CableLabs

Cable Television Laboratories, Inc.

Attached is a copy of the letter that was sent with the RFP to the vendors.

August 30, 1991

Mr. John Doe
President
Cable Corporation
1234 Main Street
Any City, IA 50000

Dear Mr. Doe:

Attached is a copy of a Request of Proposal (RFP) offered by Cable Television Laboratories, Inc. (CableLabs), Tele-Communications, Inc. (TCI) and Viacom Networks (Viacom). It specifies a Digital Compression Program Delivery System (the System) which will allow program suppliers to provide multiple programs per satellite transponder channel to cable television system headends. As specified in the RFP, of paramount importance is the compatibility of the System with the future digital compression distribution requirements of cable television systems. Given the rapid developments occurring in the realm of digital compression transmission systems, it is critical that the System be robust enough to accommodate the to-be-developed requirements and needs of digital compression use by cable television system operators in their provision of service to cable customers.

Any entity that intends to be a respondent to the attached RFP shall submit a letter evidencing its intention to bid on this RFP by the close of business on September 16, 1991 to the following address:

CableLabs
1050 Walnut Street, Suite 500
Boulder, CO 80302

Attn: Craig K. Tanner
Intent to Bid
Digital Compression Program Delivery System RFP

It is contemplated that we will conduct a bidder's conference on September 19, 1991. Your intent to bid letter will serve also as your stated intention to attend that bidder's conference. We will inform you of the location and time of the bidder's conference after receipt of your intent to bid letter.

Entities that have sent us an intent to bid letter shall submit four original copies of their responses to this RFP by the close of business on October 31, 1991 to the following address:

CableLabs
1050 Walnut Street, Suite 500
Boulder, CO 80302

Attn: Craig K. Tanner
RFP Response
Digital Compression Program Delivery System RFP

A provision governing the confidentiality of responses received is provided at Section 8.0 of the attached RFP. Please note that faxed responses will not be accepted nor will responses from entities that have not submitted their intent to bid letter by the established deadline. The issuers of the RFP reserve the right to extend the above mentioned intent to bid letter and/or the RFP response deadlines or to change in any way these submission provisions.

It is expected that your initial response to this RFP will focus upon how you expect to complete this effort, the schedule you contemplate for completing the effort and a price and/or pricing scheme for your proposed completion of the project.

Joint submittals from multiple vendors to this RFP will be accepted.

Summary Description of the System

The System consists of the uplink segment and a family of downlink systems, ranging from commercial units to consumer IRD and cable television system customer decompression terminal equipment. Beyond simply providing compression, the System is intended to provide multiple video outputs with four CD quality audio channels each, VBI text signals, full addressability and encryption of each channel and sub-channel and full remote system control.

To determine suitability, as discussed in the RFP, a schedule must be supplied by perspective vendors, including, but not limited to, dates for:

- Demonstration of the video and audio digital compression algorithms, channel coding, modulation scheme, encryption, error detection, correction, etc.
- Accurate computer simulation, using the level of arithmetic precision planned for hardware implementation, may be used to augment the demonstration.
- Completion dates for final tests of pre-production prototypes and first production.
- Product production and delivery schedules.

Deployment of the System is contemplated to occur by the second calendar quarter of 1992.

Thus, the System should be state-of-the-art, ready for deployment by the second calendar quarter of 1992, and in a position to be made available to cable system operators from multiple suppliers on an interoperable basis.

License Agreement will be required in any grant of a contract pursuant to the RFP

It is also important to note that, as a condition of any ultimate award of a contract with a respondent or respondents, said respondent or respondents will be asked to agree to a License Agreement with CableLabs covering both proprietary and nonproprietary technology and information related to the System. The License Agreement will permit CableLabs to engage in further research and development of the technology (subject to a cross-license back to the respondent or respondents) and to sublicense the technology to third parties as authorized by the License Agreement's terms. Your intent to bid letter will be construed by the issuers of this RFP as your willingness to enter into good faith negotiations and an ultimate agreement on such provisions as a condition of any award of a contract.

Other Provisions

The issuers of this RFP will evaluate all initial responses to this RFP. At our sole option, we may request further information from some of the initial respondents. It is our hope that we would select an initial respondent or respondents to engage in contract negotiations and a contract award. However, we make no promise that this procedure will be followed, that the final contractor will be an initial respondent or respondents, or that any agreement will be entered into with any contractor at all. We may consider all factors we believe are pertinent and select or decide not to select a bidder solely in our own discretion. Furthermore, the issuance of this RFP and subsequent receipt and evaluation of responses does not imply an obligation on the part of the issuers or other parties to purchase equipment.

Sincerely,

Baryn S. Futa
Chief Operating Officer
CableLabs

RFP FOR
DIGITAL COMPRESSION PROGRAM DELIVERY SYSTEM
ADDENDUM

Customer Premises Terminal
September 20, 1991

11.0 INTRODUCTION

11.1 Objective

This addendum to the August 30th RFP is for a digital compression program delivery system Customer Premises Terminal (CPT) compatible with the satellite digital compression program delivery system.

The objective of the CPT is to directly receive a cable containing digitally compressed video or conventional analog NTSC video. The CPT shall be designed to be installed at multi-site locations where each CPT receives the signal from the cable headend via a conventional coax distribution system. Several versions of the CPT device are anticipated including a stand-alone settop terminal providing an NTSC output, a demultiplexer/decoder compatible with conventional analog settop converters, and a plug-in module compatible with cable ready televisions and VCRs. The objective of each device is to minimize the investment required to add digital video technology to the in-place cable system by providing flexible solutions based on the consumer requirements.

The objective of the CPT is to provide the capability to receive all or a portion of the bit stream carried by the satellite delivery system, as well as conventional analog video. The technical description of the satellite delivery system is presented in the companion document "RFP FOR DIGITAL COMPRESSION PROGRAM DELIVERY SYSTEM". The system design assumes that the digitized compressed video is passed through the headend where authorization and control information for subscribers within the local cable plant may be inserted in the data stream. Other approaches could include the use of different compression algorithms optimized for cable.

Vendors are encouraged to develop the complete range of CPT family of devices, however they are not required to do so to participate in the RFP, and may produce the equipment in any mixture. However, if a vendor chooses to build any single component of the system, they are required to assist the chosen vendor(s) of the remaining components of the system in developing a compatible product.

Additionally, this addendum seeks comment from bidders regarding the effect of varying received C/N ratios on the capacity and functionality of the satellite program delivery system described in the companion document.

11.2 Potential Vendors

As stated in the companion document, proposals in response to this RFP are requested from all interested vendors that have a currently developed and operating digital compression system, or technology that is ready for practical implementation. Vendors shall have a demonstrated ability and in-house resources to support a long range program with production volumes in the hundreds of thousands of units.

11.3 Related Documents

In addition to the documents shown in the RFP, the following is a list of documents that are relevant to the CPT as described in this addendum.

UL 1459, Modems
CSR 47 FCC Part 68, Modems

12.0 QUANTITY AND SCHEDULE

Respondents shall provide scheduled dates for product availability, quantities, and associated prices for delivery to a designated U.S. location. As part of the RFP, the vendor shall clearly identify prototype units, pre-production units and final production units.

13.0 VENDOR SELECTION

The vendor shall be selected on the basis of criteria included in the RFP, Section 3.0.

14.0 SYSTEM GENERAL DESCRIPTION

The CPT accepts a signal from a cable television distribution system which may include both conventional VSB analog and compressed digital signals, and converts that signal into a format suitable for display on conventional consumer television. The CPT must contain the capability to tune to and accept a variety of conventional 6 MHz wide analog video channels, some of which may be scrambled using commercially available analog scrambling systems, and also accept a variety of digitally compressed signals in either a single channel per carrier format or a multiplexed digital data TDMA format.

14.1 CPT Incoming Signal

The incoming signal to the CPT is from a conventional cable distribution plant with drop coax lead to the CPT device. Bandwidth for specific cable systems may vary from 54-300 MHz up to a range of 54-1000 MHz with a channel frequency plan using either HRC, IRC, or STD channel assignments.

The signal received at the CPT may vary over a wide range of amplitude with frequency tilt over the bandwidth. Typical cable signal distortions such as those arising from reflections, phase jitter, and intermodulation may also impact incoming signal quality.

14.2 CPT Output Signals

The CPT decodes the embedded signals from the transponder or originating at the cable headend and converts the signals back to NTSC video and FM audio modulated onto a channel 3 or 4 RF carrier, and baseband video audio and data including consumer data, teletext, and closed captioning as required by the consumer.

The objective of the system is to have these signals duplicate as close as possible the original signals prior to encoding and compression.

15.0 GENERAL REQUIREMENTS

15.1 CPT Requirements

Several versions of the CPT are required to insure compatibility with the wide variety of cable system configurations in use. These differences include frequency plans, bandwidth, and analog scrambling systems. One version would provide the digital decompression and conversion of digital channels and operate in conjunction with a cable ready TV or cable settop decoder. This device should provide a direct RF bypass of analog video channels and convert the digital channels to an unused TV channel for tuning.

15.1.1 Video Outputs

- The video outputs from the CPT shall include NTSC modulated on a RF carrier at video channel 3 or 4 with a RF amplitude compatible with commercial televisions and also baseband outputs consisting of composite NTSC video and Y/C baseband. (Other output options are described in Sections 16.2.3 through 16.2.6).

15.1.2 Audio Outputs

Any of the four compressed audio channels embedded within each of the compressed digitized video channels, shall be capable of combining with the decompressed video channel as part of the RF modulated NTSC signal. Also all four audio channels shall be available on output connectors as baseband signals. The audio channel selections shall be made by either the satellite signal provider or the headend operator, or at their option, left to the selection of the viewer.

15.1.3 Video Compression Ratio Change Tracking

The degree of compression for each channel shall be automatically determined based on the quality and number of channels to be compressed into one signal at the source. The decompression shall be capable of automatically and seamlessly tracking changes in the compression ratio and decompressing the video and audio outputs over the entire range of compression ratio changes. Compression ratio changes shall produce no audio pops or video artifacts.

15.1.4 Auxiliary Data

One separate data signal, preferably on a nine or twenty-five pin RS232 computer serial port style female connector shall be available for the serial data channel. The data rate for this signal shall track the data rate of the incoming channel auxiliary data.

15.1.5 VBI Signal

Signals carried in the VBI of NTSC video are transmitted over a separate data path. The CPT shall be capable of reinserting these signals back onto the appropriate lines of the VBI as part of the NTSC video output. These signals include all digital data within lines 10 through 21 of the VBI for both field 1 and lines 273 through 284 of field 2.

15.1.5.1 Teletext Channel

The CPT shall include the capability of capturing and displaying as part of the video output one teletext channel for the selected video channel. The teletext format shall be of the same type and quality as the EIA 516 North American Standard.

The control and addressing capability shall support up to 1000 pages of teletext information. The products must be able to select specific pages for display including page scrolling, back paging or page jumps. The format and control frame for the teletext pages must include the ability to format the pages into blocks or groups of pages where the product shall be able to load an entire block of pages into the device local memory. This feature is designed to reduce access time required to capture pages of teletext information.

When activated by either a command from the compressor or at the device, the teletext page shall be displayed with the video information as an overlay or a replacement for the normal video channel. This feature may be overridden at the discretion of the subscriber.

15.1.5.2 VITS

If the input signal contains a VITS component, the VITS must be reconstructed and added to the output signal. This signal shall be captured periodically and sampled at the encoder, transmitted at a low data rate as a PCM signal and reconstructed onto the appropriate vertical blanking line on the output video signal at the CPT.

15.1.5.3 VIRS

If the input signal contains a VIRS component, the VIRS must be contained in the output signal.

15.1.6 Subscriber Messages

The CPT shall support messages sent directly to specific subscribers. In addition, the system must support the distribution of unique page messages that can be updated at least once per minute to a limited number of users. Typical uses of this capability would be to provide a personalized stock "ticker" service and subscriber billing. The number of individual subscribers supported shall be related along with a description of message transmission speed. This information is carried on the teletext channel.

15.1.7 Anticopy Capability

The CPT shall include an anticopy provision to prevent unauthorized recording of any of the baseband decoded outputs. This provision shall be controlled as part of the individual unit addressability, either locally by the cable operator for CPT units or via the master data stream from the compressor. Selected devices may be authorized to copy programs while other devices are prohibited. Enabling the anticopy function must not impair the recovery and display of closed captions, nor should it cause any picture artifacts.

15.1.8 System Security

The CPT shall be designed to defeat modifications to the device intended to obtain unauthorized video, audio, or data services. Known methods of obtaining services include "Three Musketeers" where a device is modified to obtain additional services using the authorization key for purchased services, "Cloning" by duplication of a master unit, "Key

Distribution" which allows units to be authorized. and "Reverse Engineering" through access to custom IC logic and internal software.

A minimum of two simultaneous paths of decryption authorization shall be accepted. The primary route of encryption authorization shall be incorporated within the signal itself. The secondary authorization shall be accomplished via some other communication path (i.e. smart card, telephone, etc.).

The vendor shall discuss the potential to periodically upgrade the system security using code changes, hardware upgrades, or other methods as defined by the vendor.

The issuers of the RFP retain the right and expect to have an independent third party review all of the security elements of the CPT including software programming and hardware design prior to releasing the design into production.

15.1.9 Signal Acquisition

The CPT shall achieve full signal acquisition within an acceptably short period of time after a channel change or signal interruption, such that viewers have the ability to comfortably switch from channel to channel. The vendor shall conduct a study to determine the maximum acceptable acquisition time and worst case pause per channel when "grazing" through channels. The image shall be frozen or blanked during the acquisition period.

15.1.10 Virtual Channels

The CPT shall be capable of tracking virtual channels by retuning and controlling channel assignments through a control channel in order to create in real-time, program channels built from programming selected from other compressed channels. This capability must be addressable, allowing each device to select programming independently of all other receiving sites. The video switch between synchronized sources must not cause a roll, or other visible artifact. The audio switch between synchronized sources must not cause a pop or other audible artifact. It is recognized that text and data channels may not be compatible with virtual channels.

If enabled by the cable operator, the virtual channel creation shall be transparent to the cable operator and fully controlled by the uplink System. Alternately, the cable operator may substitute a control channel for virtual channel assignments within the cable system.

The CPT shall integrate standard video channels within the same family of virtual channels and provide a channel output indicator (numbers or up to 5 letters) for tuning purposes that are mapped by the control channel.

The virtual channel map shall be maintained in the event of a power outage and not require retransmission to activate the device after power has returned. This virtual channel map is downloaded from the controlling source to the individual CPT and stored in nonvolatile memory within the device.

15.1.11 Device Controls and Displays

All controls and functions of the CPT shall be implemented on both the device and a separate infrared remote control unit. Preference is for on-screen display of functions and channels when activated by the control. The remote control function shall be activated through the control channel. Typical functions included on the remote control are as follows:

On/Off Switch controlling the AC output receptacle and display
Channel Selection
Channel Increment
Channel Decrement
Pay Per View Functions - including on screen ordering and debit account information
Volume Control
Favorite Channel Control.

All devices shall also incorporate operational status and mode of operation indicators that are of value to a consumer such as an on screen display (OSD), LED, and/or meters. On-screen display of information shall include channel, time remaining for program, volume level, PPV account information, software settings, and a program guide if available.

15.1.12 Audience Polling

Each device shall provide the capability, when activated, of tracing audience viewing patterns to be used for market research purposes.

15.1.13 One-Way Interactive Data Channel

Provision shall be made for a 1200 bits per second asynchronous RS449 or RS232 data channel from the program source to the device to support interactive services. As a minimum, this data stream shall be available as serial data compatible with a teletext terminal equivalent to a DEC VT100 or other teletext computer terminal. Vendors shall discuss the potential for on-screen display of these services including a program guide and text display compatible with the viewed channel. Vendors may also wish to discuss a two-way interactive data channel. If on-screen display is proposed, the vendor shall include a discussion of text or graphics formatting requirements.

15.1.14 Audio Channels

Each device shall provide up to 4 audio channels that may be assigned to the selected video channel through the control channel. These may be used for alternate language applications, stereo sound, or surround sound as selected by the system control. The assigned channels shall be selected by the headend operator or by the satellite signal provider, or at their option, left to the selection of the viewer.

15.1.15 Internal Diagnostics

The CPT shall include a self diagnostic program that can be used to identify a failure. The objective of the diagnostic capability is to isolate a failure down to a module within the unit or the quality of the input signal. Examples include, signal level, number of parity errors within a given time, channel assignments not stored in the CPT, authorization level, or tampering of the box causing the system to disable.

The display of failures and diagnostic information shall be activated through some atypical sequence of key strokes and not require specialized equipment or the input signal to be present. The vendor shall discuss the merits and cost impact of providing an internal memory storing past events including the time of first detecting a failure if a real time diagnostic capability is proposed.

