RP 113-1996
Revision of RP 113-1992

SMPTE RECOMMENDED PRACTICE

Supervisory Protocol for Digital Control Interface

1 General

1.1 Scope

This practice defines the supervisory protocol used within a general purpose communication channel of an interface system which transports data and digital control signals between equipment utilized in the production, post-production, and/or transmission of visual and aural information. It is intended that the supervisory protocol described in this practice be part of an overall system, allowing interconnection of programmable and nonprogrammable equipment as required to configure an operational system with a defined function, and to allow rapid reconfiguration of a system to provide more than one defined function utilizing a given group of equipment.

1.1.1 The primary intent of this practice is to establish supervisory procedures of the communication channel for the purpose of transmitting control messages to equipment by external means. (The contents of the messages are not defined.) This practice, or sections thereof, may be applied to the interconnection of elements within an item of equipment.

1.2 Definitions

(See figure 1.) For the purposes of this practice, the following definitions apply:

1.2.1 bus controller: Each system contains one bus controller which supervises all tributaries in the system. Supervision is exercised through the use of this supervisory protocol.

1.2.2 byte: A byte consists of eight bits of information. Bits used to effect transmission such as byte start, parity, or end are not part of the byte.

1.2.3 tributary: A tributary transfers messages to and from an operational device via the interface system. The tributary is distinct from the function of the operational device and exists to transfer control messages between the communication channel and the device.

1.2.4 word: A word consists of a byte and associated bits used to effect transmission such as start, parity, or end.

2 Message types

Two types of messages shall be transmitted on the channel:

Supervisory messages to supervise the channel and direct the flow of device messages.

Device messages to control operation of equipment functions. This type of message shall be transmitted only within standard message blocks or during device defined communications modes. Details of device messages are specified in RP 138.

3 Tributary addresses

Tributary addresses shall consist of two bytes: the most significant byte, which is transmitted first, and the least significant byte. The most significant bit of both bytes shall be set to binary 1. This provides an address range starting at 8080_h. Each tributary shall be assigned two unique addresses, a SELECT address and a POLL address.

3.1 Select address

An address in which the least significant bit of the least significant byte equals binary 0 is a SELECT address.

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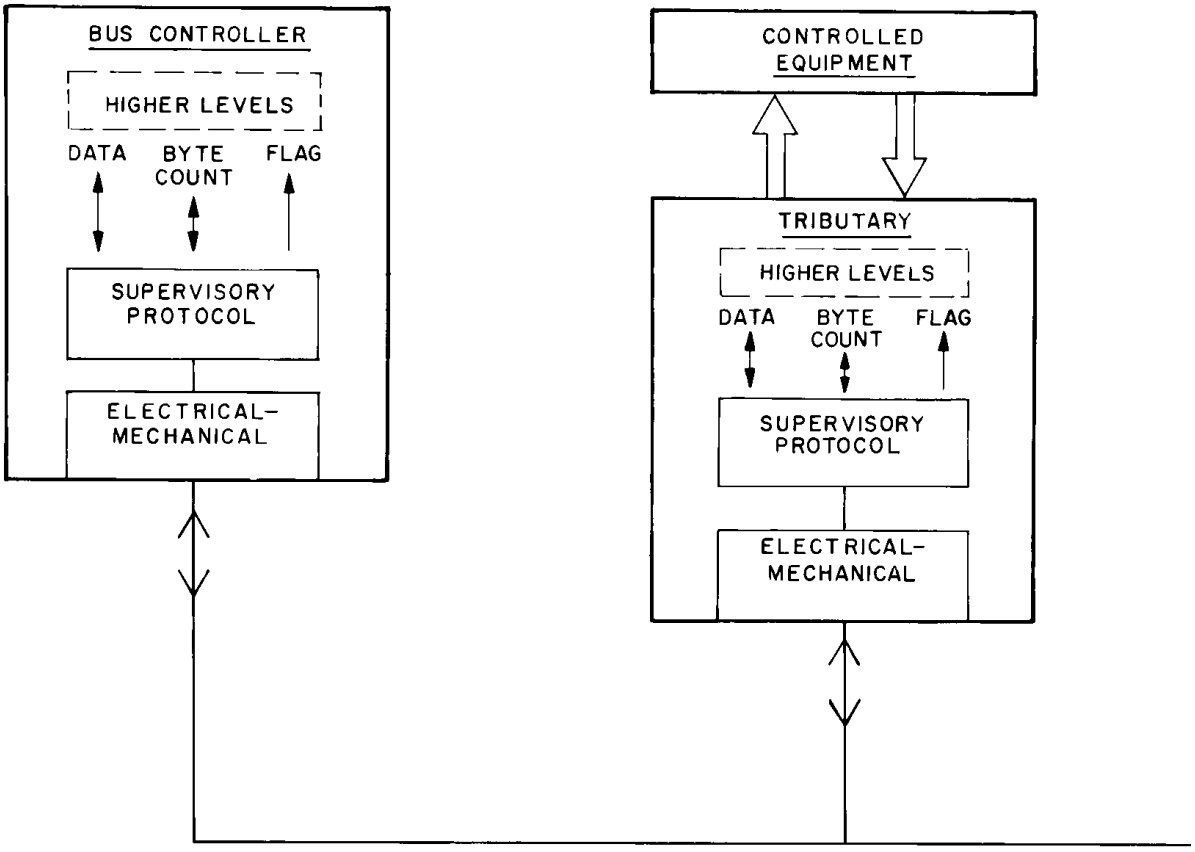


