t_{int} = one video field time
= 1/(59.940 fields per sec)
= 16.68 msec

therefore, in slave mode, the delay in the Encoder only is:

t_{rtd} (Encoder) max = 292.57 + 6.71 + 16.68
= 316 msec

or:

t_{rtd} (Encoder) min = 42.66 + 6.71 + 16.68
= 66 msec

The total real time delay through the Encoder and Decoder is, therefore:

Total real time delay (slave), max = 2 * t_{rtd} (Encoder)
= 632 msec

Total real time delay (slave), min = 132 msec

If the clock associated with the interface data is internal, TVT1/4 Encoder in clock master mode, the delay depends only on FEC (t_{FEC}) and interleaving (t_{int}), which is:

<u>Master Mode</u>

Total real time delay (master) = 2 * (6.71 + 16.68)
= 46.78 msec

3.2.9 Acquisition Time

From the time of channel selection to the time the data can be effectively communicated will be less than 60 seconds. Ongoing ABBE development efforts will reduce this time by reducing the 'training' time, or the time for the ABBE to become set up and able to operate.

4. Additional Information

4.1 Two-Way Transmission

4.1.1. Two-Way Transmission Capability

Two-way transmission capability can be effectively accomplished using the capabilities of the TVT1/4 Encoder and Decoder system to deliver high volumes of data at high speeds from the data source to the using facility, and landline or wireless MODEMs as a slower return path for control commands and responses. Some possible applications are discussed in 4.3.

WavePhore has demonstrated two-way capability at its own facility by establishing a LAN extension with a file server located at Arizona State University using one of their ITFS as the forward path with a dial-up modem link as the return path. This system has been operating for 22 months and is used as a WavePhore demonstration of an interactive system. In Switzerland, a two-way system has been installed at a Siemens subsidiary. This system uses the cable as the forward path and dial-up modems as the return path.

4.1.1.1 Return Path Description

A number of return paths are possible. In general, connection to a computer at the receiving end will normally be required in order to: (a) handle large amounts of data, (b) handle high data rates, (c) provide access to data storage, (d) provide the means for decoding data addresses, (e) allow manipulation of data, (f) provide a means to display the data, (g) allow output of data to a printer, and (h) provide means for manual interface via a keyboard or a touch screen. This computer can be a simple personal computer, a sophisticated main frame computer, or something in between.

A telephone dial-up MODEM is a common part of most computer systems, and as such can be used to close the loop with the transmitting data source. It would be used to communicate setup commands between the source and the user, and to provide the appropriate responses when requested. This could also be a radio (wireless) communications link or other low speed data transmission system.

The above would be an example of point-to-point communications with return capability. An extension of this would be the use of a receiving computer as a file server, relaying the data to multiple terminal locations as well as communicating their responses via a single MODEM and telephone line or radio.

More sophisticated versions of the latter would be the use of a Local Area Network (LAN), Wide Area Network (WAN) or, Metropolitan Area Network (MAN). A LAN might link computers within a building or across a college campus. A WAN might link computers, or LANs, across the country or throughout the world. An MAN might link

networks across a metropolitan area using high-speed digital lines such as T1, T3, or fiber optics.

4.1.1.2 Error Correction of Forward Data Path

The WavePhore TVT1/4 System uses an interleaved Reed Solomon (225,205) forward error correction scheme. For description see 3.2.2.4.1 above.

4.2 Ghost Canceling

4.2.1 Multipath Environment

Ghost canceling systems approved by FCC (47 C.F.R.¶ 73.68 (a) 21 (iv)) and OET Bulletin 68 (available through FCC) would be unaffected by the WavePhore techniques. WavePhore is using a multi-tapped Adaptive Baseband Equalizer with good results to optimize the signal quality and content of the data. Future systems may utilize special Integrated Circuits to accomplish this function in a cost effective manner when they become available.

During the NAB Show at Las Vegas in March, 1994, WavePhore's Encoder was installed on Channel 13 and successfully transmitted data to its companion Decoder at a receiver cite that was exhibiting at least four major ghosts on the television screen. This demonstrates the effectiveness of WavePhore's Adaptive Baseband Equalizer (ABBE) in eliminating the effects of multipath signals. The FCC approved Phillips ghost cancelling system was also operating on Channel 13 at the time. Ghosts were essentially eliminated either with or without the Wavephore system installed. The WavePhore system continued to operate successfully with the Phillips system installed. This demonstrated that neither system will adversely affect the other

4.2.2 Impacts on Data Signal

Data in the WavePhore TVT1/4 is placed on the active portion of the video signal and is not affected by the ghost canceling reference signal. WavePhore's system was unaffected by the FCC approved Phillips ghost cancelling system during tests at the NAB show noted above, see 4.2.1, above.

4.3 Intended Applications

4.3.1 General Features

WavePhore's TVT1/4 supports a variety of data transmission applications. The TVT1/4 System accepts RS-422/449 digital data at a rate of 384 to 393 Kbps and encodes it onto the baseband video signal which is then transmitted to all points within the reach of the broadcast signal. The data can then be extracted from the video signal by a receiver equipped with a TVT1/4 Decoder and distributed to a single user or group of users via RS-422/449 format to the user.