16.0 SYSTEM SPECIFICATIONS

16.1 CPT Input Signal Specifications

RF Input

Band width	54 MHz to 1000 MHz in 6 MHz channel spacing using IRC, HRC, or STD frequency channel assignments. (Alternate frequency assignments will be considered).
Amplitude	-5 dBmv to +15 dBmv
Tilt	12 dB
Return Loss	12 dB on tuned channel, 4 dB across band
Noise Figure	< 12 dB

AC Power

Line Frequency	57 Hz - 63 Hz
Voltage	115 VAC +/-10%
Power Consumption	< 100 W

16.2 CPT Output Signal Specifications

16.2.1 NTSC

Frequency Response	+/- 0.5 dB to 4.2 MHz - 3 dB at 5.0 MHz - 12 dB beyond 6.0 MHz
Chrominance Bandwidth	-3 dB at 3.58 MHz +620 KHz (I,Q) -1.3 MHz (I), -620 KHz (Q)
Y Vertical Response	At least 20% response at 330 lines
Return Loss	Greater than 30 dB to 6 MHz

RF Modulated NTSC

Frequency	Channel 3 or 4
Frequency Drift	< 50 Khz within 2 hours
Level	66 dBuv +/-1 dB

16.2.2 Y/C (VHS or S-VHS compatible)

Y Frequency Response	+/-0.5 dB to 5.0 MHz
C Frequency Response	-0.5 dB at 3.58 MHz +/-2.25 MHz -12 dB beyond 3.58+/-2.9 MHz
Return Loss (Y and C)	Greater than 30 dB to 6 MHz
Negative sync of Luminance, no burst	
Y Vertical Response	At least 20% response at 330 lines
Return Loss	Greater than 30 dB to 6 MHz

16.2.3 YUV (Optional)

Y Frequency Response	+/-0.5 dB to 5.0 MHz -3 dB at 5.0 MHz -12 dB beyond 6.0 MHz
C Frequency Response	+/-0.5 dB to 2.25 MHz more than -12 dB at 2.9 MHz
Y Signal Level	1 Vp-p into 75 ohm
C Signal Level	0.7 Vp-p into 75 ohm
Return Loss (Y and C)	Greater than 30 dB to 6 MHz
Y Vertical Response	At least 20% response at 330 lines
Return Loss	Greater than 30 dB to 6 MHz

16.2.4 RGB (Optional)

Frequency Response	+/-0.5 dB to 5.0 MHz -12 dB at 6.0 MHz
Signal level G:	1 Vp-p into 75 ohm
R,B:	0.7 Vp-p into 75 ohm
Negative Sync on Green	
Vertical resolution	At least 20% response at 330 lines
Return Loss	Greater than 30 dB to 6 MHz

16.2.5 Digital Composite (Optional)

Serial: See Appendix B for Specification
Parallel: To be determined

16.2.6 Digital Component (Optional)

Serial: See Appendix B for Specification
Parallel: CCIR Rec 601 and 656, SMPTE RP-125

16.2.7 Audio Specifications

Frequency Response	+/-0.5 dB 20 Hz to 20 KHz
Total Harmonic Distortion	Less than 0.2% 20 Hz to 20 KHz at +20 dBm
Hum and Noise	Greater than 80 dBm below +4 dBm
Crosstalk Isolation	Greater than 80 dBm from 20 Hz to 20 KHz at +20 dBm on all channels except the measured channel.

16.3 Carrier to Noise Performance

The CPT shall not allow more than one uncorrected error event every 24 hours when operated within the input signal level specifications (interference not included). The vendor shall identify all assumptions for incoming signal quality.

16.4 Error Propagation and Concealment

To the extent possible, error concealment should be used to disguise errors visually, by replacing a corrupted data block or sample with a correlated data block or sample.

In the event an error occurs that cannot be concealed or corrected, the degradation caused by the error shall not propagate a visually detectable defect for a duration greater than 100 milliseconds.

The device shall achieve full signal acquisition within an acceptably short period of time after a channel change, scene change or signal interruption. The vendor shall conduct a study to determine the maximum acceptable acquisition time. The current displayed image shall be blanked or frozen during acquisition.

16.5 Mechanical Requirements of the CPT

1. The CPT shall be a desk top design with optional rack mounting.

2. The device shall operate at 5% - 95% non-condensing humidity over 0 C to 50 C temperature and up to 10,000 ft altitude.

3. The connectors shall include the following:

RF

Input of 54 to 1000 MHz using type F female connector, 75 ohm unbalanced.

All units shall provide a type F female connector for the RF modulated output

Video Output

RCA female connectors each being 75 ohm unbalanced.

Audio Output

RCA female connectors for a minimum of two outputs with a barrier strip for two outputs.

16.6 Certification Requirements

The vendor shall obtain FCC, UL, and CSA approval for all components in the system prior to production release.

The vendor shall provide a minimum of 25 prototypes and 100 pre-production units of each device and supporting control equipment as part of the customer certification process.

17.0 SUBSCRIBER CONTROL SYSTEM

17.1 System Capability

The Subscriber Control System provides the network management, control and monitoring of all devices within a defined network. Satellite networked systems with potentially millions of subscribers require a significant amount of computer processing capability and data storage. These systems are expected to require large computers possibly networked together in a parallel structure.

Cable headend-based control systems may have as few as a thousand subscribers or a few hundreds of thousands of subscribers. These systems will require a computer system based on personal computers for the smaller systems up to a minicomputer-based system. The vendor is expected to provide Subscriber Control Systems that are cost effective and functional across this wide range of system requirements with an upgrade plan that allows the systems to grow as subscribers are added.

This system is described as part of the Digital Compression Delivery System RFP with the following additional features.

a. Maintain subscriber files for up to 100 million subscribers including the following information for each subscriber:

1.) Affiliate Name assigned to the device
2.) Affiliate ID
3.) Contact Information
4.) Device address as appropriate
5.) Authorized services
6.) Virtual Channel schedule
7.) Channel Map
8.) Expansion Capability

b. A telephone response manager sufficient to process pay per view, home shopping, interactive television, subscriber questions, change in authorization, and other functions requiring subscriber interaction where the primary capability is based on computerized voice response to questions based on touch tone input. Capability to switch calls to live operators shall be part of the system. Typical levels of activity are as follows:

1.) 350,000 calls each day with a peak call of 10,000 calls at an average time of 10 seconds.
2.) A log of 50 PPV events
3.) Access to the past 50 PPV purchases for a subscriber
4.) Viewer Preference reports and Nielsen tracking information
5.) Credit History for purchases using internal or external data bases

RFP For Digital Compression

Program Delivery System

August 30, 1991

Table Of Contents

RFP FOR DIGITAL COMPRESSION PROGRAM DELIVERY SYSTEM

1.0 INTRODUCTION

1.1 Objective

This request for proposal (RFP) is for a digital compression program delivery system ("the system") consisting of a signal compression unit and a decompression unit. The objective of the system is to provide the capability to transmit multiple channels of video and audio information via various degrees of compression through existing satellite transponders, and ultimately, over existing cable television plant. The compressor system shall be designed to be installed in a signal stream at a central site. The decompressors shall be designed to be installed at multi-site locations where each decompressor receives the signal from the compressor. This system shall be compatible with existing C and Ku Band satellite transmission technologies including 2 degree spacing, and existing cable plant.

Designs for three versions of the decompressor will ultimately be required. The first, described in this Request for Proposal, is a commercial unit designed to be installed at cable television headends, where the signals from the decompressor shall be retransmitted over conventional cable plant. The second and third versions of the decompressor will be described in an addendum to this RFP to be issued at the time of the bidders' conference. The units described in this later document will be a decompressor to be designed as a set-top terminal for use by cable television subscribers, and a unit which shall be designed for installation in consumer satellite receive locations, to include an integrated consumer-grade satellite receiver.

A primary objective of this RFP is to preserve the ability of cable television operators to implement later digital compression of signals over terrestrial cable systems, with compressed satellite signals as the source materials. To this end, the satellite digital compression system proposed must address the following two attributes:

1. Delivered quality must be demonstrated to be high enough that it will support concatenation of an additional, future digital compression algorithm of currently unknown nature for terrestrial cable transmission without any degradation of quality, relative to the quality that would be delivered to a cable subscriber if the terrestrial cable compression system were fed by a conventional satellite FM delivered video signal that had never been subjected to a compression/decompression cycle and where source material were studio quality NTSC.

2. The satellite digital compression system proposed must have a fully defined, companion terrestrial cable digital compression system (utilizing either the same compression algorithm, or a different one) that would lead to a demonstration in prototype form.

If unable to address both options, please explain why.

1.2 Potential Vendors

Proposals in response to this RFP are requested from all interested vendors that have a currently developed and operating satellite digital compression system, or technology that is ready for practical implementation. Vendors should have a demonstrated ability and in-house resources to support a long range program with production volumes in the thousands of systems.

1.3 Related Documents

Following is a list of documents, not necessarily exhaustive, that may be relevant to this RFP:

SMPTE RP-125, "Bit Parallel Digital Interface for Component Video Signals"
CCIR Rec. 601, "Encoding Parameters of Digital Television for Studios"
CCIR Rec. 656, "Interface for Digital Component Video Signals in 525 Line and 625 Television Systems"
CCIR Rec. 470-1, "Television Systems", (Report 624-3, "Characteristics of Television Systems")
SuperNTSC specs
Eidak specs (if available)
Macrovision specs (if available)
Proposed SMPTE Standard, T14.224, fifth draft, "Serial Digital Interface for 10 bit 4:2:2 component and 4 fsc NTSC Composite Digital Signals".
UL 1409, Cable Products
CSA C22.2#1-M90
CSR 47 FCC Part 15B

EIA-RS-170-A Standards for color television studio facilities
EIA-RS-189-A Standards for encoded color bar signals
EIA-RS-232-C Standards for data communications interfaces
IEB #9 Application notes for EIA-RS-232C
EIA/TIA-250-C Electrical performance for television transmission systems
NTC Report #7 Standards for video facility testing
EIA-RS-310-C Standards for racks, panels and associated equipment
EIA-RS-422-A Standards for balanced digital interface circuits
EIA-RS-423-A Standards for unbalanced digital interface circuits
EIA-RS-449 General purpose interface for data terminal equipment
Code of Federal Regulations CFR #47, parts 21, 25 and 94 FCC regulations for private, common carrier and satellite transmissions
Hughes Communications Galaxy, Inc. Galaxy/Westar uplink access requirements (video broadcast) and Ku band system, satellite access procedures 10/29/90
GE American Comm., Inc. Commercial operations systems users guide 1/90
GTE Spacenet Corp. Operations procedures Appendix D
Hughes Communications, GE American Communications and GTE Spacenet specifications for the following satellites:
Galaxy I, Galaxy IR, Galaxy III, Galaxy V, SBS 5, SBS 6
Satcom F1R, Satcom C-1, Satcom C-3, Satcom C-4, Satcom K1
Spacenet 1, Spacenet 3, GStar 4, ASC-1, Spacenet 4
Comsat World Systems Division, U.S. Earth Station Owner/Operators Guide, August 1990 Appendix G, SSOGS 100-600
Astra 1A, Astra 1B, Pas-1, Pas-2
Intelsat V AF ( ), Intelsat VI F( ), Eutesat F( )

2.0 QUANTITY AND SCHEDULE

Respondents shall provide scheduled dates for product availability, quantities, and associated prices for delivery to a designated U.S. location. As part of the RFP the vendor shall clearly identify prototype units, pre-production units, and final production units.

3.0 VENDOR SELECTION

The vendor shall be selected on the basis of criteria including, but not limited to, those listed below. As part of the review process, the customer retains the sole right to weigh each criterion based on the RFP issuers' sole judgement of the importance of each item on a case by case basis.

3.1 Vendor's demonstrated ability to easily interface to a variety of cable compression systems. Vendor shall be required to demonstrate system performance when the proposed satellite system is concatenated with other compression systems.

3.2 Ability to demonstrate actual hardware or otherwise prove in a satisfactory manner that the vendor has the technology and the capability to implement and produce a commercial system using the proposed technology.

3.3 Technical performance and specifications of the compression system including subjective assessments of performance as well as the potential for future enhancements and higher levels of compression at a later date.

3.4 Functions and features of the compression system including flexibility of adding functions and features for future generations of products based on the technology.

3.5 Degree of security provided by the compression system including the robustness of the security hardware to not be bypassed or "reverse engineered".

3.6 The vendor's ability to demonstrate viability of the company to provide long term economic and technical support of the product and product upgrades.

3.7 Vendor's willingness to make a long term commitment to the product and user base including support and future upgrades of the design as new technology becomes available.

3.8 Price and delivery commitments.

3.9 Vendor's demonstrated ability to develop a cost-reduced decompressor using a compatible decompressor technology suitable for the subscriber marketplace.

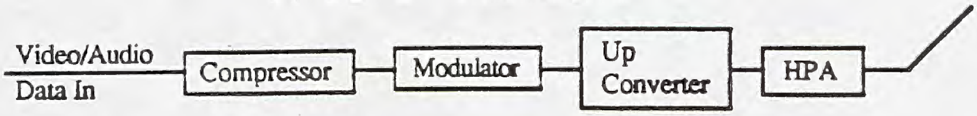
3.10 The vendor's demonstrated ability to provide for a plan for second sourcing materials for the system.

4.0 COMPRESSION SYSTEM GENERAL DESCRIPTION

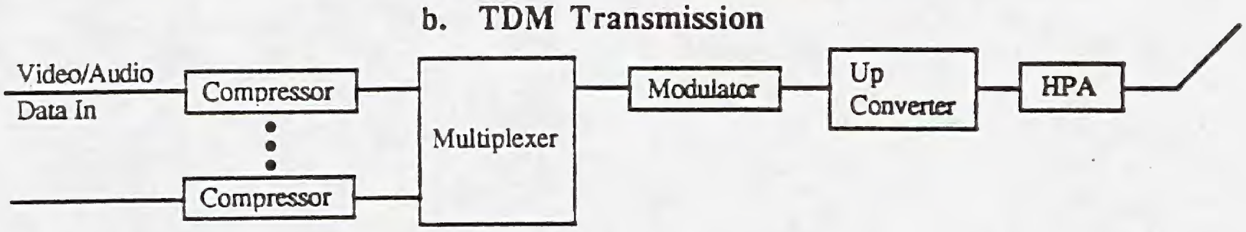
The compression system consists of a compressor located at the transmission site and decompressors located at each of the receive sites. The compressor system accepts video, audio and data inputs from a number of sources and with a range of signal quality. After compressing each signal, the combined channels are transmitted through a satellite transponder to the various receive sites. These schemes must include both single channel per transponder TDM (Time Division Multiplex) and multiple channel per transponder SCPC (Single Channel per Carrier) architectures with emphasis upon first availability of the TDM approach. Each vendor's proposal must include a description of the technology used to multiplex the various independent signals through the satellite transponder.

Figure 1

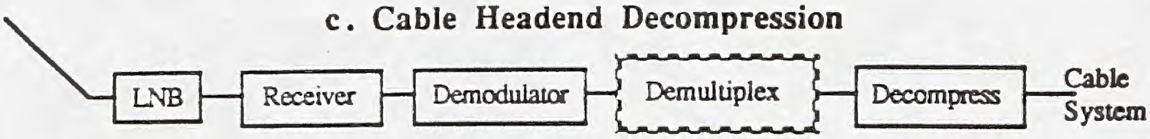
a. SCPC Transmission



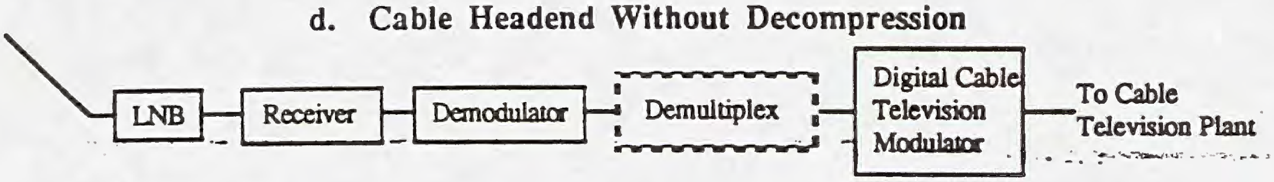
b. TDM Transmission



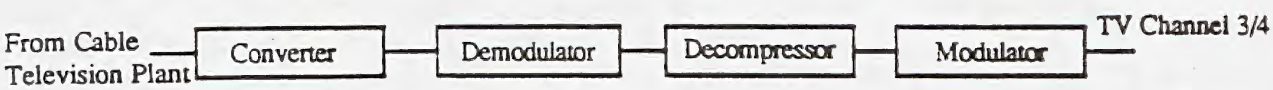
c. Cable Headend Decompression



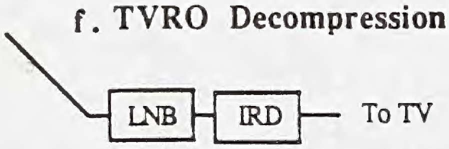
d. Cable Headend Without Decompression



e. Subscriber Decompression (Digital Converter)



f. TVRO Decompression



At each receive location, the transponder signal must be separated into the individual channels and, on a selective basis, decompressed back to signals equivalent to the original information retaining as near as possible the same signal quality prior to transmission.

4.1 The Incoming Video Signal

The input video signal is defined in Section 5.2.1.1.

The incoming video signal may be obtained from studio, off-air, common carrier delivered or locally-generated sources such as VTR's or electronic character generators.

In many applications in service today, delivering video programming to satellites for broadcast to cable television or home subscribers often use microwave, equalized cable or fiber optic systems to deliver signals from a studio to the uplink site. In some cases, off-air signals are demodulated and retransmitted.