Figure 1 – System elements

3.2 Poll address

An address in which the least significant bit of the least significant byte equals binary 1 is a POLL address.

3.3 Group addresses

Address pairs 8080-8081$_h$ and 8082-8083$_h$ through 81FE-81FF$_h$ are reserved as GROUP SELECT addresses. The addresses in which the least significant bit of the least significant byte equals binary 1 (POLL address) shall not be used but are retained in the address numbering scheme for software considerations.

3.4 Discrete addresses

Tributary addresses shall start at 8280-8281$_h$. Precisely 8064 discrete tributary address pairs are available.

3.5 Address allocation table

8080–8081$_h$	Group select — all call
8082–80FF$_h$	Group select — groups 1-63
8180–81FF$_h$	Group select — groups 64-127
8280–82FF$_h$	64 tributaries
8380–83FF$_h$	64 tributaries
•	
•	
•	
FF80–FFFF$_h$	64 tributaries

4 Tributary operational states

A tributary shall be in one of five major operational states:

IDLE: The tributary shall not perform any communications. This state shall be exited only in response to BREAK.

ACTIVE: Prerequisite for transition to other operational states. The tributary shall enter this state whenever BREAK is received.

POLL: The tributary shall transmit a single status byte to the bus controller.

SELECT: A single tributary shall enter a communications mode with the bus controller.

GROUP SELECT: All tributaries or a selected group of tributaries shall enter a communications mode with the bus controller.

5 Supervisory messages

Tributaries shall be directed to operational states through various communications sequences by supervisory messages as shown in figure 2. Supervisory messages consist of the following elements:

BREAK: Shall drive all tributaries to the ACTIVE state. (See ANSI/SMPTE 207M for code.)

(ADDR-POLL): A tributary poll address (ADDR-POLL) shall drive the addressed tributary to the POLL state.

(ADDR-SELECT): A tributary select address (ADDR-SEL) shall drive the addressed tributary to the SELECT state.

(GROUP ADDR-SEL): A group select address shall drive a group of tributaries to the GROUP SELECT state.

Supervisory character: Identify communications sequences and provide status information. Supervisory characters are single bytes within the range 00_h-$7F_h$. Supervisory characters shall consist of:

01_h	(GRP)	Group assign
02	(STX)	Start of message
03	(ESC)	Escape
04	(ACK)	Acknowledge
05	(NAK)	Not acknowledge
06	(BSY)	Busy
07	(RST)	Reset
08	(SVC)	Service request from tributary
09	(TEN)	Transmit enable

All other supervisory characters are reserved. The use of other characters for tributary supervision is noncompliant with this specification.

6 Operational sequences (See figure 2)

6.1 Idle

Tributaries in the idle state shall not perform any communications sequences.

6.1.1 Idle shall be entered under the following conditions:

– Tributary power on or reset;

– Upon receipt of an (ADDR-SEL) not assigned to the tributary;

– Upon receipt of a GROUP (ADDR-SEL) not assigned to the tributary;

– When a specified time out of six words in duration occurs;

– On receipt of an undefined byte;

– On encountering a transmission error or ambiguous condition.