TVT1/4 Decoder technology can be packaged as a stand-alone set top box, as a printed circuit board that can be inserted in a PC, or as a chip set that can be designed into an OEM manufacturer's application such as; Nintendo or Sega game boxes; universal boxes for broadcast, fiber, coax or satellite reception; or in television sets to become data-ready. Applications would vary from receive-only type units, to boxes with both intelligence and storage for advanced applications. Various options will unfold over time to satisfy revenue producing applications demanded in the market place.

4.3.2 Interactive Data Links

An emerging application area has variously been described as interactive or participatory TV. Both basically describe the viewer's interaction with the programming, *participatory* meaning that they are participating with the program or game content within their home and, *interactive* meaning they are communicating through a back channel to a central host computer or with other players at another location. WavePhore's TVT1/4 can facilitate both, and some are discussed later.

4.3.2.1 LAN Extensions

TVT1/4 technology enables the PC of a remote user, such as an individual at home, to appear as if it were attached to the local area network at the office. This is also known as tele-computing. Users are large and small corporations in congesting metropolitan areas where the employee may be encouraged to work from home part time. The return path would use a low-speed phone-line dial-up MODEM, or wireless MODEM, where only a few keystrokes would request download of a large block of data.

4.3.2.2 Corporation Links

Large corporations can establish computer data links to their subsidiaries or remote buildings via broadcast, satellite, or cable, to share the large amounts of data needed to support its operation on a day to day basis. Examples are:

mechanical drawings personnel data

standard part	inventory status
drawings	
specifications	production status
test procedures	project status
software programs	reliability data
financial data	

A typical application would utilize a TV transmitter at each location, linking mainframe computers together for full duplex operation.

4.3.2.3 Interactive Program Marketing

Participatory game vendors, such as Nintendo, Sega or Virtual Reality, are continually looking for ways to deliver new game programming to their audience. TVT1/4 data broadcasting could provide that link for downloading the data files for demonstration preview and actual sales distribution. The game manufacturers would be most willing to equip their game systems with decoder technology if a video network would provide a toll-road through which the distribution could take place. Coupling the down-load of a new demo game with an on air advertisement would be an unbeatable combination. This would replace a channel of distribution that costs in excess of 25% of their revenue stream. Again, a value pricing opportunity for the distribution channel.

4.3.2.4 Interactive Games with Telephone or Radio Feedback

All data needed to display game information on a local PC could be addressed and sent via a data-ready local TV to that user's PC terminal. The user's responses would be sent via a simple phone line or cellular return link.

4.3.3 Targeted Demographic Advertising

Network television advertisers pay for 30 second intervals in which to advertise a specific product to a network's audience. With WavePhore's encoder technology, a different commercial can be customized and sent to a subset of that audience for which it is better suited. This second commercial would be digitally embedded in the analog signal and addressed to that segment of the audience where an intelligent, data-ready TV, would decode it and substitute it for the original analog version. As an example, a Chevrolet message could be sent to one part of the audience and a Cadillac message to another where it would be better suited. The addressability of the TVT1/4 decoders would allow for specific demographic profiling to the household level, allowing the network to optimize its advertising effectiveness in areas containing such a demographic overlay. Most likely, the 'must-carry rule' would allow this practice to move with the network signal through cable systems as it is related to advertising content.

4.3.4 Audio Distribution

The TVT1/4 digital data path can be used for the distribution of supplemental audio. This could be thought of as multiplexing audio telephone conversations for distribution via Television signals via broadcast, satellite, or microwave without the need for cabling. TVT1/4 technology can accommodate 24 voice grade, or two CD quality compressed sound channels to a networks's listening audience. Future intentions are to expand this to the full T1 capability of 96 voice and six CD channels. The options are endless, whether it be a supplemental transmission of audio in a different language or data in synch with the video, or whether it be unrelated communications that happen to be using the same carrier.

4.3.5 Data Distribution

In a broad sense, there are a variety of applications that can be generically described as data distribution tasks. The current market discussions of the "Data Highway" and the "New Media", focus on moving large volumes of data from one point to millions of other points at high speed and low cost. Satellite, coax, and fiber have taken on this role recently where telcos and cable companies have been the only carriers of this data. Now broadcasters can participate as both a content provider as well as the digital carrier of that content and do it now! A few of these data distribution applications are discussed below.

4.3.5.1 CD Music & Video Distribution

Delivery of CD music directly to record stores is an application being discussed by Blockbuster Video as an adjunct to their movie and game rental business. As a major supplier of CD music, this might well be a way to cut cost of distribution and allow them to reach a broader market than is being reached today.

4.3.5.2 Desk Top News

Moving digital news data from one point to multiple receiver points is basically a data distribution application. The entire New York Times, or USA Today could be downloaded to subscribers in less than a minute, thereby giving a whole new distribution method to the publishing industry. With advanced profiles of interest, only those segments of the publications relevant to each customer could be downloaded.