1. Impaired video signal inputs can be expected in some applications, and the compressor shall obtain timing information from horizontal sync reference within the signal when color burst is missing or its quality is insufficient. Also the system shall be designed in accordance with CCIR recommendation 470-1.

2. The compressor must also determine if color burst is missing due to black/white transmission, and color burst must be muted in all decompressors during those periods to reduce any artifacts that might appear in consumer televisions.

4.2 The Incoming Audio Signal

The input audio signal is defined in Section 5.2.1.2.

In general, audio input signals can be expected to vary on the nominal average program level (APL) and the normal peak program level (PPL) at the input to the compressor. Provision must be made to adjust all levels between 0 dBm and 10 dBm APL and PPL levels of +10 to +20 dBm using standard attenuators and amplifiers.

4.3 The Incoming Auxiliary Data Signal

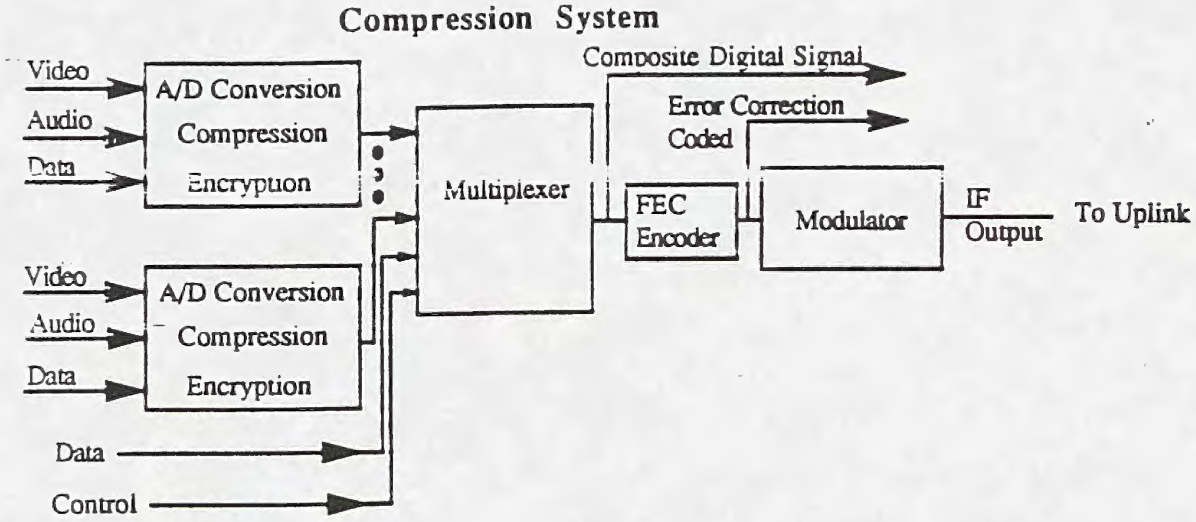
This signal is compatible with industry standard asynchronous data transmission. This signal is defined in Section 5.2.2.3.

4.4 Compression System

The encoding system accepts the input signals defined in 4.1, 4.2 and 4.3 from one or more sources and provides both digital baseband and modulated IF signals containing the information content of these signals to a satellite uplink. Also provided within these signals are command and ancillary information as defined elsewhere in this specification.

A functional block diagram for the encoding system's basic configuration is shown in Figure 2. This diagram does not necessarily specify a system architecture.

Figure 2



4.5 Decompression System

The decompression system accepts the signal(s) received from a transponder and decodes that signal back to all of the input signals originally supplied to the encoding system. Input signals may include an L band IF, composite baseband digital and low speed digital interface, 70 MHz IF, etc.

A functional block diagram for the decoding system shall include a number of basic versions as suggested in the drawings below.

Figure 3

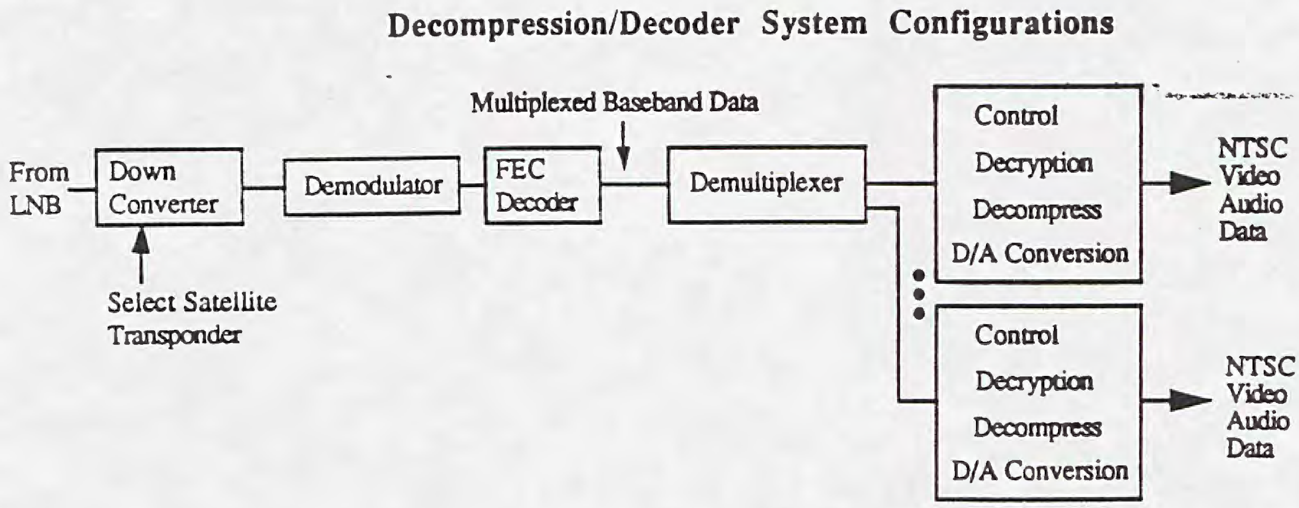


Figure 3 Continued

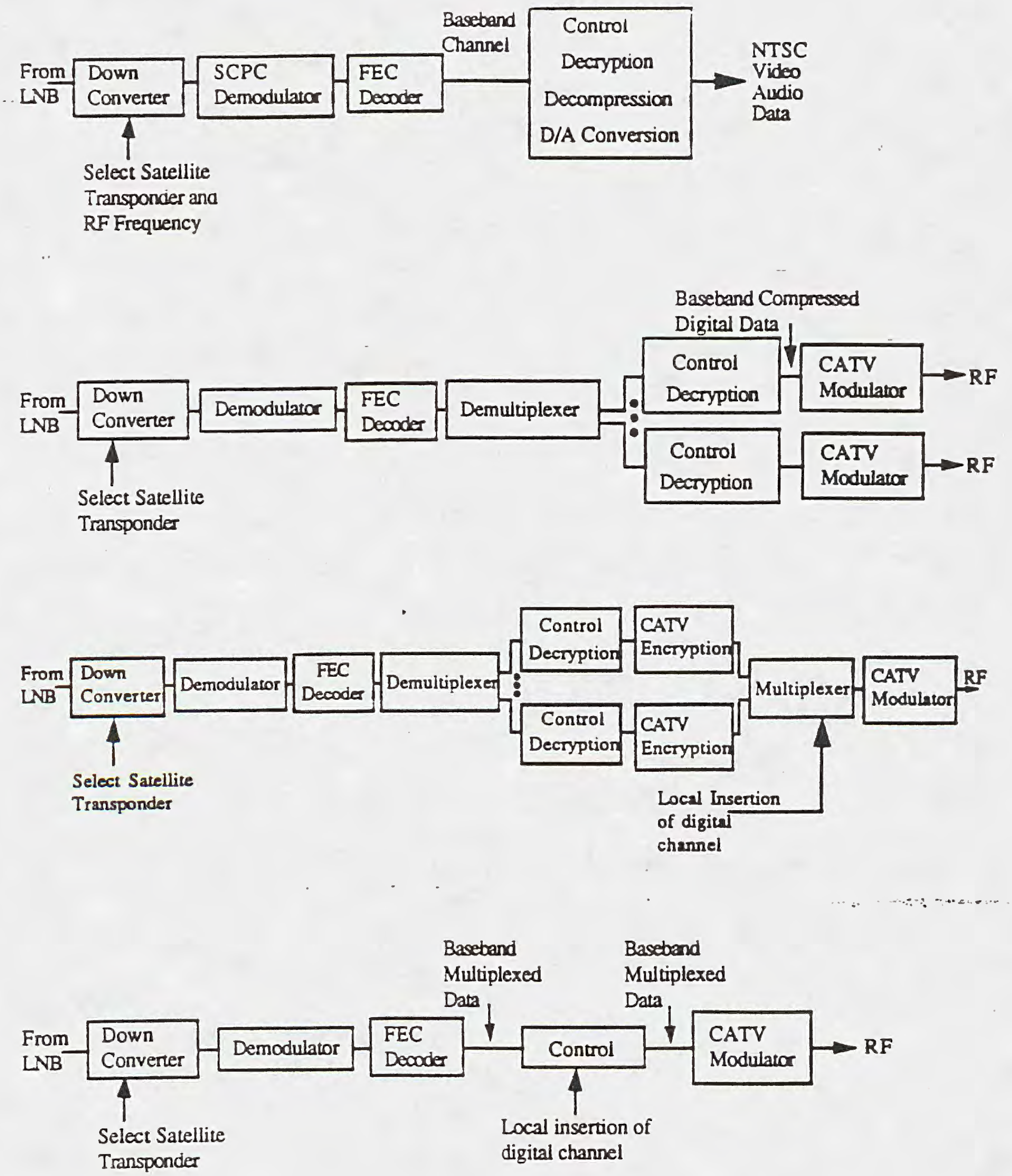
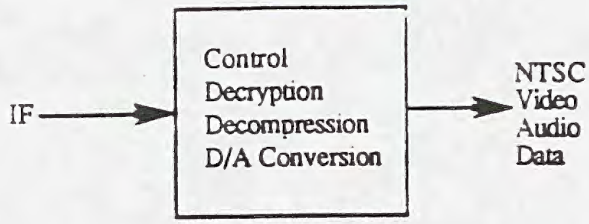
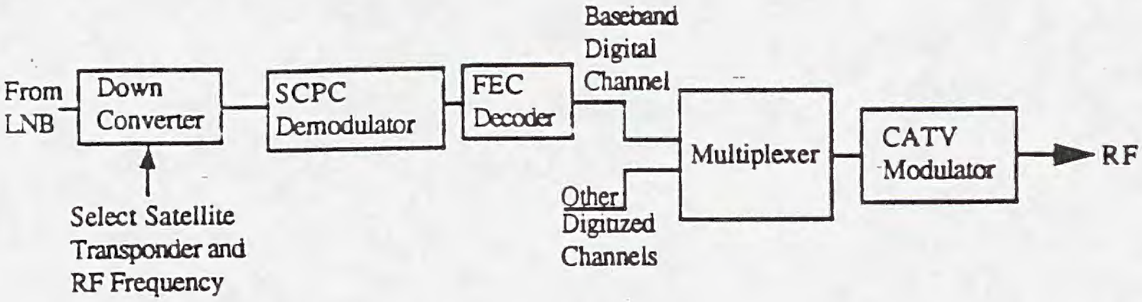


Figure 3 Continued





4.6 VBI Signals

Additional digital and analog signals contained within lines 10 through 21 of the vertical blanking interval must be transmitted and re-inserted in the vertical interval of the output. Refer to section 5.1.5.

4.7 Satellite Link Parameters

The design of the equipment shall include considerations of the satellite transponders that will carry the modulated digital signal. Vendors shall provide assumptions and calculations of the link budget including, but not limited to, the following parameters:

1. The design must operate to its specifications using both TWT (Traveling Wave Tube) and SSPA (Solid State Power Amplifier) transponder designs on KU and C band transponders for the satellites listed in Section 1.3.

   a. Satellite impairments and variations must be evaluated carefully and the vendor must respond with information on the following:

      i. Operating point on transponder including input backoff and output backoff levels.

      ii. Adjacent transponder or cross-polarized transponder interference levels.

      iii. Frequency plans for single channel per carrier designs, including EIRP/Carrier, acceptable intermodulation predictions, and predicted adjacent satellite interference from full transponder signals into the SCPC signals.

      iv. Transponder test plan specifying a specific transponder and the corresponding data for test locations applicable to that transponder.

v. Derivation of the transmission channel noise-bandwidth and a spectrum plot of the modulated signal showing its occupied bandwidth.

vi. A complete definition of how the vendor will determine impairments due to:

a. Mispolarization/Faraday effects
b. Rain fading/antenna mispointing
c. Atmospheric absorption
d. AM-PM variations in the transponder due to the above

vii. Effects due to the variation in amplitude response and amplitude response and group delay of transponders.

viii. Effects due to amplitude linearity of the received L band signal due to various cable lengths in receive systems.

b. The satellite transponder should be assumed to be 36 MHz or less in bandwidth.

c. Respondents shall describe the modulation scheme in depth, and provide EbNo requirements versus corrected and uncorrected bit error rate and associated signal quality. In addition the respondents will show how they derive the carrier noise ratio conversion factor from EbNo.

2. Vendor shall demonstrate system performance over actual listed satellite transponders for at least one each TWT and SSPA design transponders. The test system shall also be demonstrated to operate effectively using standard Klystron or TWT ground power amplifiers that may be saturated.

The receive system shall operate properly using standard dielectric resonant oscillator (DRO) design low noise block converters (LNB) as defined herein and standard cable television receive antennas.

4.8 The Cable Television Plant

Part of the task of designing the compressor/decompressor must be to evaluate the potential design of the cable television digital modulator and its low cost companion digital converter.

1. The interface from the satellite compression system to the cable television compression system must be an EIA standard interface, as shall all interfaces between modular portions of the system. (See drawings in Section 4.5.).

2. The digital modulator should transmit its signal(s) into the standard 6 MHz cable television frequency plan so that it can be incorporated into existing cable plants.

3. The vendor shall demonstrate the digital timing versus real video signal timing issues that affect the feasibility of doing ad insertion or video program substitution (virtual channels).

4. The cable television compression system will normally be located at the headend site and will normally be mounted in equipment racks or cabinets.

5. The cable television compression system shall use a 19" wide rack shelf(s) capable of mounting in a 24" or less depth cabinet as defined in EIA-RS-310-C.

6. The cable television compression system shall operate from standard domestic US AC power of 120 volts 60 Hz within a range of ±10% in voltage and within a range of 47-63 Hz.

Power consumption for the cable television compression system, including any associated equipment, shall be specified.

7. The cable television compression system shall operate properly at 5% to 95% humidity over a temperature range of 0-50°C at altitudes up to 10,000 ft.

8. The digital modulator and its output signal must be compatible with existing cable television hardware used in standard cable television systems.

   a. The cable television plants may include fiber optic AM/FM/Digitally modulated trunks, AML/FML microwave systems, transportation trunk designs using coaxial cable, and the standard coaxial trunk, distribution and passive equipment operating today or in the foreseeable future.

   b. The vendor shall specify operating carrier level, bandwidth and noise objectives for the digital cable television signals.

   c. The frequency plan used in the digital modulator and converter must be carefully considered in order to provide simple, user-friendly channel selection to subscribers regardless of cable operators' dynamically varying usage and assignment of compressed digital channels.

4.9 Output Signals

The following signals shall be included as outputs of the decompressor:

NTSC
RGB
YUV
Up to 4 channels of audio for each video channel
Auxiliary data
VBI signals included in the NTSC signal

Refer to Section 6 for output signal specifications.

5.0 GENERAL REQUIREMENTS

Vendor shall provide detailed descriptions as to how each of the following criteria will be met by the proposed system. If a particular requirement cannot be met as described, the vendor shall propose an alternative concept with sufficient detail to understand the alternate approach desired by the vendor.

5.1 General Features

5.1.1 Video

This RFP requests a system design that encompasses two quality levels of video transmission: Studio Quality and Entertainment Quality. As well, there are two source modes of video: video sources and film sources. Either mode may be displayed with either quality level.

Video sources originate and are displayed at a 59.94 Hz field rate, while film originates at 24 frames per second and displayed at 59.94 Hz field rate, using a 3/2 pulldown. Film's inherent temporal redundancy reduces its required data information bandwidth, and can be coded with a lower transmission bit rate than video, or at a higher quality level for the same transmission bit rate.

5.1.2 Number of Audio Channels Combined With Each Video Channel

Four near-CD quality audio channels per each video channel are required. Audio channels may carry mono, stereo, second language, surround sound, or other information. Each of the four audio channels may be used independently of one another or together in any combination or configuration changeable from the uplink control center or remote location.

The user shall have the capability to preset certain audio channel configurations. The decompressor is required in a minimum configuration to output only the audio channel(s) associated with the selected video output.

Audio outputs shall include analog baseband, and digital data per Section 6.2.

5.1.3 Video Compression Ratio Change Tracking

The degree of compression for each channel shall be automatically determined based on the quality and number of channels to be compressed into one transponder signal. The decompressor shall be capable of automatically and seamlessly tracking changes in the compression ratio and steering the audio and video outputs to the same output over the entire range of compression ratio changes. For example, the video and audio on output 1 will continue to appear on output 1 as the compression ratio is moved between 4 and 8 channels.