6.1.2 A tributary shall exit the IDLE state only on receipt of BREAK.

6.2 Active

A tributary in the ACTIVE state shall perform communications sequences as directed by the bus controller.

6.2.1 All tributaries shall enter the ACTIVE state whenever BREAK is received and on completion of a poll sequence.

6.2.2 A tributary shall exit the ACTIVE state on receipt of an address which directs it to the POLL, SELECT, or GROUP SELECT states. A time out between the two address bytes shall cause the tributary to enter the IDLE state.

6.3 Poll

The POLL state shall be used to determine the presence and status of a tributary.

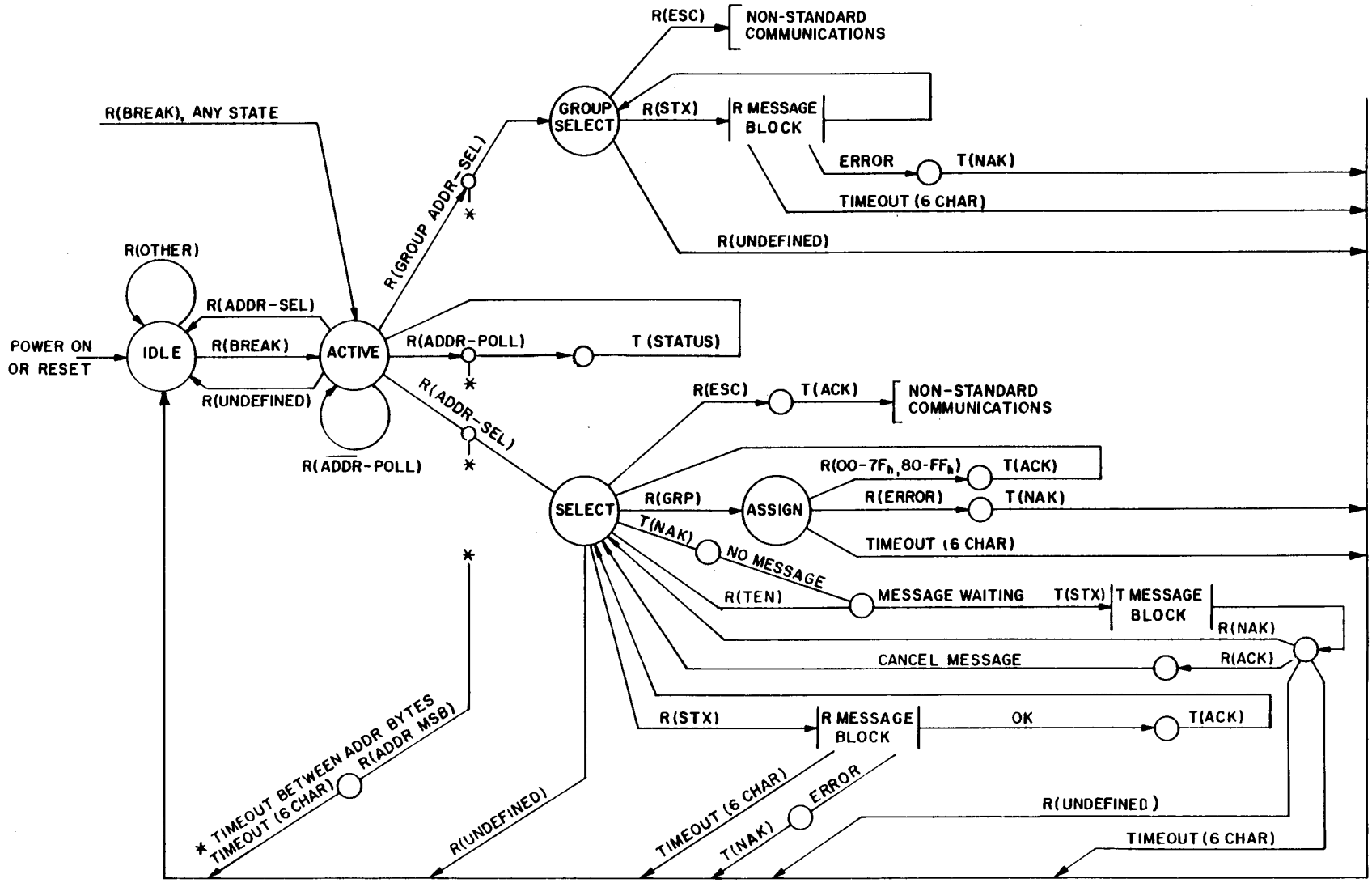


Figure 2 – Tributary supervisory protocol

6.3.1 A tributary shall enter the POLL state on receipt of its poll address (ADDR-POLL). The tributary shall transmit one supervisory character to indicate its status, then return to the ACTIVE state. Tributaries not addressed shall remain in the ACTIVE state. Supervisory characters transmitted shall be of the following:

RESET (07_h): Tributary has powered up or been reset since last poll;

NAK (05_h): An exception (time out, undefined byte, etc.) condition has occurred since last poll or select;

BSY (06_h): Tributary not available to receive messages;

SVC (08_h): Service request from tributary;

ACK (04_h): Tributary available to receive messages.

These characters rank in priority according to the order shown above.

6.4 Select

6.4.1 A single tributary shall enter the SELECT state on receipt of its select address (ADDR-SEL). All other tributaries shall transition to the IDLE state. A tributary in the SELECT state shall execute the communications sequences detailed in 6.4.1.1 through 6.4.1.4 as directed by the bus controller.

6.4.1.1 Receive message

Supervisory character STX (02_h) shall be followed by a message block containing the following characters:

– byte 1: byte count of bytes 2 through n (0 = 256 bytes).

– bytes 2 through n: (256 bytes maximum) — device defined message.

– byte n + 1: checksum = twos complement of the least significant byte of the sum of bytes 1 through n.

The tributary shall indicate error-free reception by responding with ACK and shall return to the SELECT state.

On encountering an error during reception, the tributary shall respond with NAK, then transition to IDLE.

If transmission from the bus controller is interrupted for more than the time-out period, the tributary shall transition to IDLE.