The current TV signal can be used to transmit addressable data through any medium presently available; broadcast, cable or microwave link. TVT1/4 can decode the addresses of the data and distribute only the desired data to the user's computer for display and/or storage. Some types of specific news areas are listed.

medical	sports
international	entertainment
financial	weather

business	employment
stocks & bonds	want ads
travel	real estate

4.3.5.3 Travel Information

The travel industry has long been looking for ways to send large amounts of information to the elite leisure and business travel audiences as well as to maintain its normal business. Some of these types of information are listed.

- travelogue videos and audio
- rate and package information
- airline schedules and status
- hotel and motel prices and availability
- street and road maps with directions

4.3.5.4 Tower Information

TV broadcast signals can transmit digitized information for display on towers such as:

- weather conditions
- road conditions
- traffic conditions
- sea conditions
- forest conditions
- seismic conditions
- emergency instructions
- sports news
- ski conditions
- gambling odds
- prices on:
  - stocks and bonds
  - store merchandise
  - banking rates
  - hotel rates
  - money exchange rates
- world news headlines
- warehouse inventory status
- telephone directory info

4.3.6 Supplemental Data

Another creative use of the TVT1/4 data broadcast pipeline would be to supplement normal TV programming with additional, related statistical information. Sports programming lends itself to this with the audience's hunger for "the numbers" that bring historical data to the real time performance being played out on the screen. Obviously, this facility could be used for all types of programming.

4.3.7 Computer Software Download

Using the high speed data channel to move computer software from the publisher to a broad group of potential users for demonstration and sales purposes is another application. PCs equipped with a decoder add-in board could be targeted by software publishers for demonstration copies of their programs without the cost of delivering diskettes, documentation and sales packaging. It would also give vendors invaluable demographic information about his customers that is not available today through the channels of distribution in current use. Distribution costs in the packaged software business run in excess of 40% of sales today promising a value added pricing opportunity for implementing a pure digital path from publisher to consumer.

4.3.8 CD ROM Replacements

Many business and commercial applications are driven by large files of information packaged and distributed on CD ROM diskettes. The Discovery Channel is planning on using CD to distribute data making their broadcast interactive. Many businesses use CDs to move price books and large inquiry files to regional and retail distribution outlets. The cost of preparing and distributing these CD's could be eliminated by targeting a broadcast signal to all identified decoders. A process that today takes many days and considerable cost to complete could be accomplished in a matter of minutes using the TVT1/4 data path over any of the major networks. The user would always have current information.

4.3.9 Credit Card Hot List Distribution

There are a variety of commercial applications for this technology. A very good example would be to move the American Express Hot Card File from the AMEX headquarters to all of their retailers each day. A brief broadcast of this list every hour or so to the AMEX retailers could eliminate the need for the on-line card verification required today which adds cost to processing and slows the sales transaction.

4.3.10 Distance Learning

Information related to a televised class would be downloaded to the student and automatically enter his PC at the right time during the lecture. Such information might be class notes, multiple choice sheets, images or a second language. Potential users are owners of educational channels, community colleges, universities, etc..

In addition, large amounts of data can be transferred from a university library data bank to a satellite university campus or to any authorized user's computer for analysis and off-site use and/or storage.

4.3.11 Revenue Potential

The revenue potential of the data transmission technology proposed here is discussed briefly. Quoting from Digital Media, June 23, 1993, "Use of broadcast spectrum for digital data and wireless would generate 10 times as much revenue as traditional broadcast activity." Still quoting, John Abel, EVP of NAB agreed emphatically, "We are not discussing HDTV, we are discussing economic use of bandwidth! And the broadcast spectrum has wide bandwidth available now with little cost for use in the National Infrastructure Initiatives (NII), as opposed to the cable and telephone companies who talk about this so much. Broadcasters will have to be freed to offer such new services over their spectrum, but many stand ready to do so soon"

Value added consumer entertainment services also promise a revenue windfall. Each $1 of for-fee programming enhancement or game services delivered to 85,000,000 homes and paid for on a monthly basis is a $1 billion dollar annually recurring revenue stream. Data broadcasting is the only distribution network that can reach that many homes now. Many services will be transaction priced much like pay-per-view today. Others can be on a subscription basis to targeted sets of consumers. Others can be advertiser supported delivering a valuable service to their prospective customers in exchange for listening to a sales message. The full range of revenue enhancing opportunities is open to data broadcasting. And your pricing levels will be most competitive because there is not cost to users for the bandwidth used.

4.4 Interference to and from future HDTV Service

HDTV will eventually occupy the current TV bands along with existing NTSC service. Incorporation of the proposed data signal within an NTSC broadcast band would have no impact on the desired-to-undesired signal ratios between NTSC and HDTV signals. Data in the WavePhore system is transparent compared to any upper layer in simplex broadcast form. The Encoder frequencies are crystal controlled and only the upper side-band of the video signal is filtered out leaving the lower side-band unchanged. Likewise, the data is filtered to remove harmonics as well as most of its upper sideband and its gain is adjusted to be only 20 dB above the noise floor before it is added to the video signal. Since it is inherent to the channel to which it is added, its information is contained on the same video frequency.

