant. It associates the coded and formatted data with a particular participant of those available in the session. It connects two presentation entities providing housekeeping services

(remapping, dialect identification, error recovery, etc.).

Layer 4 provides facilities for safe **transport** of data from end to end of a system.

Layer 3 dismembers and reassembles transported data into packages for sequential transfer via a **network** system.

Layer 2 establishes a **data link** providing reliable error-free transmission in the presence of line disturbances. Where applicable, the association achieved in layer 5 is converted to an absolute system address. Layer 2 establishes a communication between physical units and is defined for the ESbus in SMPTE RP 113.

Layer 1 defines the hardware properties needed to set up a **physical link** for the logically linked data and is defined for the ESbus in ANSI/SMPTE 207M.

The above description shows:

– how data generated by each layer is handed on from layer to layer; and

– how the quality of service increases from bottom to top.

It should be noted that layers 7, 6, and 5 are concerned with the specific application service; layers 4 to 1 relate to a general transport service. The logical tributary encompasses layers 1 to 5 inclusive.

3.5 OSI model applied to a television control system

It is very helpful to define a remote control system for television equipment using a layered technique.

Because of the protection properties within the supervisory protocol SMPTE RP 113, (2), there is little need for additional end-to-end control facilities normally incorporated in entity (4).

The remaining layers 7, 6, 5, 3, 2, and 1 are of particular importance for ESbus digital control interface application.

The **applications** layer (7) — An applications process performs a specified system function such as playing a video tape. Each applications entity consists of a physical device and the necessary hardware and software interface to connect the entity to lower network layers. The interface is device specific and will vary according to the characteristics of the equipment being controlled. The **applications** layer is not within the scope of the ESbus documentation.

The **presentation** layer (6) contains the **virtual machine**, which responds to defined data — the **control language** in a defined manner regardless of the characteristics of the physical machine used at the applications level. Each type of virtual machine utilizes a distinct **dialect** within the overall control language. **Common** and **virtual machine** (type specific) messages are **presentation** layer constructs.

The **session** layer (5) connects two presentation entities and controls communications between them. It provides such services as mapping logical addresses to physical addresses, identification of the dialect required for the type of machine used, error recovery, etc. **System service** control messages relating to linkage and grouping are considered **session** layer activities.

The **transport** layer (4) normally manages data to and from the session layer, isolating it from potential changes in hardware technology. To do this, this layer may break up messages into smaller packets, and provide the means for them to be received correctly at the other end. It provides for safe transport of system data. There are arguably no true transport layer functions required by the ESbus structure; thus, it is considered that this layer's function is encompassed by the **system service** control structure.

The **network** layer (3) provides message blocking (concatenation) and segmentation such as to allow more effective use of the message block. **System service** control messages relating to blocking and segmentation are considered **network** layer activities.

The **data link** layer (2) establishes communication between physical units connected to the network and provides data synchronization, data transfer, and error recovery services. Local networks include an **access** sublevel within the data link which apportions use of the network between several connected entities. The access method used in this guideline is polling initiated by the bus controller. SMPTE RP 113 **supervisory** protocol provides datalink layer functions.

The **physical** layer (1) consists of the electrical and mechanical specifications which define the actual communication channel. ANSI/SMPTE 207M provides these specifications.

Figure 1 illustrates the functional distribution of ESbus functions within the OSI model layers.

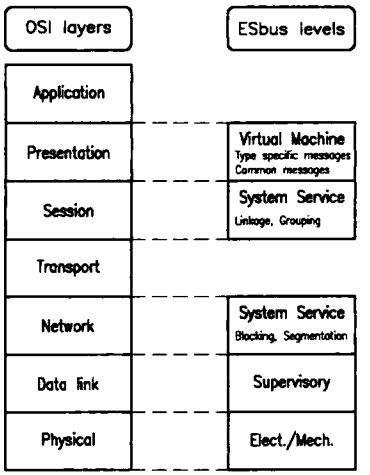

Figure 1 – Functional distribution of ESbus functions

4 Specifications

4.1 General

The specification set out in the following sections conforms to the interpretation of the OSI model.

The presentation layer (6), the virtual machine, for a broadcast equipment control standard is defined by the individual equipment type-specific message. The relevant protocol is commonly referred to as the message language. Each generic equipment type (e.g., video tape recorder, audio tape recorder, telecine, vision mixer, etc.) is allocated a specific subset of messages, a dialect, which takes account of all necessary controllable functions.

Clause 4.2 describes the supervisory protocol for the interface bus in the basic local network, a function of the data link layer. Clause 4.3 deals with tributary interconnections both within the local network and through an interconnection bus.

Clause 4.4 describes the electrical and mechanical characteristics physical link (OSI layer 1) of the interface bus.