The tributary shall transfer a complete message, the byte count specified above, and a “block ready” indication to the entities using the system for control.

6.4.1.2 Transmit message

A tributary shall notify the bus controller that a message is waiting by transmitting SVC (08_h) during POLL. Upon receipt of TEN (09_h) while in SELECT, the tributary shall transmit a standard message block as defined in 6.4.1.1.

6.4.1.3 Assign tributary to group

Supervisory character GRP (01_h) shall be followed by a single byte:

00_h deletes all previous group assignments.

If the most significant bit of the byte following GRP ($01\text{-}7F_h$) is a ZERO, the assignment of the tributary to the address represented by the following seven bits of that byte is deleted (1_h to 127_h).

80_h assigns the tributary to groups 1-127.

If the most significant bit of the byte following GRP (01_h) is a ONE, the tributary is assigned to the address represented by the following seven bits of that byte (1_h to 127_h).

A tributary may be removed from or assigned to more than one group by repeating the assignment sequence.

If transmission from the bus controller is interrupted for more than the time-out period between receipt of GRP and the group assignment byte, the tributary shall transition to IDLE.

All group addresses except “all call” (8080_h) shall be deleted at tributary power-up or reset.

6.4.1.4 Nonstandard communications

Supervisory character ESC (03_h) shall release a tributary to nonstandard communications sequences. The tributary shall respond with ACK; it shall exit the ESC mode only in response to BREAK.

6.4.2 The tributary shall exit SELECT on receipt of BREAK or in response to the exceptional conditions noted in 6.4.1.1 through 6.4.1.3 above.

6.5 Group select

6.5.1 Groups of tributaries shall enter the GROUP SELECT state on receipt of their group select address (GROUP ADDR-SEL). All tributaries not assigned to the group shall transition to IDLE. Tributaries in the GROUP SELECT state shall execute the communications sequences detailed in 6.5.1.1 and 6.5.1.2 as directed by the bus controller.

6.5.1.1 Receive message

Supervisory character STX shall be followed by a message block as defined in 6.4.1.1.

Each tributary returns to GROUP SELECT state after error-free reception of the block; no response shall be transmitted.