On the Decoder end, the WavePhore's channel tuner can discriminate between adjacent NTSC channels of equal strength. Additional studies will be required to ensure immunity from disturbance from an adjacent HDTV channel, but at present, WavePhore does not believe its process will be degraded under these circumstances.

4.5 Anticipated Costs

The Encoder pricing has not been finalized for the public broadcast industry, but the company does plan to license all interested broadcasters to use the Encoders at reasonable rates.

It is anticipated that through continued development and migration toward a chip set implementation, the cost of the Decoder would be in the range of $300 for a stand-alone Decoder, $200 for a PC add on card, and $100 for a chip set for integration into other devices. These are anticipated prices for a quantity of one, with discounts anticipated for significant quantity orders.

4.6 Upper Layers of OSI Reference Model (3 and above)

The WavePhore system is transparent to layers three and above of the OSI Reference Model. It is independent to the external data patterns or protocol structures. At such time as protocols become defined by the NDBC Data Transport Prototype Working Group, it will be implemented in the WavePhore system.

4.7 Co-existence with Scrambling

The WavePhore system is independent of the structure of the data being received and placed on the video signal and will have no affect on the validity of the data being communicated provided the characteristics of the active video line is not modified. Should the video be digitized, data using WavePhore's Encode and Decoder will not be degraded provided the digitized resolution is greater than 8 bits. The system has operated with ABC and Cipher II scramblers with no adverse affects.

4.8 Co-existence with Compression

Compression algorithms remain to be tested, however since the TVT1/4 system places data in the area of the video signal that carries visible information, compression in this area will normally corrupt the data.

4.9 Recordability

4.9.1 Use of Commercial and Consumer Level Equipment

Since the data is an inherent part of the video signal, with no signals outside the normal video range, it will maintain its data integrity when recorded with a studio quality video recorder. WavePhore has successfully recorded composite video data and retrieved it on playback using a "C" format video tape recorder. WavePhore has successfully recorded on "D2" format.

4.9.2 Impacts of Recording on Data and Video Signals

See comments in 4.9.1, above.

5. Availability of Hardware for Testing

5.1 Testing and Evaluation

A fully functioning TVT1/4 Encoder and Decoder can be delivered on or before November 1, 1994 for test and evaluation. Prototypes are currently in use.

The TVT1/4 can be evaluated using the following equipment:

Tektronics Model VM-700A Video Measurement Set

Tektronics Model 2712 Frequency Analyzer

Telecommunications Techniques Corp., Model Fireberd 6000 Communications Analyzer (Bit Error Rate Tester).

The Video Measurement Set automatically monitors and measures video signals, provides digital waveforms and vector displays for manual measurements, and provides storage capabilities. The Spectrum Analyzer is a portable unit which incorporates a Tektronix software package with a frequency range of 9 KHz to 1.8 GHz, and has a sensitivity to -139 dBm.

5.2 Interface Requirements

The Encoder is a 19 inch rack mounted unit. The Decoder is a 17 inch desk top unit. The Encoder power requirements are 90 to 132 VAC, 47 or 63 Hz, 170 watts. The Decoder power requirements are 95 to 260 VAC, 47 to 63 Hz, 50 watts. Input data to the Encoder and output data from the Decoder must be as specified by standard RS-422/449, each requiring a 37-position mating connector, per MS18271-4, with pin assignments per Figure 3.6-A of RS-449. The video input and output, and the two video monitor connectors on the Encoder require standard male BNC cable connectors. The video output from the Decoder requires a mating male F cable end connector. The video cable required is 75 ohm RG-59.

6. REFERENCES

The following references may be used to support this proposal.

[1] IEEE Standard Dictionary of Electrical and Electronics Terms - Fourth Edition, ANSI/IEEE Std 100-1988.

[2] Abbreviations for Use on Drawings and in Text, ANSI Y1.1-1972(R1984).

[3] Standard Letter Symbols for Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units), ANSI/IEEE Std 260-1978(R1985).

[4] Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering, ANSI/IEEE Std 280-1985.

[5] Letter Symbols, Abbreviations, Terms, and Definitions for Discrete Semiconductor and Optoelectronic Devices, JEDEC Std. No. 77-1981 and addendum JEDEC Std. No. 77-1-1988.

[6] Glossary of Microelectronic Terms, Definitions, and Symbols, JEDEC Std. No. 99-1985.

[7] Terms, Definitions, and Letter Symbols for Microcomputers and Memory Integrated Circuits, JEDEC Std. No. 100-1982.

[8] Graphic Symbols for Electrical and Electronic Diagrams, ANSI/IEEE Std 315-1975(R1989) and supplement ANSI/IEEE Std 315A-1986.

[9] Electrical and Electronics Diagrams, ANSI Y14.15-1966(R1973) and supplements ANSI Y14.15a-1971(R1973) and ANSI Y14.15b-1973.

[10] Graphical Symbols for Logic Functions, ANSI/IEEE Std 91-1984.

[11] Standards for Logic Diagrams, ANSI/IEEE Std 991-1986.