4.2 Bus controller

A bus controller is associated with each local network. It supervises communications between all other devices which are connected to the network through the use of a supervisory protocol. The bus controller may be incorporated into a device which performs additional functions, such as an operational control panel, but it is a distinct system entity whose function is delivery of control messages and the management of the control network. The supervisory protocol is specified in SMPTE RP 113.

4.3 Tributaries

Each operational device in a system connects to the network through a tributary. A tributary transfers the messages to and from an operational device as specified by the system supervisory protocol. The tributary may be a distinct unit of equipment, or incorporated into an operational device. In any event, it is a distinct logical entity with the function of managing the network interface, synchronizing with network data flow, detecting errors, and delivering control messages to and from the controlled equipment. The tributary interconnection is specified in SMPTE RP 139.

4.4 Interface bus

The interface bus is the communication channel which carries the messages between tributaries and the bus controller. Its electrical and mechanical specifications are provided in ANSI/SMPTE 207M.

4.5 Control message architecture

Control message language is composed of vocabulary, syntax, and semantics expressed in terms of tokens, rules, and actions, respectively.

The control message architecture is described in SMPTE RP 138. The primary intent of this practice is to define the architecture of the messages to be transmitted within the supervisory protocol of the communications channel for the purpose of controlling equipment by external means. Syntax is the set of

rules which shall be applied to the vocabulary (tokens) to construct control messages.

4.6 System service messages

System service messages can affect all participants on the bus, tributaries as well as the bus controller; their effect, however, differs as between tributaries and the bus controller.

Some system service messages address the bus controller only. These originate in a tributary and cause the bus controller to set up a new internal condition, or to originate further messages.

Other system service messages are sent by the bus controller to accomplish linkage tasks in tributaries. The content of the system service messages is described in SMPTE RP 163.

4.7 Common messages

Common messages are used to perform certain functions common to all equipment types within a general-purpose communications channel of an interface system.

The content of the common messages is described in SMPTE RP 172.

4.8 Type-specific machine messages

The documents listed in this section define the type-specific virtual machine messages which are applicable to specific types of machines. Type-specific messages applicable to various categories of equipment shall be as follows:

– Audio tape recorders: SMPTE RP 171;
– Video tape recorders: SMPTE RP 170.

PROPOSED SMPTE STANDARD

SMPTE 119
Revision of
ANSI/SMPTE 119-1988

for Motion-Picture Film (70-mm) — Perforated 65-mm, KS-1870

1 Scope

This standard specifies the cutting and perforating dimensions for 70-mm motion-picture film perforated 65-mm, with a KS-type perforation and a perforation pitch of 0.1870 in (4.750 mm).

2 Dimensions

2.1 The dimensions shall be as given in figure 1 and table 1.

2.2 The dimensions pertain to a safety film as defined in ANSI/SMPTE 223M.

2.3 The dimensions apply at the time of cutting and perforating for film adjusted to a temperature of 23°C ± 1°C (nominally converted to 73°F ± 2°F) and a relative humidity of (50 ± 2)%. The manufacturer may indicate other nominal temperature and humidity conditions under which the dimensions apply.

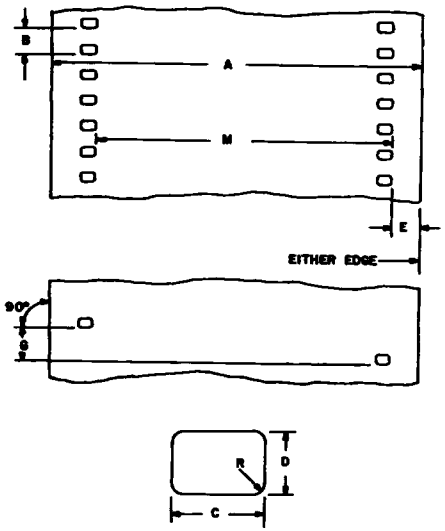

Figure 1 – 70-mm film perforated 65-mm

Table 1 – Specifications

	Dimensions	Inches	Millimeters
A	Film width	2.754 ± 0.002	69.95 ± 0.05
B	Perforation pitch	0.1870 ± 0.0004	4.750 ± 0.010
C	Perforation width	0.1100 ± 0.0004	2.794 ± 0.010
D	Perforation height	0.0780 ± 0.0004	1.981 ± 0.010
E	Edge to perforation	0.215 ± 0.002	5.46 ± 0.05
G	Perforation misalignment	0.001 max	0.03 max
L	100 consecutive perforation pitches	18.700 ± 0.015	474.98 ± 0.38
M	Lateral perforation displacement	2.214 ± 0.003	56.24 ± 0.08
R	Radius of perforation fillet	0.020 ± 0.001	0.51 ± 0.03