5.1.4 Auxiliary Data Channel

A data channel for each video channel shall be provided and output as part of the selected channel output signal. The data rate prior to encryption and error correction shall be no less than 19,200 kilobaud with the capability of selecting lower data rates if desired. The data channel shall include independent encryption and addressable to individual decompressors. The data format shall be specified prior to final vendor selection. All data channels shall be multiples of 75×2^n bits/second, and as a minimum 300, 1200, 2400, 4800, 9600, 14400 and 19200 bits/second shall be supported.

5.1.5 VBI Signals

The following signals traditionally carried in the VBI are described below. The system design must include the capacity to carry up to 200,000 bits per second of data per video channel.

5.1.5.1 Teletext Channel

One teletext channel for each video channel shall be provided. The teletext format shall be of the same quality and type as the EIA 516 North American Standard. The control and addressing capability shall support up to 1000 pages of teletext information for each video channel. As part of the response to the RFP, the vendor shall identify the time required to transmit all 1000 pages of information.

Some versions of the decompressor must be able to select specific pages for display including page scrolling, back paging, or page jumps. The format and control frame for the teletext pages must include the ability to format the pages into blocks or groups of pages where the decompressor shall be able to load an entire block of pages into the subscriber terminal local memory. This feature is designed to reduce the time required to capture pages of teletext information.

When activated at the decompressor, the teletext page shall be displayed with the video information as an overlay or a replacement for the normal video channel. This feature may be overridden at the discretion of the subscriber.

5.1.5.2 Closed Captioning Channel

Closed captioning data from line 21 in both field 1 and 2 shall be stripped from the input video waveform and coded separately into a data channel associated with the source video channel. At the decompressor, the closed captioning data shall be reinserted onto the corresponding original fields of the reconstituted video signal, in compliance with closed captioning specifications. The resulting closed captioning information shall perform in all respects exactly as the original form.

5.1.5.3 Other Digital Signals

Digital information within lines 10 through 20 must be transmitted and reinserted in the proper VBI line for each video channel.

5.1.5.4 VITS

If the input video signal contains a VITS component, the VITS must be sampled at a low frame rate and the sampled VITS used to reconstruct a VITS signal as part of the output.

5.1.6 Subscriber Messages

The System must support the distribution of unique page messages that can be updated at least once per minute to a limited number of users. The number of individual decompressor terminals supported shall be stated along with a description of message transmission speed. This information is carried on the teletext channel.

5.1.7 Anticopy Capability

The System must include an anticopy provision to prevent unauthorized recording of the baseband decoded output of subscriber decompression units. This provision shall be controlled as part of the individual unit addressability, either locally by the cable operator or via the master data stream from the compressor. Selected subscriber decompression terminals may be authorized to copy programs while other units are prohibited. Enabling the anticopy system must not impair the recovery and display of closed captions.

5.1.8 Signal Security

The compression system must use a digital encryption process that is designed to meet or exceed the following criteria:

a. Capable of providing encryption for digital data streams sufficient for the transmission of digitized and compressed video and audio sources with a system cryptographic duty cycle in harmony with current good cryptographic practice.

b. Capable of withstanding a sustained cryptographic attack by a commercially equipped laboratory for at least 72 hours for each encrypted signal.

c. Capable of encrypting multiple source material and switching between same without reinitialization of the decryption device at the subscriber home.

The encryption algorithm shall be compared to NSA algorithms and standards for encryption with endorsement by the NSA preferred. In the event that the compression system provides security levels that are not approved for export from the United States, alternate encryption processes shall be available that can be readily implemented without significant redesign of the System.

The separate encryption of all individual video, audio, data, and teletext channels shall be accommodated. Encryption shall be applied separately to each channel provided. A "three musketeers" attack must be impossible wherein identical copies of an authorized box will not in themselves be authorized. Now that it is understood how pirates attack scrambling systems, "hardware and software" elements for decoding and decryption shall be "designed" to be secure against electrical and physical modifications intended to defeat them.

A minimum of two simultaneous paths of decryption authorization shall be accepted. The primary route of encryption authorization shall be incorporated within the signal itself. The secondary authorization shall be accomplished via some other communication path (i.e. smart card, telephone, etc.).

The design must include an encryption concept that accounts for both signal security, (i.e. preventing the ability to decode the signal using a "black box"), and circuit security, (i.e. preventing the ability to modify the box to decode unauthorized channels). Each channel of video, audio, teletext, and data must have independent keys with unique decode instructions for each service.

The vendor shall discuss the potential to periodically upgrade the system security using code changes, hardware upgrades, or other methods as defined by the vendor.

5.1.9 Uplink System Failures

The uplink shall consist of the primary system, a hot-standby backup system and associated sensing/monitoring equipment. The inputs to the primary compressor are compared to the decompressed outputs. If a difference between the inputs and the expanded outputs exceeds a predetermined limit, a failure is declared and action taken.

If a failure is detected on the primary system, the backup system shall be switched on line. If a backup failure is similarly detected, the System shall hold in its last operational state.

Whenever a failure is detected the system shall provide an output signal to indicate this condition. the output signal indicating fault shall be a standard group of form C relay contacts, capable of handling up to 24 VDC at 3 watts. In addition, the logic shall initiate a summary fault, using another form C relay. The user shall have the capability to program the conditions and limits under which failure is detected and automatic backup is initiated.

For maintenance purposes and large system backup, a 1-for-N backup configuration should be detailed.

It is important that the system have operational status and mode of operation indicators such as an on-screen display (OSD), LED and/or meters to indicate mode of operation and status of the system. Also required is a computer port, computer, and appropriate software with the capability to monitor and access the status of the system.

5.1.10 Decompressor System, Cable Television Headend Unit

A "family" of equipment configurations will be required for cable television downlinks. These are illustrated in Figure 3. All of the configurations do not have to be available initially, but must be planned for, priced and described. The number of video and audio signals from a transponder used by a given cable television system will vary from one to all, possibly dynamically over time. Also, the processing necessary per derived channel will also be different, channel by channel. The configurations will include:

> One or more derived video(s), audio(s), and aux(s) bit stream(s) with no processing but FEC added as necessary connected to a digital cable television RF modulator.
>
> One or more derived video(s), audio(s), and aux(s) bit streams decoded and converted to NTSC with standard NTSC video and audio output interfaced and a data interface.

The cable television system shall have a backup capability. In the ideal implementation, the downlink system should support a Y for N backup system in which Y equals the number of backup systems and N equals the number of primary systems to be backed up. Automatic failure sensing and changeover equipment then switches the failed unit off line and a backup on line.

As a minimum, the cable television downlink system shall support a 1 for 1 redundant configuration with automatic backup.

A standalone commercial cable television system shall be proposed that accepts the IF output of a satellite receiver.

All system video and audio analog output connections shall interface with the existing cable television channel modulators and video scramblers. The decompressor shall also incorporate a compressed digital output that will directly interface with the cable television digital modulation unit.

It is important that the cable television system have operational status and mode of operation indicators, such as an on screen display (OSD), LED and/or meters. A form C relay contact summary alarm shall be provided on the cable television decompressor indicating fault.

5.1.11 Virtual Channels Via Remote Retune

The System must be capable of creating virtual channels by retuning and controlling cable television decompressors through a control channel in order to create, in realtime, program channels built from programming selected from other compressed channels on the satellite, other compressed channels from other sources, and standard channels from up to 10 external sources. This capability must be addressable, allowing each receiving site to select programming independently of all other receiving sites. The video switch between synchronized sources must not cause a roll, or any other visible artifact. The audio switch between synchronized sources must not cause a pop or any other audible artifact.

It is recognized that text and data channels may not be compatible with virtual channels.

Virtual channel creation shall be transparent to the cable operator and fully controlled by the uplink System.

The following will illustrate creation of a virtual channel. Given four video continuities, perhaps consisting of short news stories, a virtual channel could be created by retuning or switching channel A into the virtual channel for 30 seconds, then switch to channel B for one minute, then to C and D for appropriate durations. By properly scheduling the segments and retuning, a large number of virtual channels could be created from these four base channels.

5.1.12 Cable Compatibility

It is an objective of the design to interconnect the satellite compression system with cable compression systems with simple, low cost interface hardware that introduces no incremental degradation in the signal quality. As part of the response, the vendor shall define the requirements of this interface and determine if the satellite compression system is compatible with cable. If the proposed system requires conversion back to full bandwidth video and another compression process is required for the cable distribution system, the impact on quality of the signal at the cable consumer unit must be predicted and the cost of the additional conversion process be estimated.

The multiplexed satellite compressed channels shall be able to be individually extracted from the data stream and passed as a digital bit stream for each individual channel without decompression, to the cable compression system. As part of the response the vendor shall define the data format and rate of each of the individual compressed channels along with the requirements on the cable compression system to receive these data streams.

The objective of the cable compatibility requirement is to allow cable operators the flexibility to select and route program services based on their individual requirements.

The satellite compression system shall be designed to accommodate local commercial insertion at the cable system level. If the interface between the satellite and the cable compression system is digital, appropriate hooks, data breaks, and coding shall be incorporated to allow digital compressed insertion.

5.1.13 Long Term Compatibility of the Compression Technique

It is expected that this system will be in operation for at least 7 years. Every reasonable effort must be made to ensure that the satellite compression technique and its interface to a cable compression system shall be compatible with digital consumer VCR's and other consumer devices.

It is desirable for the satellite and the cable television digital modulation sub-systems to accept, transmit, and receive digital HDTV signals at a bit rate that is a superset of the compressed NTSC bit rate.

The compression/decompression system shall be compatible with SuperNTSC encoding. The compression algorithm shall not degrade SuperNTSC processing.

5.1.14 Multilevel Addressing/Security Hierarchy

The System shall incorporate an addressing/security plan with the following features:

5.1.14.1 Uplink addressing to the headend with full descrambling
5.1.14.2 Uplink addressing to the headend without full descrambling but allowing the cable operator to insert cable system addressing information to the subscriber for full descrambling.

The local cable system insertion equipment must have all of the features of the national encryption system and both systems must be supported by the in-home consumer device.

5.1.15 Production Quality Control

Objective test and measurement procedures shall be developed jointly between the vendor and purchaser of this system. These procedures shall be used to evaluate the system during the selection process to verify adherence to specifications during production and to verify performance during the operational life of the System.

All compression/decompression hardware and software shall be electrically activated and fully tested for a specified period of time before delivery to reduce early life failures and insure reliable operation. The vendor shall provide a list of testing procedures and recommended burn-in time periods with their proposal.

For uplink systems, detailed printed records of tests performed on each unit shall be maintained and shipped with each unit. For high volume products, the vendor shall propose a production test plan including qualification sample programs that meet or exceed the quality inspection requirements of the cable industry.

5.1.16 Audience Polling

The system shall provide the capability, when activated, of tracing audience viewing patterns to be used for market research purposes.

5.1.17 One-Way Interactive Data Channel

Provision shall be made for a 1200 bits per second asynchronous RS449 or RS232 data channel from the program source to the subscriber terminal to support interactive services. Vendors may also wish to discuss a two way interactive data channel.

5.1.18 Remote Control and Indicator Output

The compressor and cable headend decompressor shall allow indicators and controls to be placed at a remote control location that is at least 100 feet away from the system.

5.2 Quality Assessment for Compressed Signals

While traditional objective video and audio tests have served well over the years, in today's compression systems, subjective quality does not necessarily correlate with objective measurements. This tends to make test results unreliable.

For example, a compressed video system may measure up to the RS-250-B "short haul" level, but picture quality on typical program material may be poor. For this reason the following video and audio quality assessment test plan is recommended.

5.2.1 Video Tests

Since video artifacts are difficult to predict in compression systems, a number of testing approaches and a wide variety of test materials will be employed to ensure detection. They will consist of subjective tests (including typical video, film source, and graphics) using CCIR Rec. 500 guidelines, multi-dimensional video tests, and conventional analog test patterns.

5.2.2 Audio Tests

Standard frequency response, THD and SNR measurements will be made, but in addition, level dependent THD and SNR will also be tested. As well, subjective quality tests will be included.

5.2.3 Operational Tests

These tests will include concatenation of two compression systems in a variety of combinations, tests to identify artifacts caused by switching between compressed digital sources and tests to identify artifacts caused by a temporary loss of data will be performed.

5.2.4 Comparison of System Performance

The results of each test for each system will be quantified and normalized. These ratings will be organized into a matrix with each system as rows and each rating as columns.

In the absence of extreme scores, arithmetic means for each system will be compared to determine overall performance. If, however, a system were to have an unacceptable rating in one or more critical areas, it would be eliminated from consideration, unless the vendor were able to correct the problem. For a more detailed discussion of these tests, please refer to the attached Appendix A.

6.0 SYSTEM SPECIFICATIONS

6.1 Compressor Input Signals

6.1.1 Analog Signal Input

6.1.1.1 Video Input Specifications

Up to eight individual signals of any combination of the following types.

a.) NTSC

Impedance	75 ohms
Level	1.0 V ±0.3 Vp-p
Sync	Negative
Connector	BNCx2 (loopthrough)
Return Loss	Greater than 30 dB
Level Adjust	±3 dB

b.) RGB

Inputs	1 each for R, G, B
Impedance	75 ohms
Level	G 1.0 V ±0.3 Vp-p R,B 0.7 V ±0.2Vp-p
Sync	on G only; Negative
Connector	BNCx2 (loopthrough) for R, G, B each
Return Loss	Greater than 30 dB
Level Adjust	±3 dB

c.) Y/R-Y/B-Y

Inputs	1 each for Y, R-Y, B-Y
Impedance	75 ohms
Level	Y 1.0 V ±0.3 Vp-p R-Y,B-Y 0.7 V ±0.2Vp-p
Sync	on Y only; Negative
Connector	BNCx2 (loopthrough) for Y, R-Y, B-Y each
Return Loss	Greater than 30 dB
Level Adjust	±3 dB

6.1.1.2 Audio Input Specifications

Up to four baseband balanced for each video channel. Each baseband channel may carry an independent audio signal with independent amplitude levels.

Impedance	600 ohms
Signal level adjust	±6 dB
Connector	XLR 3-pin female
Level (nominal)	+4 dBm
Level (clipping)	+20 dBm
Crosstalk	< -50dB

6.1.2 Digital Signal Input

6.1.2.1 Digital Video Input

Digital video baseband input of D1 or D2 specification must be available as optional inputs. A specification for serial digital video is attached as Appendix B.

6.1.2.2 Digital Audio Input

Four digital audio inputs with the following specifications must be available as an option for each video compressor channel:

a.) Data Rate

AES/EBU, 48K samples/sec, 20 bits, linear
32 K samples/sec, 16 bits linear
44.1 K samples/sec, 16 bits, linear
48.0 K samples/sec. 16 bits linear

6.1.2.3 Auxiliary Data Signal Input

1. This shall operate with standard data communications equipment using the EIA-RS-232-C or EIA-RS-449 interface for asynchronous data transmission at transmission speeds up to 19,200 bits/second.

2. This port shall provide all standard control signals (such as request-to-send, clear-to-send, data-terminal-ready, etc.) such that all standard data protocols for asynchronous circuits can be implemented.

3. The vendor shall use the correct connector for the EIA specification implemented and all electrical specifications shall be adhered to.

6.2 Video Specifications

The video signals in Sections 6.2.1 to 6.2.4 shall conform to the following picture signal impairment performance limits specified by EIA RS-250-B:

Chrominance-to-Luminance Gain Inequality
Chrominance-to-Luminance Delay Inequality
Field Time Waveform Distortion
Line Time Waveform Distortion
Short Time Waveform Distortion
Long Time Waveform Distortion (Bounce)
Insertion Gain Variation
Luminance Nonlinearity
Differential Gain
Differential Phase
Chrominance-to-Luminance Intermodulation
Chrominance Nonlinear Gain
Chrominance Nonlinear Phase
Dynamic Gain of the Picture Signal
Dynamic Gain of the Synchronizing Signal
Transient Synchronizing Signal Nonlinearity
Signal-to-Noise Ratio (10 kHz - 5.0 MHz)
Signal-to-Low Frequency Noise Ratio (0-10 kHz)
Signal-to-Periodic Noise Ratio (300 Hz - 5.0 MHz)

The cable television (CATV) headend unit shall conform to short haul specifications; the consumer units shall conform to medium haul specifications. Additionally, the frequency response and other characteristics are specified in the following sections:

6.2.1 NTSC

	Cable Television Headend Unit
Frequency Response	±0.25 dB to 4.2 MHz -3 dB at 5.0 MHz -12 dB beyond 6.0 MHz
Chrominance Bandwidth	-3 dB at 3.58 MHz+ 620 KHz (I,Q), -1.3 MHz (I), -620 KHz (Q)
Y Vertical Response	At least 20% response at 330 lines
Return Loss	Greater than 30 dB to 6 MHz

6.2.2 Y/C

	Cable Television Headend Unit
Y Frequency response	±0.25 dB to 5.0 MHz
C Frequency response	-0.5 dB at 3.58 ±2.25 MHz -12 dB beyond 3.58 ± 2.9 MHz
Return Loss (Y and C)	Greater than 30 dB to 6 MHz
Negative sync on Luminance, no burst	
Y Vertical Response	At least 20% response at 330 lines
Return Loss	Greater than 30 dB to 6 MHz

6.2.3 YUV

	Cable Television Headend Unit
Y Frequency response	±0.25 dB to 5.0MHz -3 dB at 5.0 MHz -12 dB beyond 6.0 MHz
C Frequency response	±0.5 dB to 2.25 MHz more than -12 dB at 2.9 MHz
Y Signal level	1 Vp-p into 75 Ω
C Signal level	0.7 Vp-p into 75 Ω
Y Vertical response	At least 20% response at 330 lines
Return Loss	Greater than 30 dB to 6 MHz

6.2.4 RGB

	Cable Television Headend Unit
Frequency response	±0.25 dB to 5.0 MHz -12 dB at 6.0 MHz
Signal level G:	1.0 Vp-p into 75 Ω
R,B:	0.7 Vp-p into 75 Ω
Negative sync on Green.	
Vertical resolution	At least 20% response at 330 lines
Return loss	Greater than 30 dB to 6 MHz

6.2.5 Digital Composite

Serial: See Appendix B for specification.
Parallel: To be determined.