APPENDIX A
STUDY on COVERAGE

Critical Viewing and Listening Tests of
Normal Television Programming with
Simultaneous Insertion of a
384 Kbs Packetized Data Stream
November 1993

Study by COHEN, DIPPELL AND EVERIST, P.C., Radio and Television Consulting Engineers, Washington, D.C..

See under separate cover.

APPENDIX B
GLOSSARY

Back Porch. The portion of the video signal which lies between the trailing edge of the horizontal sync pulse and the start of the active picture time. Burst is located on back porch.

Baseband. The range of frequencies over which signal amplitude remains constant (within some limit) as it is passed through a system.

Blanking Level. Refers to the 0 IRE level which exists before and after horizontal sync and during the vertical interval.

Breezeway. The portion of the video signal which lies between the trailing edge of the horizontal sync pulse and the start of burst. Breezeway is part of the back porch.

Broad Pulses. Another name for the vertical synchronizing pulses in the center of the vertical interval. These pulses are long enough to be distinguished from all others, and are the part of the signal actually detected by vertical sync separators.

Burst. A small reference packet of subcarrier sine wave, typically 8 or 9 cycles, which is sent on every line of video. Since the carrier is suppressed, this phase and frequency reference is required for synchronous demodulation of the color information in the receiver.

CATV. Community Antenna Television (CATV), Cable Television (colloquial). Data communications based on radio frequency (RF) transmission, generally using 75-ohm coaxial cable as the transmission medium. Communications is via coaxial cable where multiple frequency-divided channels allow mixed transmissions to be carried simultaneously, broadband.

Chrominance. Chrominance refers to the color information in a television picture. Chrominance can be further broken down into two properties of color, Hue and saturation.

Chrominance Signal. The high-frequency portion of the video signal which is obtained by quadrature amplitude modulation of 3.58 MHz subcarrier by R-Y and B-Y.

Color Difference Signals. Signals used by color television systems to convey color information in such a way that the signals go to zero when there is no color in the picture. R-Y, B-Y, I and Q are all color difference signals.

Communication Network. The total network of devices and transmission media (radio, cables, etc.) necessary to transmit and receive intelligence.

Component Video. Video which exists in the form of three separate signals, all of which are required in order to completely specify the color picture. For example: R, G and B or Y, R-Y, and B-Y.

Composite Video. A single video signal containing all of the necessary information to reproduce a color picture. Created by adding quadrature amplitude modulated R-Y and B-Y to the luminance signal.

CW. Continuous Wave. Refers to a separate subcarrier sine wave used for synchronization of chrominance information.

Data communications. The transmission and reception of data, often including operations such as coding, decoding, and validation.

dB (Decibel). A decibel is a logarithmic unit used to describe signal ratios. For voltages, dB=20 Log10 (V1/V2)

Demodulator. In general, this term refers to any device which recovers the original signal after it has modulated a high frequency carrier. In television, it may refer to:

1) An instrument which takes video in its transmitted form (modulated picture carrier) and converts it to baseband.

2) The circuits which recover R-Y and B-Y from the composite signal.

Equalizer. The pulses which occur before and after the broad pulses in the vertical interval.

Envelope Detection. A demodulation process in which the shape of the RF envelope is sensed. This is the process used by a diode detector.

Ethernet. A popular local network design characterized by 10 Mbit/s baseband transmission over a shielded coaxial cable. Standardized by the IEEE as specification IEEE 802.3, referring to the Ethernet local-network design or being compatible with Ethernet.

Field. In interlaced scan systems, the information for one picture is divided up into two fields. Each field contains one half of the lines required to produce the entire picture. Adjacent lines in the picture are in alternate fields.

FM. Frequency Modulation (FM) is the process by which the frequency of a carrier signal is varied in proportion to the signal of interest. In the NTSC television system, audio information is transmitted using FM.

Frame. A frame contains all the information required for a complete picture. For interlaced scan systems, there are two fields in a frame.

Front Porch. The portion of the video signal between the end of active picture time and the leading edge of horizontal sync.

Gateway. A conceptual or logical network station that serves to interconnect two otherwise incompatible networks, network nodes, subnetworks, or devices. It performs a protocol-conversion operation across a wide spectrum of communications functions or layers.

Genlock. The process of locking both sync and burst of one signal to sync and burst of another, making the two signals completely synchronous.

Group Delay. Distortion that results when a group of related frequencies differ in "arrival time" after passing through a circuit, such as a vestigial sideband filter.

Harmonic Distortion. If a sine wave of a single frequency is put into a system, and harmonic content at multiples of that frequency appears at the output, there is harmonic distortion present in the system. Harmonic distortion is caused by non-linearities in the system.

Horizontal Blanking. Horizontal blanking is the entire time between the end of the active picture time of one line and the beginning of active picture time of the next line. It extends from the start of front porch to the end of back porch.

Horizontal Sync. Horizontal sync is the -40 IRE pulse occurring at the beginning of each line. This pulse signals the picture monitor to go back to the left side of the screen and trace another horizontal line of picture information.

Hue. Hue is the property of color which allows us to distinguish between colors such as red, yellow, purple, etc.