On encountering an error during reception, a tributary shall respond with NAK, then transition to IDLE.

If transmission from the bus controller is interrupted for more than the time-out period, tributaries shall transition to IDLE.

6.5.1.2 Nonstandard communications

Supervisory character ESC shall release a group to nonstandard communications in accordance with 6.4.1.4. Tributaries shall exit this mode only in response to BREAK.

6.5.2 Tributaries shall exit GROUP SELECT on receipt of BREAK or in response to the exceptional conditions noted in 6.5.1.1.

7 Bus controller operation

7.1 System synchronization

The bus controller shall transmit BREAK when power is turned on and after being reset.

7.2 Tributary response time out

The bus controller shall transmit BREAK when a tributary fails to respond within the following time-out periods:

– In response to ADDR-POLL, GRP (#), ESC, TEN, END OF MSG BLOCK – 6 words.

8 Guidelines

8.1 Function of this practice

This practice specifies the supervisory protocol used within the communication channel. The protocol is the sequence of characters used to transfer messages between the bus controller and tributaries, provide recovery from error conditions, and generally supervise the usage of the communication channel. This practice is concerned only with channel supervision. Electrical/mechanical characteristics are specified in separate standards since many types of channels which can deliver eight-bit binary bytes and a unique BREAK condition can operate under supervision of the protocol. Message content is specified by standards which are independent of both electrical/mechanical and supervisory characteristics of the communication channel.

8.2 System configurations

This supervisory protocol permits supervision of point-to-point and multipoint systems. A point-to-point configuration is one in which a communication channel is connected to only one tributary. The bus controller may be connected to more than one channel, each having one tributary. This configuration has the advantage of speed since the dedicated channels provide access to all tributaries simultaneously.

The multipoint bus configuration is one in which more than one tributary is connected to a channel. This configuration has the advantage of reduced cabling costs and complexity. The main disadvantage of multipoint is that messages to different tributaries must queue up and be sent serially on the bus. This configuration is therefore slower in response time than point-to-point systems.

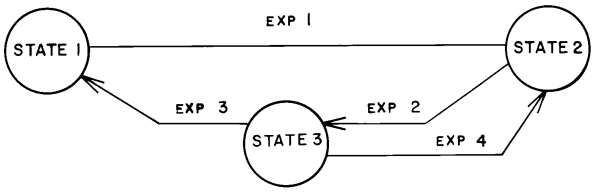
8.3 State diagrams

The supervisory procedures are described by means of state diagrams that show how the interfacing hard-

ware and software in a tributary follow sequences of bytes as they are received from the communication channel.

8.3.1 Each state (condition) that a tributary can assume is represented graphically as a circle; major states are identified by an upper case label or mnemonic within the circle:

8.3.2 All possible transitions between states are represented by arrows between the states; each transition is qualified by an expression which will produce the transition:

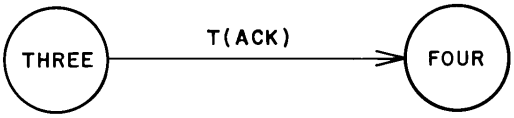


8.3.3 Expressions can be messages received from or transmitted to the communication channel, or local messages generated within the tributary.

8.3.3.1 Messages received from the channel are represented by R followed by the received message in parentheses:

indicates transition from state ONE to state TWO on receipt of the message GRP.

8.3.3.2 Messages transmitted to the bus are represented by T followed by the transmitted message in parentheses:



indicates transition from state THREE to state FOUR after transmitting the message ACK.

8.3.3.3 Local messages are represented by lower case labels:

indicates transition from state FIVE to state SIX when reset occurs.

8.4 Channel synchronization

Data density is maximized by allowing the transmission of binary data in all device messages. This means that there must be no combination of transmitted bytes which can be interpreted as a channel synchronization command. The channel synchronization command is a unique transmission sequence called BREAK. This sequence cannot be accidentally generated by normal communications. Tributaries receiving BREAK are required to immediately transfer to the ACTIVE state regardless of what they are currently doing in relation to the communication channel. On power up, a tributary enters the IDLE state and ignores all bus transactions until it receives BREAK. Electrical specifications appropriate for use with this supervisory protocol assure that BREAK cannot be generated accidentally.