6.2.6 Digital Component

Serial: See Appendix B for specification.
Parallel: CCIR Rec. 601 and 656, SMPTE RP-125

6.3 Audio Specifications

	Cable Television Headend Unit
Frequency Response	±0.25 dB 20 Hz to 20 KHz
Total Harmonic Distortion	Less than 0.2% 20 Hz to 20 KHz at +20 dBm
Hum and Noise	Greater than 80dB below +4dBm
Crosstalk Isolation	Greater than 80 dB from 20 Hz to 20 KHz at +20 dBm on all channels except the measured channel.

As per AES/EBU spec., ANSI S4.40

6.4 Satellite Data Channel Specifications

6.4.1 Bit Error Rate Performance

The video compression system modem shall attempt to provide the following minimum performance:

1. In a local electronic-to-electronic loop, the FEC encoder/digital data modulator cascade shall have a serial baseband pseudonoise sequence as test-data input, with the modulator IF output directly connected to the demodulator IF input, and the demodulator/FEC decoder cascade baseband serial bit stream output recovering the test data. Error correction overhead must be added at the modulator and removed at the demodulator with correction of detected channel errors disabled at the FEC decoder. The background (dribble) bit error ratio of this IF back-to-back configuration measured at the test data output shall be no more than 10^{-10}.

2. The addition of RF upconversion and downconversion between the modem IF input and output in an RF back-to-back configuration shall increase the background bit error ratio to no more than 10^{-9}. All BER measurements must be stationary over a 72 hour period.

3. The addition of a complete satellite link with a TWT or SSPA transponder at test locations specified with clear sky conditions shall be inserted between the RF input and output. The link parameters listed in Section 4.7 must be specified for a bit error ratio of 10^{-10} with error correction enabled.

6.4.2 Carrier to Noise Performance

The system shall not allow more than one uncorrected error event every 24 hours at C or KU band receiving sites as determined in Section 4.7.a.1.e. (interference not included).

The System shall meet all performance objectives with typical cable television equipment using standard LNA's and LNB's. As part of the response to the RFP, the vendor shall identify all assumptions for incoming signal quality.

6.4.3 Carrier to Interference Performance

For independent cochannel interference sources such as cross polarized signals and intermodulation products with a C/I of at least 10 dB, the link performance shall be reduced by no more than the equivalent C/N performance when the noise is the aggregate thermal noise plus interference power.

The system shall meet all performance objectives with typical cable television equipment using standard LNA's and LNB's. As part of the response to the RFP, the vendor shall identify all assumptions for incoming signal quality.

6.4.4 Error Propagation and Concealment

To the extent possible, error concealment should be used to disguise errors visually, by replacing a corrupted data block or sample with a correlated data block or sample.

In the event an error occurs that cannot be corrected or concealed, the degradation caused by the error shall not propagate a visually detectable defect for a duration greater than 100 milliseconds.

The system shall achieve full signal acquisition within an acceptable short period of time after a channel change or signal interruption. Vendor shall conduct a study to determine the maximum acceptable acquisition time. The current displayed image shall be blanked or frozen during acquisition.

6.5 Mechanical and Environmental Requirements of the Compression System

The encoding system will normally be located at the production or uplink site and will normally be mounted in equipment racks or cabinets.

1. The system shall use a 19" wide rack shelf(s) capable of mounting in a 30" or less depth cabinet as defined in EIA-RS-310-C. Airflow shall be front-to-back or back-to-front.

2. The vendors response shall include detail on the rack height of the system shelf(s), a rack layout drawing, and suggested cooling.

3. The encoding system shall operate from standard domestic US AC power of 120 volts 60 Hz within a range of ±10% in voltage and within a range of 47-63 Hz.

   Power consumption for the system, including any associated equipment, such as CRT displays, PC terminals, computer and memory devices, and test equipment shall be specified.

4. The system shall operate properly at 5% to 95% non-condensing humidity over a temperature range of 0-50°C at altitudes up to 10,000 ft.

5. The encoding system shall have provisions for the following output signals:

   a. IF output -- the modulated digital signal output, using a 75 Ohm cable of up to 100 feet with a 50 Ohm BNC connector, unbalanced and adjustable over a range of -10 to +5 dBm.

   b. An unmodulated digital bitstream output containing the multiplexed A/V and other signals will be provided, conforming to an RS-422 electrical format.

c. The IF signal shall be filtered to remove any potential interference to adjacent channels on the satellite or microwave radio as defined herein for radio channels or transponders of 36 MHz or less.

The vendor shall specify the required temperature and long-term frequency stability, acceptable phase noise and other required parameters of the upconverter.

d. A composite video sync signal (black burst) shall also be provided as an output in the compressor to allow studio or transmission equipment to be synchronized to the compressor. This shall be a 1 volt peak-to-peak 75 Ohm cable of up to 100 feet with a 50 Ohm BNC connector, unbalanced in accordance with EIA-RS-170-A.

e. The compressor shall include a provision for fault alarms, testing and display of faults.

Form C contact closure relays shall be implemented for major components. This shall be a DPDT, each contact capable of connecting up to 24 volts of at least 3 watts.

f. An IF monitor port similar to the IF output shall also be incorporated for testing purposes.

6. The encoding system shall be constructed of the following modules, each of which shall have EIA standard interfaces that are accessible to the operator:

Compressor
Multiplexer
Encryption Controller
Forward Error Correction Encoder
Modulator

6.6 Mechanical and Environmental Requirements of the Decompression System

1. The commercial cable television decompressor shall be a 19" rack-mounted unit that mounts in a 24" deep rack, meeting all requirements of EIA-RS-310-C.

2. The unit shall operate from 120 VAC 60 Hz ± 10% voltage and 47-63 Hz frequency.

3. The unit shall operate at 5%-95% non-condensing humidity over 0-50°C temperature at up to 10,000 ft. altitude.

4. The connectors shall include the following:

a. L band RF input of 950-1450 MHz at input level of -70 to -25 dBm using a type F female connector, 75 Ohms unbalanced. This is the satellite input signal from the LNB. A horizontal and vertical input is required on the cable television version for both Ku band and C band inputs (4 total), such that polarity and switching is accomplished in the unit.

b. The cable television version should include an IF loop through connection using a 70 MHz center frequency. This shall operate at a level of +10 to -20 dBm to allow testing in conjunction with the compressor IF output signal. These shall be BNC female 75 Ohm cable, unbalanced.

c. The video output(s) shall be female BNC connectors on the cable television version being 75 Ohms unbalanced, providing the levels defined in Section 5.2.1.1.

d. The audio outputs shall be connected on the cable television version using miniaturized barrier strips for each of four audio circuits associated with the selected video channel. Each circuit shall be 600 Ohms balanced as defined in Section 5.2.1.2.

e. An AC fuse or circuit breaker shall be located on the rear panel of the cable television unit.

f. LNB power shall be available on the RF input circuits and this must be selectable port-by-port on the cable television version using a rear panel switch. The cable television version must provide a fused +18 VDC at up to 500 mA current.

g. The cable television version must include a digital output signal that uses the EIA-RS-422-A interface (consistent with the compressor digital interfaces) on the rear panel if a demultiplex is used, the low speed digital circuit(s) using EIA-RS-422-A interfaces shall also be provided on the rear panel. Channel data using EIA-RS-232-C/RS-449-A shall also be provided on the rear panel of the cable television version.

5. The design of the cable television L band down converter portion must be front panel manually tunable using either thumb-wheel or key pad or push button controls.

The local oscillator must be designed to be frequency-agile in steps of 20 MHz for C band tuning standard satellite frequency plans and the Ku band frequency tuning will require tuning steps of 250 KHz or smaller so that center frequencies of the various Ku band transponders are available.

6. A horizontal/vertical polarity switch shall be provided on the front panel of the cable television headend receiver..

6.6.1 Prototypes

The vendor shall provide a minimum of 25 prototype decompressors and two compressors as part of the certification process. A joint test program shall be developed to use in confirming performance of the System.

6.6.2 Preproduction

The vendor shall provide a minimum of 100 preproduction decompressors and two compressors to confirm final design changes prior to production release. These units shall be used to support a field test program.

6.6.3 Certification Requirements

The vendor shall obtain FCC, UL, and CSA approval for all components in the system prior to production release.

7.0 SUBSCRIBER CONTROL SYSTEM

7.1 Objective

Cable television operators must have the ability to manage the service level to their customers in two ways: with a local control system, or by interacting with a national control system -- particularly in the case of smaller cable systems where this would be economically desirable.

7.2 System Capability

The Subscriber Control System (SCS) provides the network management, control, and monitoring of all compressors and decompressors within a defined network. All system configuration and device control is implemented through the control software within the SCS including compressor configuration, and configuration and authorization of all decompression devices connected to the network.

For the compressors connected within a single multiplexed output channel, the SCS provides all control information to the compressor including the virtual channel assignments, channel location as packed into the bit stream, authorized decompressor devices for each compressor, encryption control, control and command data, and the capability to process status report information from the compressor for system verification and reports.

For the decompressor devices, the SCS maintains subscriber information including authorized channels and events, update device key codes for descrambling authorized channels, create all text messages, load decompressor configuration including virtual channel assignments, and initiate and accept device responses to request for information.

The SCS shall have the capability to independently control these functions or accept a data stream from other computer systems that have the capability to implement any desired function. This linking process, provides the capability to network multiple SCS systems together and share one data base and system control facilities between several SCS controllers.

7.3 Required Functions

1. Authorize individual compressors receiving the multiplexed data necessary to process individual channels.

2. Initialize individual compressors to a configuration defining each channel's position in the multiplexed data stream, define channel address, channel compression ratio, and system configuration.

3. Provide encryption, decryption keys, and system security. Include provision for updates of security control information. Include both active and passive security protection for all devices within the system.

4. Monitor compressor status and report failures. Maintain a log of system activity including an audit trail of operator activity by individual.

5. Authorize individual decompressor devices to accept specific channels or programs. Force tune individual devices or groups of devices to specific channels.

6. Maintain affiliate files in a relational data base. Incorporate the capability to update individual records, groups of records, or the entire data base while maintaining system control.

7. Provide multi-user input capability based on the size of the data base with a growth strategy that does not require system configuration changes to expand the number of input terminals. Incorporate system security for each data entry operator including via computer networks, Allow user commands via pull-down menus or by command input at the option of the user. Provide the capability to assign functions to specific levels of security and log users to individual levels. Maintain a log of all activity.

8. Include a range of user defined reports generated on command or at timed intervals in a programmable format compatible with a relational data base program.

9. Include a redundant operating feature with a fully backed up data base and SCS computer. Self checking shall be performed on a real time basis and automatic switch-over to the back up computer and data base shall be completed without interruption of the system operation.

10. Provide real time control of the following functions:

    a. Pay per view events based on call-in and impulse systems
    b. Two way interactive commands and data streams
    c. Channel authorizations
    d. Text messages to individual devices or groups of devices

    e. Allow decompressor control on an individual, or up to 50 unique group codes that the system operator may define.
    f. Security and encryption/decryption key codes.

11. The system shall provide fast transaction time, with an imperceptible time delay for the operator.

12. The system shall be designed to provide the local cable operator the ability to insert decompressor control information in the digital data without requiring the data to be decoded and recoded.

7.4 Programming Requirements

The control software within the SCS shall be written using code that is readily portable to other computer platforms. The fundamental basis for the control software shall be based on a relational data base architecture compatible with future expansions and features of the code. The data base shall be structured as one large data base or an interconnected data base shared between some number of SCS computer systems. All documentation and source codes shall be provided as part of the deliverables.

All user input and user output shall be based on definition files providing the capability to customize the format and information required based on the preferences of the individual system operator. These control files shall include sufficient capability to provide user input with a minimum of training and short cut command based inputs for skilled operators.

All real time control requirements shall be processed and inserted in the outbound data stream within 3 seconds of the command initiation . As the system complexity and size of the data base grows, provision for future parallel processing systems sharing the real time tasks shall be included in the design structure.

7.5 System Specifications

7.5.1 Data Base Specifications

The data base shall be sized to provide storage of the total number of compressors and decompressors expected during the next few years. At present more than 10,000 headends with a channel capacity of 150 channels would be a reasonable size to consider. However, growth in system features and flexibility in addressing may require a much higher limit. A reasonable maximum for compressors and decompressors would be to expect a market of more than 10,000 headends with fifteen decompressors at each headend serving a viewer market size of 100 million decompressors. The file structure shall include the capability to modify and expand this file based on a configuration file. The data base requirements for each device include the following information:

1.) Affiliate Name assigned to device
2.) Affiliate ID
3.) Contact Information
4.) Decompressor address as appropriate
5.) Services authorized
6.) Virtual channel schedule
7.) Channel Map
8.) Reserved field for future use

7.6 Hardware Requirements

The hardware platform for the SCS shall be flexible based on the size of the data base for a specific operating system and the desired response time for real time control events. Consideration shall be given to expandable systems, for example parallel processors where the computing and data base requirements can be expanded without reconfiguring the software as the system is expanded to the next increment in growth. As part of the RFP, the vendor shall define the practical limits for each increment of growth of the system and the changes in configuration necessary to accommodate the increase in facilities.

All hardware shall be commercially available systems from major manufacturers that are reasonably expected to be in business for the next ten years.

7.7 System Reliability

The hardware and software of the system shall meet an availability requirement of 99.99% including redundant backup systems. Time to diagnose and repair a system failure shall not exceed 8 hours.

All software failures shall include failure codes sufficient to understand the conditions prior to and possibly causing the system crash.

8.0 CONFIDENTIALITY PROVISION

All information delivered to CableLabs in response to this RFP shall be submitted by each company without any obligation of confidentiality on the part of any of CableLabs, TCI or Viacom, unless the information is appropriately legended as "CONFIDENTIAL" and is not within any of the exceptions to confidentiality set forth below ("Confidential Information"). Except as required in connection with review and evaluation of the proposal, CableLabs, TCI and Viacom will not use or disclose any Confidential Information submitted by any Company without the prior consent of that company. No copies shall be made of each submission, and access to the Confidential Information shall be restricted to those officers, board members, employees, consultants and other agents of CableLabs, TCI and Viacom who have a need to know the information in order to assist in the review and evaluation. All persons having access to the Confidential Information shall be contractually bound to maintain its confidentiality. At the conclusion of the selection process, the original submissions provided by RFP respondents will be returned to the vendor.

Confidential Information shall not include any information which:

1. prior to submission is known by, or in the possession of, CableLabs, TCI or Viacom without any restriction on its use or disclosure;

2. is currently available, or becomes available, to CableLabs, TCI or Viacom from a third-party without any non-disclosure obligation in favor of the company originally supplying the same;

3. is or becomes generally known or readily ascertainable in the cable television industry (or industries supplying or servicing that industry) through no fault of CableLabs, TCI or Viacom; or

4. is independently developed by CableLabs, TCI or Viacom.

In each case the burden of proving the availability of the exception shall be on the party claiming the exception.

8.1 Confidentiality of Verbal Information

If information which is considered to be confidential is presented verbally, the following procedure must be adhered to:

1. The confidential information shall be noted as such during the verbal presentation.

2. All confidential material presented verbally shall be submitted in writing to the other party within 14 days for review of accuracy, and for approval.

Any obligation to maintain the confidentiality of Confidential Information submitted by any company in response to this RFP shall terminate and all obligations shall cease one year following the date of submission.

QUALITY ASSESSMENT METHODS FOR DIGITALLY COMPRESSED VIDEO

1. Introduction

Over the years, objective tests for analog television systems have been developed into a set of tried and true measurement techniques. Standards such as RS-250-B and NTC-7 include all the familiar test signals such as color bars, multiburst, modulated ramp and pulse and bar, to name a few.

Since the signals were based on an a priori knowledge of typical defects in analog television systems, the measures are very highly correlated with subjective picture quality. In fact, these tests are so reliable, that many equipment manufacturers have been able to create automated "test sets" which can monitor signal quality continuously and can alert operators to "out of spec" conditions.

Recent advances in non-linear digital video processing, such as video compression, have created a class of artifacts which are not easily tested using the objective techniques listed above, where certain systems produce "good" pictures despite poor RS-250-B ratings. And to make matters worse, systems which measure acceptably on objective tests may exhibit disturbing artifacts when portraying certain types of video material.