Hum. Undesirable coupling of the 60 Hz power sine wave into other electrical signals.

Intercarrier Sound. A method used to recover audio information in the NTSC system. Sound is separated from video by beating the sound carrier against the video carrier, producing a 4.5 MHz IF which contains the sound information.

IEEE. Institute of Electrical and Electronics Engineers.

IEEE 802.3. Referring to the Ethernet local-network design or compatibility with Ethernet.

IRE. A unit equal to 1/140 of the peak-to-peak amplitude of the video signal, which is typically one volt. The 0 IRE point is at blanking level, with sync tip at -40 IRE and white extending to +100 IRE. IRE stands for Institute of Radio Engineers, the organization which defined the unit.

I/O. Input and/or output.

Linear Distortion. Refers to distortions which are independent of signal amplitude.

LAN. Local Area Network. A computer and communications network that covers a limited geographical area, allows every node to communicate with every other node, and does not require a central node or processor.

Luminance. The signal which represents brightness, or the amount of light in the picture. This is the only signal required for black and white pictures, and for color systems it is obtained as a weighted sum (Y=0.3R + 0.59G + 0.11B) of the R, G and B signals.

Modem. Modulator/Demodulator. A device that modulates and demodulates signals transmitted over communication facilities. Converts (a) digital data to an analog signal that can be transmitted on a telecommunication line and (b) converts the analog signal received to digital data.

Modulation. A process which allows signal information to be moved to other frequencies in order to facilitate transmission of frequency-domain multiplexing. See AM and FM for details.

Non-Linear Distortion. Refers to distortions which are amplitude dependent.

NTSC. National Television System Committee. The organization which developed the television standard currently in use in the United States, Canada and Japan. Now generally used to refer to that standard.

OEM. Original Equipment Manufacturer.

Packet. A block of binary information containing a variety of types of control information and data that is treated as a unit.

PAL. Phase Alternate Line. Refers to the television system used in Europe and many other parts of the world. The phase of the chrominance signal alternates from line to line to help cancel out phase errors.

Quadrature AM. A process which allows two different signals to modulate a single carrier frequency. The two signals of interest Amplitude Modulate carrier signals which are the same frequency but differ in phase by 90 degrees (hence the Quadrature notation). The two resultant signals can be added together, and both signals recovered at the other end, if they are also demodulated 90 degrees apart.

Quadrature Distortion. Distortion resulting from the asymmetry of sidebands used in vestigial sideband television transmission. Quadrature distortion appears when

envelope detection is used, but can be eliminated by using a synchronous demodulator.

RF. Radio Frequency. In television applications, RF generally refers to the television signal after the picture carrier modulation process.

RGB. Red, Green and Blue. The three primary colors used in color television's additive color reproduction system. These are the three color signals generated by the camera and used by the picture monitor to produce a picture.

RS-232C. A type of standardized cable connection.

R-Y. One of the color difference signals used in the NTSC system, obtained by subtracting luminance from the red camera signal. The R-Y signal drives the vertical axis of a vectorscope.

Saturation. The property of color which relates to the amount of white light in the color. Highly saturated colors are vivid, while less saturated colors appear pastel. For example, red is highly saturated, while pink is the same hue but much less saturated.

Subcarrier. The modulation sidebands of the color subcarrier contains the R-Y and B-Y information. For NTSC, subcarrier frequency is 3.579545 MHz.

Synchronous Detection. A demodulation process in which the original signal is recovered by multiplying the modulated signal with the output of a synchronous oscillator locked to the carrier.

T1. An AT&T term for a digital carrier facility that transmits a DS-1 formatted digital signal at 1.544 Mbits/s.

Throughput. The total useful information processed or communicated during a specified time period. Expressed in bits per second or packets per second.

Unmodulated. When used to describe television test signals, this term refers to pulses and pedestals which do not have high-frequency chrominance information added to them.

V.32. A data transmission protocol.

VBI. Vertical Blanking Interval. Video data to the CRT display is blanked during the Vertical Interval, see Vertical Interval definition below.

Vertical Interval. The synchronizing information which appears between fields and signals the picture monitor to go back to the top of the screen to begin another vertical scan.

WAN. Wide Area Network. A computer/communications network covering a wide geographical area that allows every node to communicate with every other node, and requires a central node or processor.

Y. Abbreviation for luminance.

Zero Carrier Reference. A 120 IRE pulse in the vertical interval which is produced by the demodulator to provide a reference for evaluating depth of modulation.