8.5 Supervisory message components

The protocol uses BREAK, tributary addresses, and a small number of predefined supervisory characters to manage the communication channel. Since the addresses and supervisory characters are eight-bit binary bytes, they must be recognized by being received immediately after BREAK. The only supervisory message that is unconditionally recognizable is the BREAK sequence.

8.5.1 Tributary addresses

Tributary addresses consist of two bytes. Up to 8064 tributaries can be addressed uniquely. A one-byte addressing scheme would serve most small system applications with a saving in channel overhead, but complex reassignment strategies would have to be employed in order to accommodate larger users.

The address bytes are characterized by a 1 in the most significant bit. Each tributary is assigned two addresses, a SELECT address and a POLL address. The least significant bit of the least significant byte is set to 0 for SELECT and 1 for POLL.

A unique two-byte address serves as an all-call SELECT address. When this address is transmitted, all tributaries in a multipoint system simultaneously receive and act on system messages.

Tributaries can be assigned to one or more of 127 group SELECT addresses. These addresses allow simultaneous operation with selected groups of tributaries in multipoint systems similar to all-call.

During all-call or group operation, transmission by the tributaries is allowed only when an error condition is encountered, since other transmission could cause channel errors as several tributaries attempt to transmit at the same time. When error conditions are encountered, tributaries transmit the supervisory character NAK; reception of the NAK, or an error indicating channel contention, alerts the bus controller to an error condition in one or more tributaries. The bus controller must assert BREAK and poll individual tributaries to determine which tributary(ies) has encountered an error and the nature of the error.

8.5.2 Supervisory characters

The only supervisory characters used are those given in clause 5. Supervisory characters are single eight-bit bytes in which the most significant bit is 0. Implementations of this protocol must not use any other supervisory characters for nonspecified functions as such use would render a tributary incompatible with other systems and could occasion serious operational failures if other supervisory functions are added to this practice in the future.

8.6 Poll sequence

The POLL sequence is used to verify tributary presence and status. In multipoint systems, the POLL sequence allows all tributaries to be scanned quickly to see if servicing or attention is required by any of them.

Status characters transmitted by a tributary inform the bus controller of the tributary's current condition. Characters associated with specific conditions are detailed in 6.3.1. The tributary is required to send the highest priority status character applicable to its condition if more than one applies. All status characters except service request (SVC) apply to conditions within the interface function. SVC is a pass-through condition which indicates a service need by the equipment controlled through the interface. Device messages are used to identify and provide the service required.

8.7 Message receive or transmit sequences

Device messages are received or transmitted by a tributary by means of the message receive or transmit sequence from the SELECT state. This sequence offers message lengths of 1 to 256 bytes with checksum protection. Groups of tributaries can receive messages from the GROUP SELECT state.

On receipt of a message, the bus controller will transmit an ACK or NAK. It then waits for six characters for any exceptional condition (see figure 2).

All equipment control and status information is exchanged by means of device messages.

8.8 Escape sequence

The escape sequence is provided for those users who wish to remain compatible with the electrical and supervisory protocol characteristics of the interface system but require nonstandard operational sequences or messages. Single tributaries or groups of tributaries may be placed outside the normal protocol limits using this sequence. The only protocol requirement which must be observed by devices while using this sequence is the requirement to enter the ACTIVE state whenever a BREAK is received from the communication channel.

8.9 System design considerations

This practice and associated standards specify characteristics for equipment compatible with the interface system. System function and configuration is left to the system designer. Certain cautions must be observed by the designer:

8.9.1 Device messages

Device messages are specified by other standards. Only device messages which conform to those standards should be transmitted via the standard message receive/transmit facilities. Nonstandard messages should be transmitted via the escape sequence.

8.9.2 Switched tributaries

This practice and associated standards consider operation of bus controllers and tributaries to be within one communication channel. If tributaries are transferred between channels, the system designer must provide means to place them in an appropriate state before connection to a new channel. It is recommended that the tributaries be forced to the IDLE state with all group address assignments cleared before connection. Procedures for notifying a bus controller of the attachment of a tributary will generally be required; these procedures are dependent on the nature of the system and are left to the designer's discretion.

Annex A (informative)
Bibliography

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

RP 138-1996, Control Message Architecture for Digital Control Interface