With these issues in mind, a new set of objective and subjective tests must be devised to measure the range of artifacts typically encountered with all types of video compression equipment, including predictive coding, transform coding, vector quantization and temporal processing. Ideally, these tests will provide a means to measure video quality in a repeatable, quantitative manner. One testing strategy is to produce tests which isolate individual limitations of a system. Another is to use combination tests which overload the information bandwidth of the system. Useful information about system performance can be derived using both.

2. Tests of Video Compression Techniques.

Below is a list of general descriptions for testing compressed video picture quality. A wide variety of material will be presented to ensure thorough testing of all systems. Results of all the tests will be normalized and reported within a matrix chart to allow comparison of each system on each dimension.

a. Subjective Tests. Ultimately, picture quality must be judged by human observers viewing a monitor, and the following types of material should be included. Judges may consist of a small number of expert viewers, a large number of non-experts or both, which will affect the cost and complexity of this approach. CCIR Rec. 500 test methods should be observed.

   i. Typical program material: video sourced material portraying sports, news (studio and remote material), action programs, music videos, children's programs, weather forecases, promos, commercials, etc.

   ii. Film based material: since film is a major source of high resolution television material and since film to video conversion using a 3/2 pulldown has temporal redundancy implications, it must be considered separately from video origination.

iii. Computer graphics generated materials: spatial and temporal aliasing, and high spatial frequency content typical of this material represents difficulties for compression equipment.

iv. Specially designed test materials: the CCIR video compression test materials and FCC ACATS (525/60) reference test materials may be adopted for use in the test.

v. Intentional use of white noise or other uncorrelated picture material for artistic purposes, especially when combined with other video material, will challenge some approaches to compression.

vi. Rapidly switching edited material.

vii. Noisy or poor quality material.

b. Conventional Analog Tests. The use of RS-250-B tests, while not providing a sole measurement of the system, will help in conjunction with other tests to obtain an understanding of the relative quality of each system's analog video processing circuits.

c. Digitally Generated Multi-dimensional Test Sequences. A class of test sequences designed to measure horizontal, vertical and temporal frequency and temporal responses have been developed by a number of research labs involved in video system testing. Monochrome and colored zone plates, rotating disks and rotating spirals characterize these materials.

3. Concatenation Tests

Each system must be tested individually to determine its baseline performance, which can be compared with the other systems. In addition, the following concatenation tests should be performed.

a. Compressed digital to compressed digital, same system. This performance should be compared to a single pass, and to the reference.

b. Compressed digital to compressed digital, different system. for systems which claim compressed digital compatibility with others, performance should be compared to each independent performance, and to the reference.

c. Decompressed and recompressed, analog intermediate, same system. Performance should be compared to a single pass and to the reference.

d. Decompressed and recompressed, analog intermediate, different system. Performance should be compared to a single pass through each system, and to the reference.

e. Decompressed and recompressed, digital intermediate, same system. Performance compared to a single pass and to the reference.

f. Decompressed and recompressed, digital intermediate, different system. Performance compared to single pass through each system, and to the reference.

g. Same as c through f, but with video switching, effects, super and graphics on intermediate video.

4. Switching in Compressed Data Format

Artifacts encountered when switching between two compressed video data streams will be observed. These may include video flash, vertical roll, loss of horizontal sync, mixing or scrambling of picture information. As well, systems claiming compatible compressed digital formats must be tested in this manner while concatenated.

5. Loss of Data

Each system will be checked to determine the effect of a momentary and permanent data loss. Repeat or interpolation may be employed to conceal a momentary loss of video information while freeze frame output may be desirable in the case of permanent loss.

6. Audio Tests

During video testing, audio testing will check frequency response, THD, level dependent THD, signal to noise ratio (SNR) and level dependent SNR. Audio "pops" and discontinuities which may occur during switches will also be checked. In the case of sub-band coding, a noisy "tone" should be measured for delta SNR and THD.

7. Conclusion

As stated above, results of each test will be normalized and tabulated into a matrix to allow a convenient means of comparison among the systems on each dimension. In cases where individual test results are not extreme, overall performance should be considered. This could consist of comparing a weighted average of the figures of merit for each system.

In the case that a system performs very unsatisfactorily in one or more critical area, this approach may not be practical. For example, if a system exhibits unacceptable subjective picture quality, it would have to eliminated from consideration regardless of scores on other tests, unless the vendor were able to correct the problem.

Final details of the testing program remain to be worked out, however, this is a large step at arriving at an equitable means to compare signal quality for each system. Other tests, as suggested by vendors, potential customers, etc., will be included if appropriate but every effort must be made to keep the number of tests to a minimum while maintaining a thorough review.

PROPOSED SMPTE STANDARD

Serial Digital Interface for 10-bit 4:2:2 Component and 4 fsc NTSC Composite Digital Signals

(Fifth Draft)

T14.224

July, 1991

PROPOSED SMPTE STANDARD Serial Digital Interface for 10-bit 4:2:2 Component and 4 fsc NTSC Composite Digital Signals (Fifth Draft)	T14.224 July 1991

1. Scope

This document describes a serial digital interface for System M (525/60) digital television equipment operating with either 4:2:2 component signals or 4 fsc N.T.S.C. composite digital signals. [For 625 Line PAL Composite Implementation see Appendix E.] The intended use of this standard is where the signal loss at 70MHZ (4fsc) or 135 MHZ (4:2:2) due to coax cable characteristics ($1/\sqrt{f}$) does not exceed approximately 30db.

2. Referenced Documents

The following documents are referenced as part of this standard:

2.1 ANSI/SMPTE RP125 "Bit-parallel Digital Interface for Component Video Signals"

2.2 CCIR Recommendation 601 "Encoding Parameters of Digital Television for Studios"

2.3 ANSI/SMPTE T14.22/082A Composite NTSC Digital Encoding and Bit Parallel Interface

2.4 CCIR Report 624-3 "Characteristics of Television Systems"

2.5 EBU/AES ANSI S4.40-1985 "Recommended Practice for Digital Audio Engineering - Serial Transmission Format for Linearly Represented Digital Audio Data"

3. Signal Levels and Specifications

3.1 The output of the generator shall be measured across a 75ohm resistive load connected directly to the output.

3.1.1 The generator shall have an unbalanced output circuit with a source impedance of 75 ohms and a return loss of at least 15dB over a frequency range of 5MHz to 270MHz.

3.1.2 The peak to peak signal amplitude shall be 800mV ± 10%, when measured across a 75ohm resistor connected to the output terminals.

3.2 The D.C. offset as defined by the mid-amplitude point of the signal shall be nominally zero volts ± 0.5 volts.

3.3 The rise and fall times, determined between the 20% and 80% amplitude points, and measured across a 75 ohm resistive load shall lie between 0.75 and 1.50 ns and shall not differ by more than 0.5 ns.

3.4 The timing of the rising edges of the data signal shall be within ± 0.25 ns of the average timing of rising edges, as determined over a period of 1 line.

Note: This specification is tentative with further work in progress to determine measurement method.)

3.5 The receiver of the serial interface signal shall present an impedance of 75ohms with a return loss of at least 15dB over a frequency range 5MHz to 270MHz.

4.0 Connector type

The preferred connector shall have mechanical characteristics conforming to the standard BNC type. Electrical characteristics of the 75 ohm connector shall permit it to be used at frequencies up to 850 MHz.

5.0 Channel Coding

5.1 The channel coding scheme shall be scrambled NRZI.

5.2 The generator polynomial for the scrambled N.R.Z. shall be

$$G1(X)=X^9+X^4+1$$ (See Appendix A1/A2)

The polarity-free scrambled NRZI sequence shall be produced by $G2(X)=X+1$. The input signal to the scrambler shall be positive logic. (The highest voltage represents data 1, the lowest voltage data 0.)

5.3 Data word length shall be 10 bits.

6. Transmission Order

The LSB of any data word shall be transmitted first.

7. 4:2:2 Component Signal Transmission

7.1 The input source for generating a serial 4:2:2 data stream shall be S.M.P.T.E. RP125. (See Appendix H)

7.2 The bit rate for the resulting serial data stream shall be nominally 270 Mb/s.

7.3 Auxiliary data if present on the RP125 interface shall be passed transparently.

8. 4fsc Composite N.T.S.C. Signal Transmission [For 625 Line PAL Implementation see Appendix E]

8.1 The input Source for generating a serial 4fsc composite data stream shall be SMPTE T14.22/080.

8.2 The bit rate for the resulting data stream shall be nominally 143 Mb/s.

8.3 Signal processing of the input signal is necessary to provide timing and synchronizing information in the serial digital domain [TRS-ID].

8.3.1 The TRS and line number ID shall only be present following the sync leading edge which identifies a horizontal rate transition.

8.3.2 The TRS signal shall consist of 4 words. TRS word number address shall be 790,791,792,793, with corresponding values 3FF,000,000,000.

8.3.3. Line Number I.D. shall be 1 word. Line Number word number address shall be 794 with the following values:

b2	b1	b0		
0	0	0	Line 1 - 263	Field 1
0	0	1	Line 264 - 525	Field 2
0	1	0	Line 1 - 263	Field 3
0	1	1	Line 264 - 525	Field 4

b7 (MSB) b6 b5 b4 b3 (LSB)

$1 \leq X1 \leq 30$ X1 indicates the line number of each field. [Odd fields 1-30, even fields 264-293]

X1 = 31 To indicate line number 31 and up of each odd field and line number 294 and up on each even field.

X1 = 0 Not used.

$X1 = 16\ (b7)+8\ (b6)+4\ (b5)+2\ (b4)+1\ (b3)$

b8 is even parity for b7 through b0.

$b9 = \overline{b8}$

* Note b2 may be utilized when an 8 field sequence needs to be identified.

3.4 Auxiliary data - Auxiliary data may be present within the following word number boundries (See Figs 1,2,3) See also Appendix F

795 - 849	For Horizontal Sync period
795 - 815 340 - 360	For Equalizing Pulse period
795 - 260 340 - 715	For Vertical Sync period

3.4.1. The data structure for the auxiliary data shall be as follows (See Fig. 4), and positioned in the video data stream as shown in Figs. 1,2,3.

Aux Data Flag	[1 word]
Data I.D.	[1 word]
Data Block Number	[1 word]
Data Count	[1 word]
User Data	[255 words maximum within a block]
Check Sum	[1 word]

3.4.2. Aux. Data Flag (A.D.F.)

An Aux Data Flag must be present if auxiliary data is to be recognized. The Aux Data Flag shall have a value of 3FC.

3.4.2.1. There may be multiple Aux data flags following the TRS-ID. Each Aux data flag shall identify the beginning of another data block (See Fig. 5)

8.4.3. Data I.D. - The Data I.D. is intended to identify the type of data present in the user data area. (The data I.D. address is positioned as ADF word address + 1). (See Fig. 4)

8.4.3.1 The data ID may have 256 different states:

8.4.3.2 The Data ID word shall consist of 8 bits.

b7 through b0
(MSB) (LSB)

b8 is even parity for b7 through b0

$b9 = \overline{b8}$

8.5 Data Block Number

Following each data I.D., a data block number shall be inserted.

8.5.1. When bits 7 through 0 are set to zero the data block number is inactive and shall not be used by the receiver to indicate continuity of the data.

The non-active state is defined as:

b7 through b0 [All zeros]
(MSB) (LSB)

b8 is even parity for b7 through b0

$b9 = \overline{b8}$

8.5.2. The data block number, if active, shall increment (by 1) when consecutive data blocks with a common data ID exists, or when data blocks with a common data ID are to be linked.

8.5.3. The data block number shall consist of 8 bits and shall increment 1 through 255 according to modulo 255.

b7 through b0
(MSB) (LSB)

b8 is even parity for b7 through b0

$b9 = \overline{b8}$

3.6 Data Count. Data count represents the number of user data words to follow, up to a maximum of 255 words. (The data count word is positioned as Data block number - 1.) (See Figure 4.)

3.6.1. Data Count word shall consist of 8 bits.

b7 through b0
(MSB) (LSB)

b8 is even parity for b7 through b0

$b9 = \overline{b8}$

3.7 User Data Words - User Data Words may be used to convey information as identified by the Data ID word.

3.7.1 The maximum number of User Data Words identified by a given Data I.D. is 255 words, excluding the check sum.

3.7.2 User Data Words shall consist of either 8 bit words plus even parity or 9 bit words positioned at b0 through b8. b9 shall be b8.

3.7.3 Location of LSB/MSB of user data will be defined by a look up table assigned to the individual Data ID.

3.7.4 One state of the data I.D. is the definition of how a maximum of four channels of AES/EBU Audio shall be identified. (See Appendix D&G)

b7	b6	b5	b4	b3	b2	b1	b0
1 (MSB)	1	1	1	1	1	1	1 (LSB) = AES/EBU Audio

Contents of the data stream for AES/EBU Audio:

No. of Channels = 4 maximum
No. of Bits/Sample = 27
No. of Words/Sample = 3

Transmitted Data of AES/EBU Format =

Z Flag = 1 Bit (See Appendix C)
CH No (A1 to A4) = 2 Bits
Audio Data = 20 Bits
V = 1 Bit
U = 1 Bit
C = 1 Bit
P = 1 Bit

[P = even parity for the 26 Bits]

Bit\Address	x3	x3+1	x3+2
b9	b8	b8	b8
b8	(2^5)	(2^{14})	P
b7	(2^4)	(2^{13})	C
b6	(2^3)	(2^{12})	U
b5	(2^2)	(2^{11})	V
b4	(2^1)	(2^{10})	MSB(2^{19})
b3	LSB(2^0)	(2^9)	(2^{18})
b2	CH(MSB)	(2^8)	(2^{17})
b1	CH(LSB)	(2^7)	(2^{16})
b0	Z	(2^6)	(2^{15})

8.7.5 Data ID/Data Structure for data of an unregistered format.

b7	b6	b5	b4	b3	b2	b1	b0
0 (MSB)	0	0	0	0	0	0	0 (LSB)

b8 = Even parity for b7 through b0.

b9 = $\overline{b8}$

See Appendix B

8.7.6 Data ID - The remaining 254 states remain reserved and undefined.

b7 through b0
(MSB) (LSB)

(Undefined and reserved)

b8 = Even parity for b7 through b0.

$b9 = \overline{b8}$

8.8 Check Sum

The check sum word shall consist of 9 bits. The check sum word is used to determine the validity of the data ID through the user data. It is the sum of the 9 least significant bits of the data ID.

b8 through b0
(MSB) (LSB)

$b9 = \overline{b8}$

Preset all zeros. Carry shall be ignored.

The position of the check sum word is User Data +1 as shown in Figure 5.

These appendices are not part of this SMPTE Standard, but are included for information only.

Appendix B **Data ID 00 inidcates that the following data is not in a format registered by the SMPTE.**

Appendix C **The Z bit may be referred to as Preamble 1 or preamble B by some interface documents.**

Appendix D The 48KHZ samples of the AES/EBU audio data shall be locked to video in the following manner.

$$525 \text{ lines } 48\text{KHz} = F_H \times \frac{1144}{375}$$

$$625 \text{ lines } 48\text{KHz} = F_H \times \frac{384}{1125}$$

Appendix E 625 Line PAL Composite Operation

1.0 For 625 PAL Composite Serial Digital Transmission the following input source shall be used. See IEC Helical-Scan Video Cassette Recording System using 19mm magnetic tape (Format D-2 Table 8).

1.1 The nominal bit rate of this serial transmission shall be 177 Mb/s.

1.2 Signal processing of the input signal is necessary to provide timing and synchronizing information in the serial digital domain (TRS-ID)

1.2.1 The TRS and line number ID shall only be present following the sync leading edge which identifies a horizontal transition.

1.2.2 The TRS shall consist of 4 words. TRS word number address shall be 967,968,969,970 with corresponding values 3FF,000,000,000.

1.2.3 Reset of the TRS position relative to the H-sync edge shall take place once per field on lines 1 and 314. Reset is necessary due to the 25 Hz offset. Therefore, from a sample numbering standpoint all lines will have 1135 samples except lines 313 and 625 which will have exactly 1137 samples. The additional samples, on lines 313 and 625, will be numbers 1135 and 1136 just prior to the first active picture sample 000. This does not affect the continuous signal concept where all but two lines in a field have 1135 samples and the other two have 1136 (the line numbers with 1136 are a function of exact SCH phsae and the criteria for determing which samples fall in which lines).

Designers should note that sample locations in Appendix E, Figure 1 represent only line 1, field 1 as per Figure 44 in the referenced IEC document. Nearby low line numbers will be similar but the samples are slightly earlier on each line due to the 25 Hz offset. Initial determination of the position of TRS should, therefore, be done on line 1 or a nearby subsequent line. Considering the 0 SCH phase requirement of the IEC document, and the sample numbering system defined in this Appendix, the TRS location is known and exactly starts with sample 967 on each line but its distance from the leading edge of sync varies due to the 25 Hz offset."