APPENDIX C
LIST OF ABBREVIATIONS

AFC - Automatic Frequency Control
ABBE - Adaptive Baseband Equalizer
BER - Bit Error Rate
CATV - Cable TV
CD - Compact Disk
CEG - Consumer Electronic Group of EIA
EIA - Electronic Industries Association
FCC - Federal Communications Committee
HCI - Host Computer Interface
HDTV - High Density TV
IEEE - Institute of Electrical and Electronic Engineers
IRE - Institute of Radio Engineers
ITFS - Instructional Television Fixed Services
Kbps - Kilo bits per second, 1000 bits per second
LAN - Local Area Network
LCI - Local Communications Interface
MAN - Metropolitan Area Network
MDEG- 2 Standards Committee -
MDN - Metropolitan Data Network
MPEG - Motion Picture Expert Group
NAB - National Association of Broadcasters
NCTA - National Cable TV Association
NDBC - National Data Broadcasters Committee
NII - National Infrastructure Initiative
NOI - Notice of Inquiry
NTSC - National Television System Committee
OET - Office of Engineering Technology
PAL - Phase Alternate Line
PDA - Portable Digital Assistants
RPU - Remote Pickup Unit
SCH - Sub-Carrier to Horizontal
STL - Studio Transmitter Link
Telcos - Telephone Companies
VBI - Vertical Blanking Interval
VITS - Vertical Interrupt Test Signal
WAN - Wide Area Network

EXHIBIT C

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are conducted at different desired/undesired signal level (D/U), and the levels of interference at the threshold of visibility (TOV) is recorded and the audio degradation is noted. The level of interference for a bit error rate (BER) = 10^{-5} is also recorded when the NTSC+ is the desired signal.

3.2.1 Co-channel

The purpose of this test is to determine the performance of the data broadcasting system (NTSC) in the presence of co-channel interference and to determine the extent to which an NTSC+ signal will interfere with a co-channel NTSC signal. The test is to be conducted with the desired signal at the weak signal condition (-55 dBm). When NTSC is the desired signal, the best case offset condition (10,010 Hz) shall be used. When NTSC+ is the desired signal, the offset shall be 10,040 Hz. When NTSC is the desired signal, TOV and associated audio interference are to be recorded and when NTSC+ is the desired signal, BER measurements are to be recorded.

Step 1. Using NTSC+ as both the desired and undesired signal, increase the undesired NTSC signal level and record that level at TOV. This test provides a baseline for the rest of the test in this section.

Step 2. Repeat step 1 using desired and undesired signals as indicated in the matrix below. For each, record the change in BER or signal level at TOV as appropriate. The test should be performed with data on in NTSC+ signal.

Desired Signal	Undesired Signal
NTSC	NTSC+
NTSC+	NTSC
NTSC+	NTSC+

3.2.2 Adjacent-Channel

The purpose of this test is to determine the performance of the data broadcasting system (NTSC+) in the presence of interference from a distant upper and lower adjacent signal and to determine the extent to which an NTSC+ signal will interfere with an adjacent channel signal. The tests are to be conducted with the desired signal at the weak signal condition (-55 dBm). The undesired signal frequency shall be offset toward the desired frequency by 22,000 Hz. When NTSC is the desired signal, TOV and associated audio interference are to be recorded and when NTSC+ is the desired signal, BER measurements are to be recorded.

Step 1. Using NTSC as both the desired and undesired signal and with the desired signal set at the weak level (-55 dBm), increase the undesired upper adjacent NTSC signal level and record that level at TOV. This test provides a baseline for the rest of the tests in this section.

Step 2. Repeat steps 1 using desired and undesired signals as indicated in the matrix below. For each, record the change in BER or signal level at TOV as appropriate. The test should be performed with data on and in NTSC+ signal.

Desired Signal	Undesired Signal
NTSC	NTSC+
NTSC+	NTSC
NTSC+	NTSC+

Step 3. Repeat steps 1 and 2 for lower adjacent signals.

3.3 Susceptibility to Noise

It is a well known fact that noise in the transmission environment exists in two general forms -- random and impulsive. The effect of both of these forms are evaluated in the tests described below.

3.3.1 Random-Noise

The C/N at BER = 10^{-5} is determined when NTSC+ is desired at the strong signal level (-15 dBm). BER measurements are also recorded at different random noise levels bracketing the TOV level to produce BER versus C/N level plot.

3.3.2 Impulse Noise

3.3.2.1 Introduction

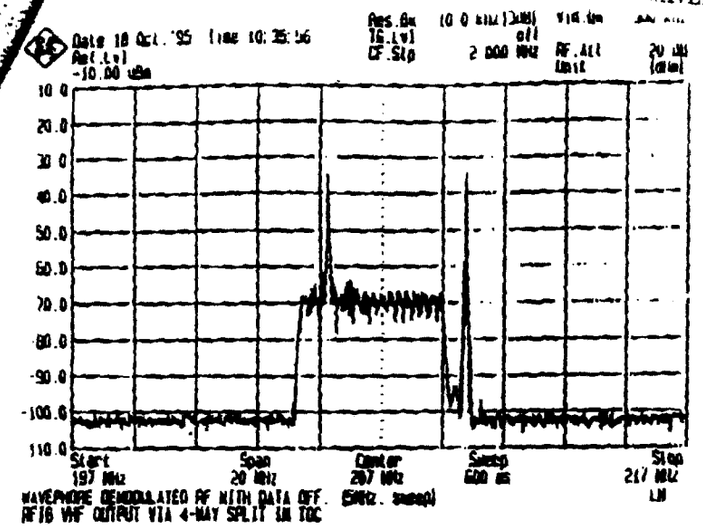
Impulse noise occurs intermittently, and perhaps only briefly, but not often at such amplitude that the desired signal is obliterated. Noise impulses may be created by automotive ignition systems or motor-driven electrical appliances. The effect of such impulses on a data transmission system is to create burst errors, the duration of which may exceed the correction capability of the system. The effect may be quite different from that of random noise, which produces a uniform distribution of digital errors.