1.2.4 Line number ID shall be 1 word. Line number word number address shall be 971 with the following values

b2 (MSB)	b1	b0 (LSB)	
0	0	0	Line 1 - 313 Field 1
0	0	1	Line 314-625 Field 2
0	1	0	Line 1 - 313 Field 3
0	1	1	Line 314-625 Field 4
1	0	0	Line 1 - 313 Field 5
1	0	1	Line 314-625 Field 6
1	1	0	Line 1 - 313 Field 7
1	1	1	Line 314-625 Field 8

b7 (MSB)	b6	b5	b4	b3 (LSB)	
0	0	0	0	0	Not Used
0	0	0	0	1	Line 1 [314]
0	0	0	1	0	Line 2 [315]
0	0	0	1	1	Line 3 [316]
1	1	1	0	1	Line 29 [342]
1	1	1	1	0	Line 30 [343]
1	1	1	1	1	Line >30 [344]

X1 = 16 (b7) + 8 (b6) + 4 (b5) + 2 (b4) + 1 (b3)

b8 is even parity for b7 through b0

$b9 = \overline{b8}$

2.1 Auxiliary Data - Auxiliary data may be present within the following word number boundaries (See Appendix E, Figs 1,2,3)

972 - 1035 for horizontal sync
972 - 994 for equalizing pulse period
404 - 426 for equalizing pulse period
972 - 302 for vertical sync period
404 - 869 for vertical sync period

2.1.1 The auxiliary data block structure is the same for 625 line operation as it is for 525 line operation.

Appendix F The auxiliary data area (may also be identified as HANC in SMPTE 125M) should be considered to be a communications channel with a finite data rate. Systems design engineers should be aware of data rate constraints, error rate through the system, and the possibility of the signal being switched.

Appendix G Definitions of Data (Data ID) will be defined in a separate document at a later date. Readers are advised to contact SMPTE Headquarters to determine the current status of any future or current work.

Appendix H As some SMPTE 125M interfaces may only carry 8 bits of video data, it is necessary for the data serializer to identify this condition and to add the necessary data to convert the 8 bit signal to a 10 bit representation. EAV and SAV of 8 bit signals must be converted in the following manner [See SMPTE 125 Para 4.5.3]

8 bit	10 bit
FF	3FF
00	000
00	000
XY	PQR (=4xXY)

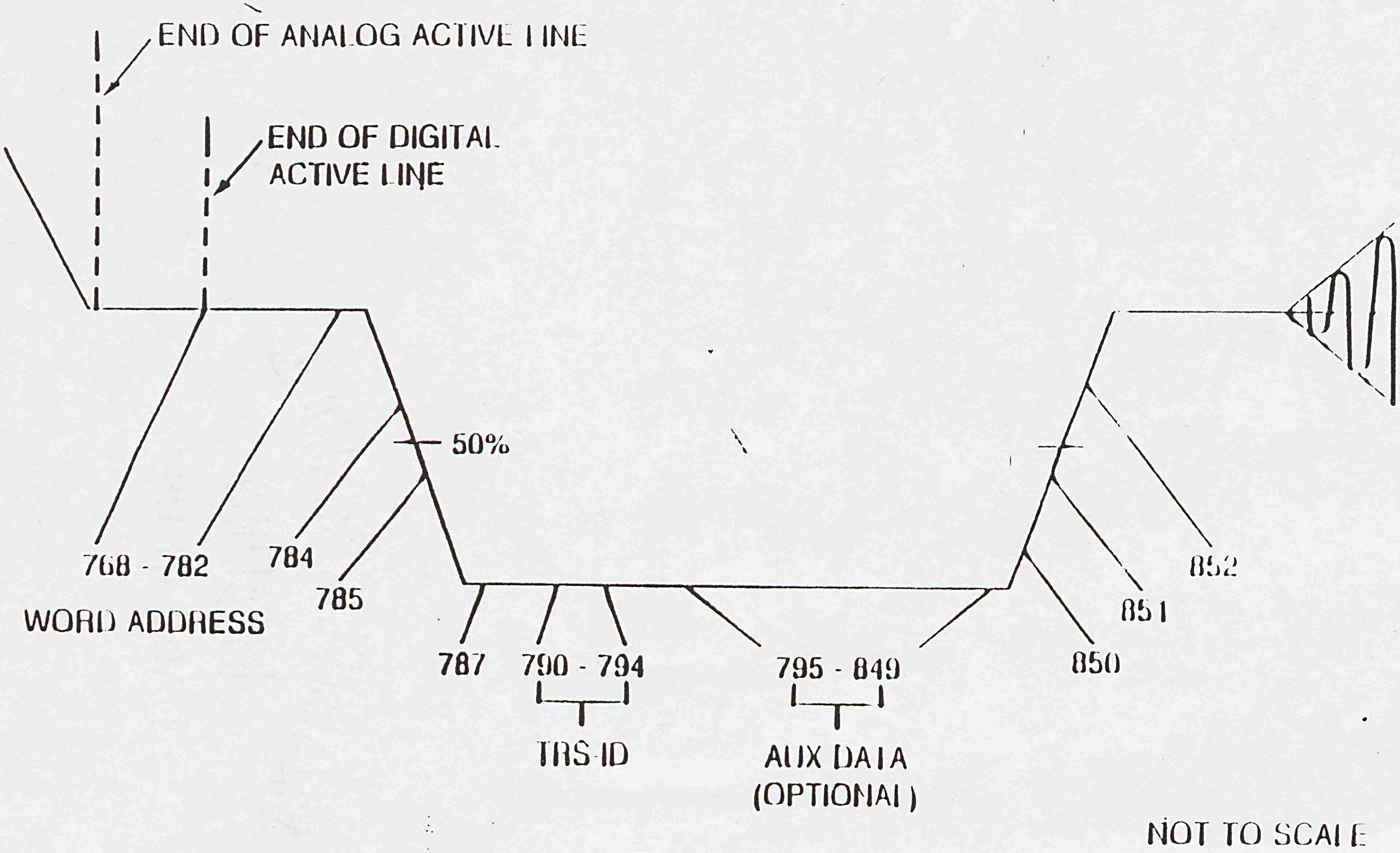
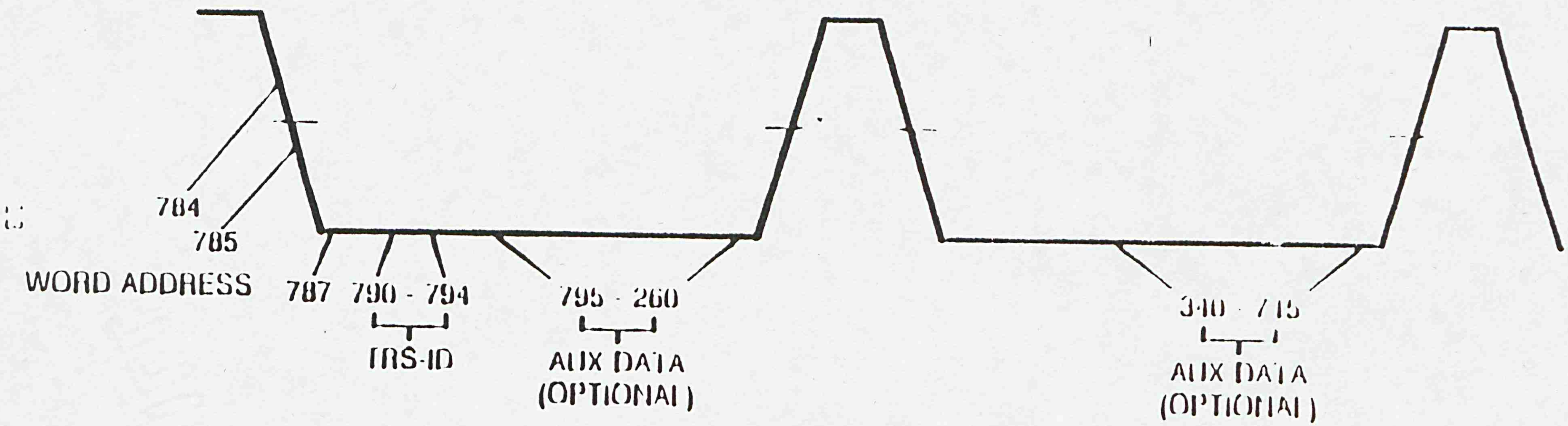


Fig. 1
Composite Digital Horizontal Sync Period Details



NOT TO SCALE

Fig. 2
Vertical Sync Details

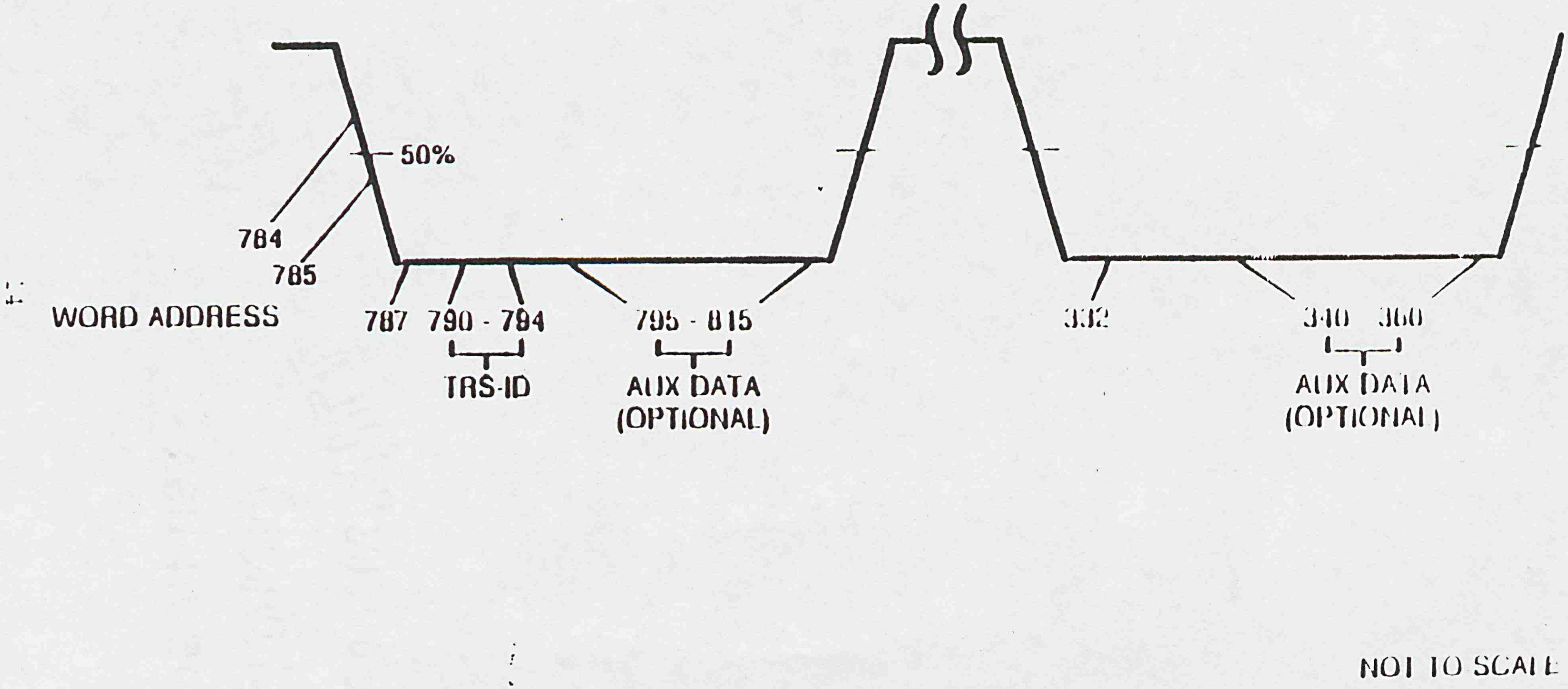
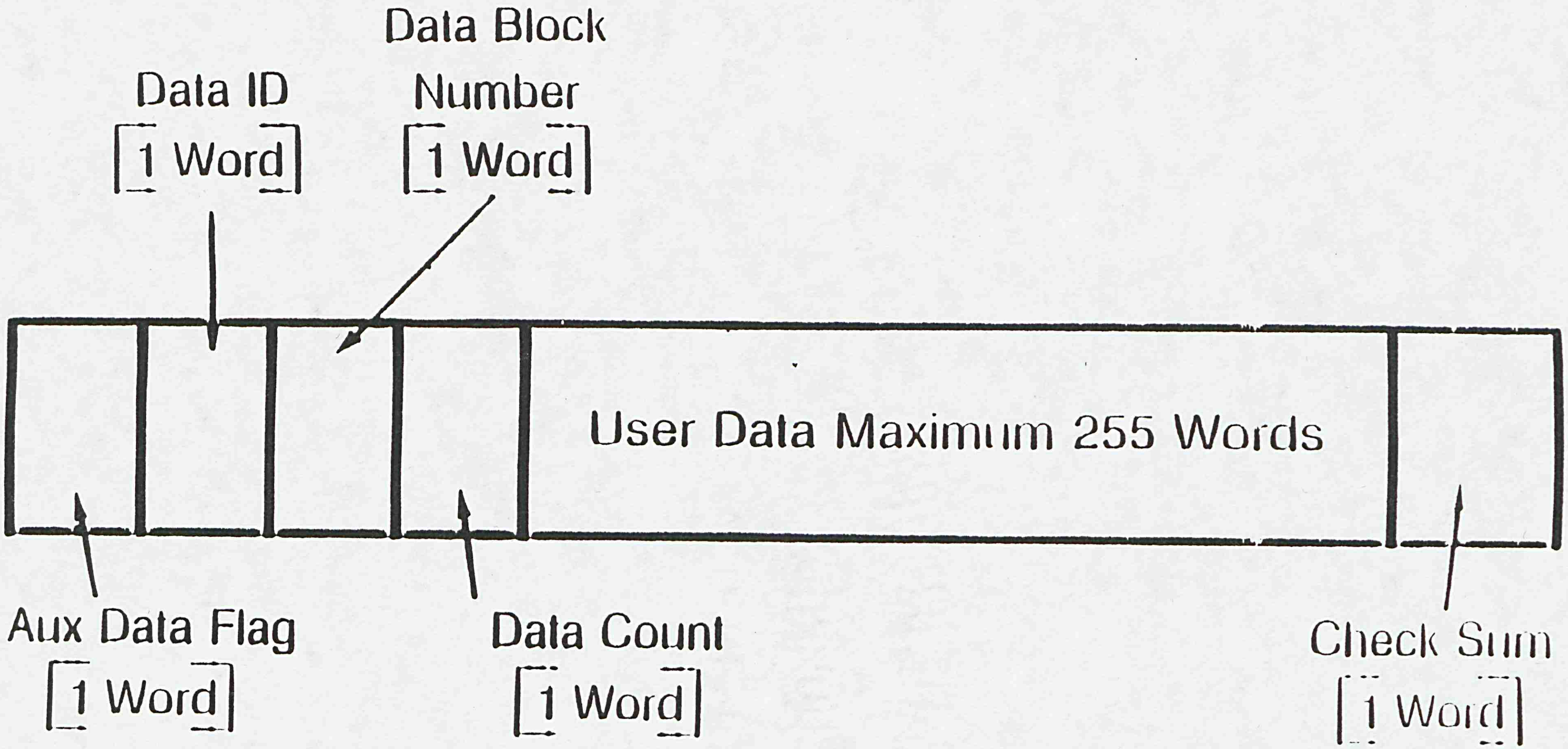
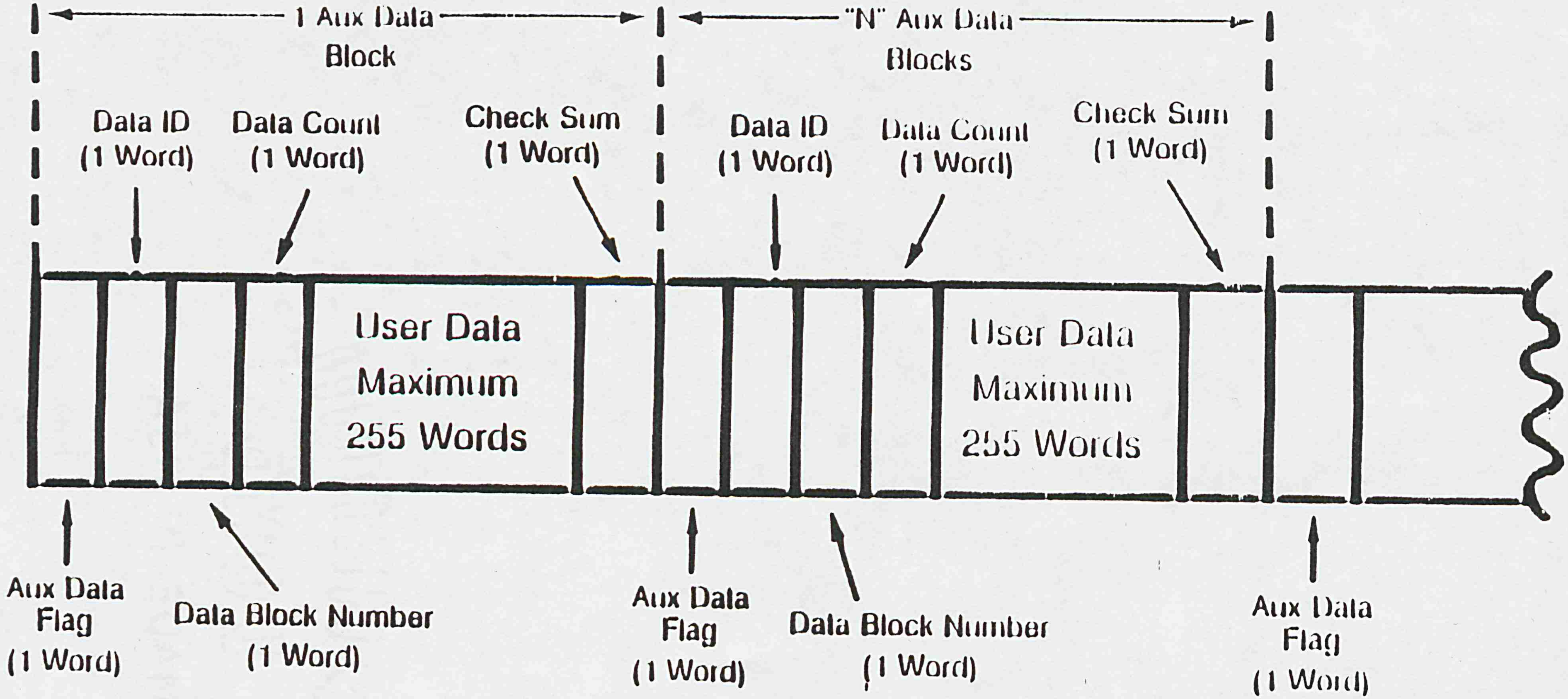