NATIONAL DATA BROADCASTING COMMITTEE WAVEPHORE THRESHOLD OF VISIBILITY (TOV) AND DATA THRESHOLD (BER) TESTS

Summary of pages 13-23

ATTC Test#	Description		Desired Power (dBm)	Undesired Power (dBm)	Desired to Undesired Ratio (dB)	Time of Test* (HH:MM)
271	Random Noise	BER	-14.88	-59.11	44.23	
290	Co-Channel NTSC into NTSC	TOV	-55	-95.28	40.28	
286	Co-Channel NTSC+ into NTSC	TOV	-55	-95.22	40.22	
275	Co-Channel NTSC into NTSC+	BER	-55.06	-94.58	39.52	
280	Co-Channel NTSC+ into NTSC+	BER	-55.12	-90.88	35.76	16:37
280	Co-Channel NTSC+ into NTSC+	BER	-55.12	-84.88	29.76	16:58
288	Upper Adj Ch NTSC into NTSC	TOV	-55	-46.74	-8.26	
284	Upper Adj Ch NTSC+ into NTSC	TOV	-55	-46.98	-8.02	
276	Upper Adj Ch NTSC into NTSC+	BER	-54.98	-53.12	-1.86	10:32
276	Upper Adj Ch NTSC into NTSC+	BER	-54.98	-53.12	-1.86	10:47
276	Upper Adj Ch NTSC into NTSC+	BER	-54.98	-48.12	-6.86	11:07
276	Upper Adj Ch NTSC into NTSC+	BER	-54.98	-46.12	-8.86	11:31
277	Upper Adj Ch NTSC+ into NTSC+	BER	-54.98	-45	-9.98	
289	Lower Adj Ch NTSC into NTSC	TOV	-55	-60.96	5.96	
285	Lower Adj Ch NTSC+ into NTSC	TOV	-55	-60.01	5.01	
278	Lower Adj Ch NTSC into NTSC+	BER	-54.89	-52.94	-1.95	
279	Lower Adj Ch NTSC+ into NTSC+	BER	-54.92	-53.1	-1.82	

*When a test was repeated on a given day, the completion times are shown. See detailed data sheets for further explanation.



Out-of-Band Emissions
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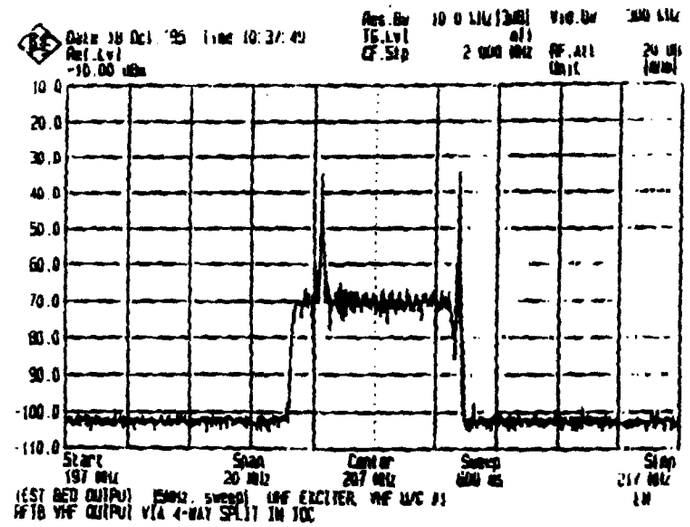
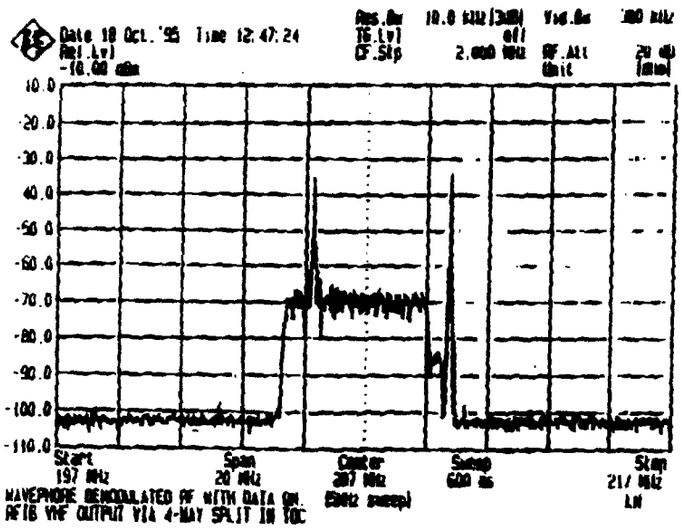


Out-of-Band Emissions
REFERENCE 10:37:49



Out-of-Band Emissions
Data ON 12:47:24

New Rc Tx T