Fig. 3
Equalizing Pulse Details



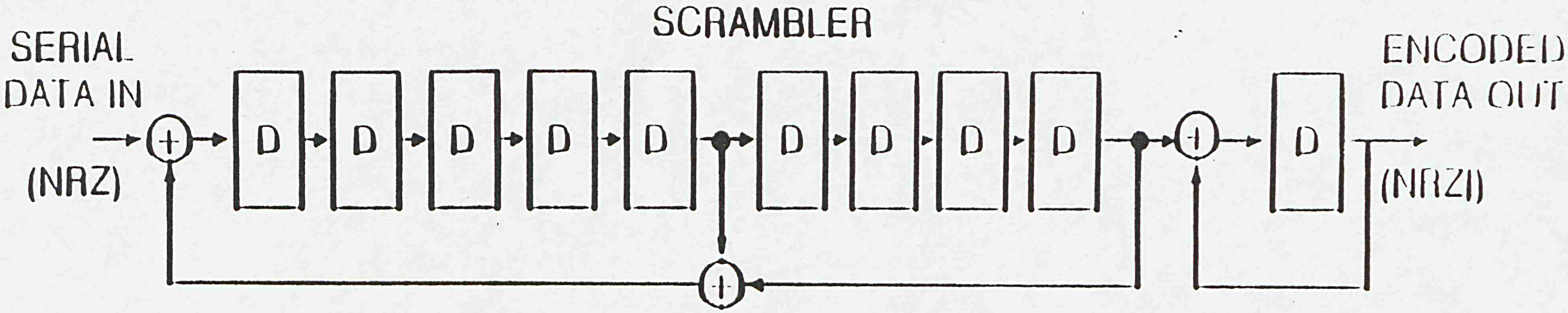
Not To Scale

Fig. 4
Aux. Data Format

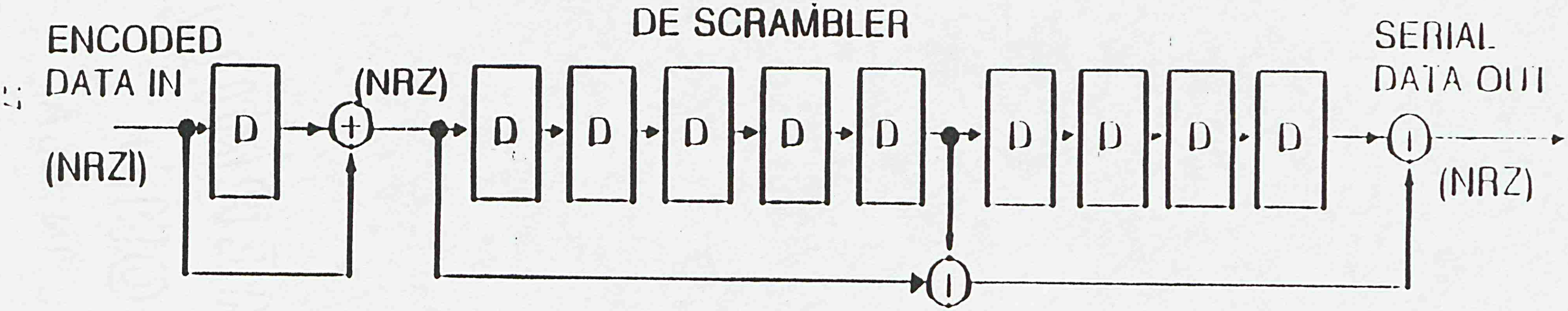


Not To Scale

Fig. 5
Multiple Aux. Data Blocks



(A) ENCODER $G_1(X) = X^9 + X^4 + 1$ $G_2(X) = X + 1$

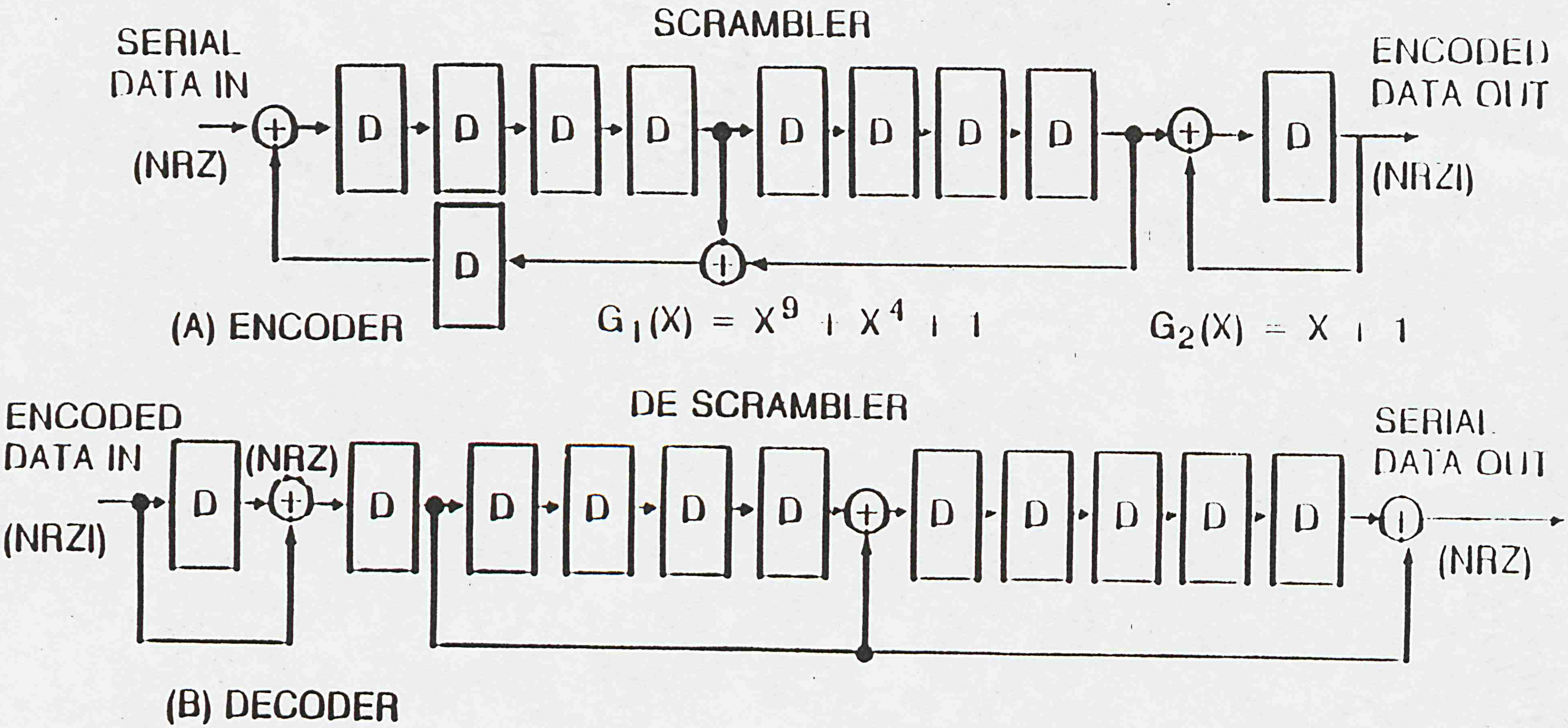


(B) DECODER

Note - This Is One Possible Implementation Of The Scrambling Algorithm

$$G_1(X) = X^9 + X^4 + 1 \qquad G_2(X) = X + 1$$

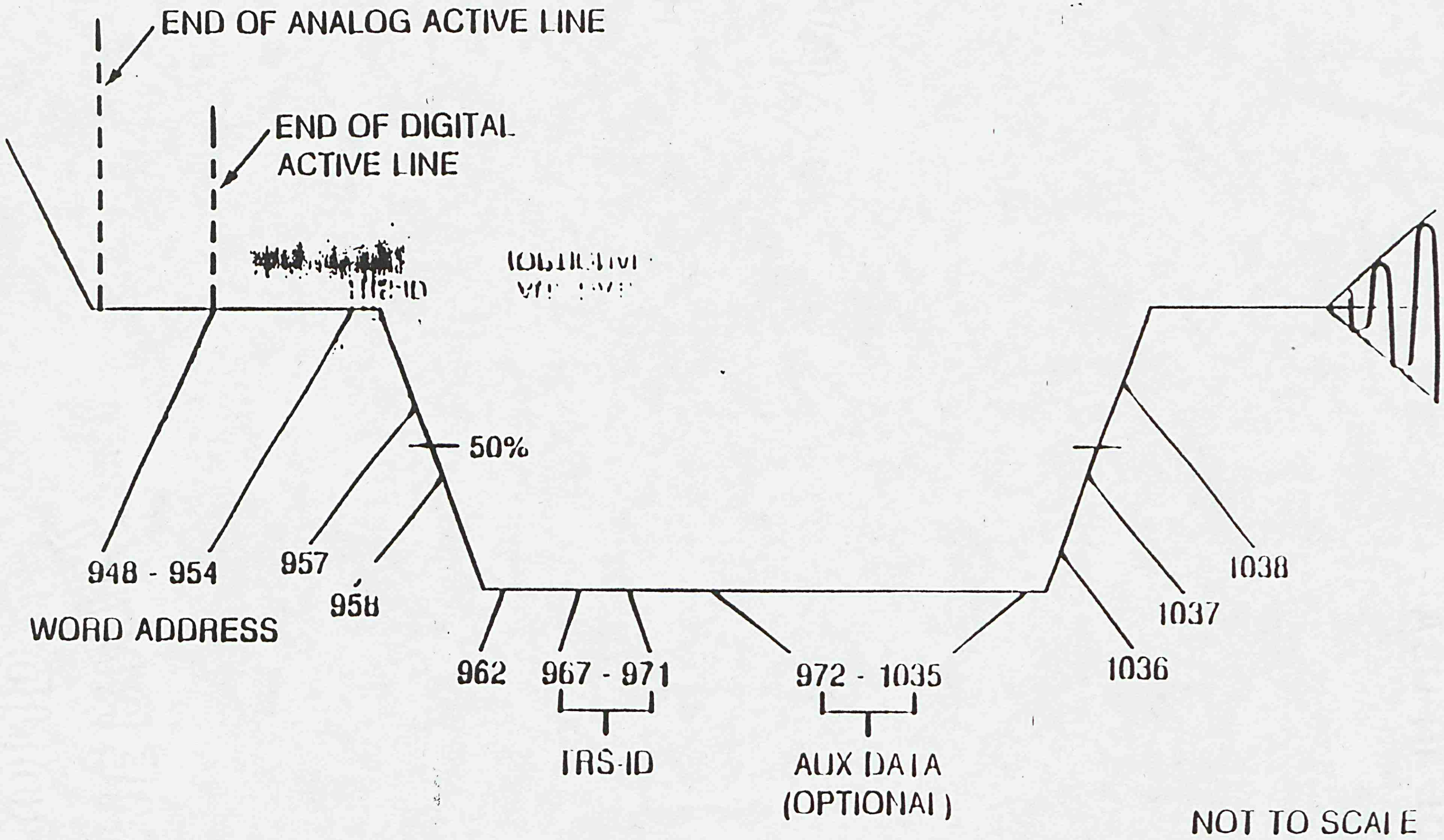
APPENDIX A1



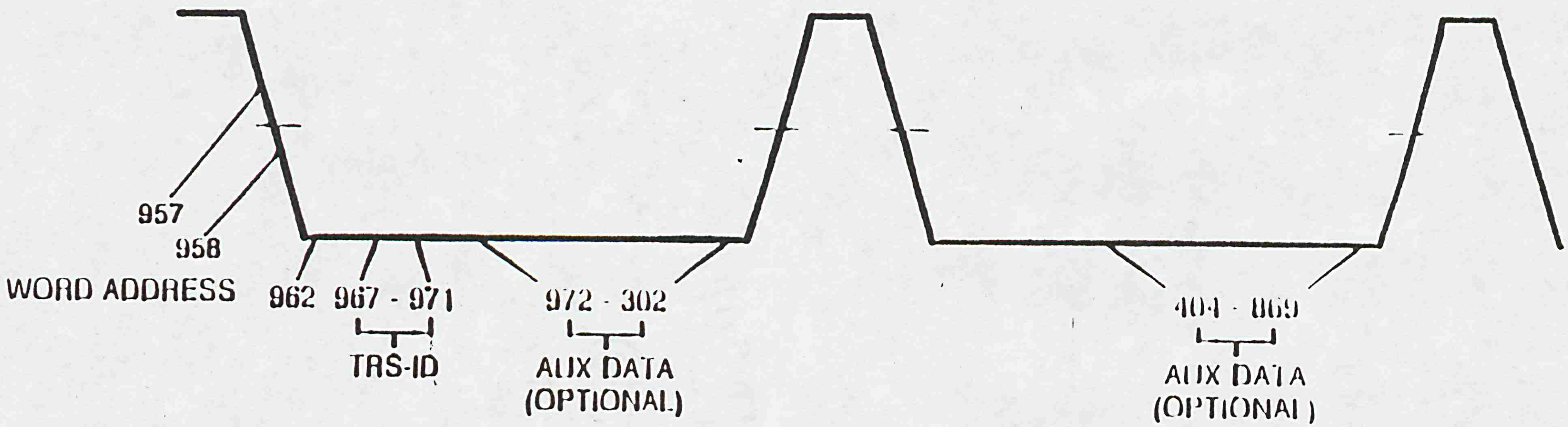
Note - This Is One Possible Implementation Of The Scrambling Algorithm

$$G_1(X) = X^9 + X^4 + 1 \qquad G_2(X) = X + 1$$

APPENDIX A2

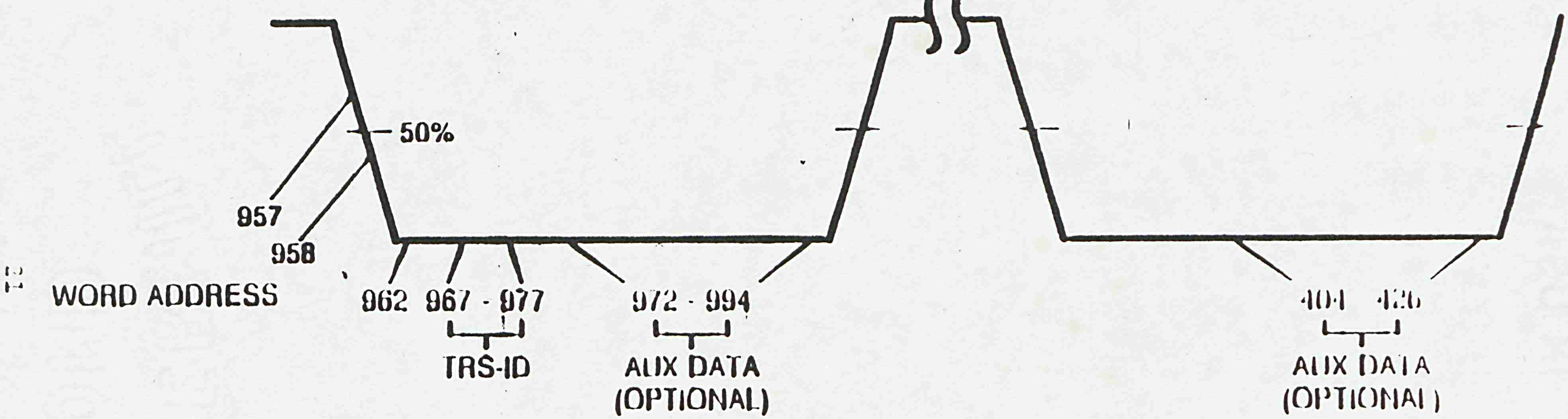


625 PAL. Composite Digital Horizontal Sync Period Details
(Appendix E Fig 1)



NOT TO SCALE

625 PAL Composite Digital Vertical Sync Details
(Appendix E Fig 2)



NOT TO SCALE

625 PAL. Composite Digital Equalizing Pulse Details
(Appendix E Fig 3)