ADDRESSABLE TERMINAL CONTROL USING THE VERTICAL INTERVAL

CARL F. SCHOENEBERGER

TOCOM, INC.

ABSTRACT

The concepts of CATV Terminal Control using the Vertical Interval for addressing are explored.

Design objectives of the TOCOM 55 PLUS™ and the advantages of baseband operation with vertical interval addressing are given. Methods used for reliable addressing, channel access control, parental key control, emergency alert, and basic system security, are discussed.

INTRODUCTION

During the past several years, the requirement for a flexible and effective method to control subscriber access to premium television has created the addressable terminal. The principal advantage of an addressable terminal is the ability to change a subscribers service capability rapidly and economically.

A number of techniques are available to transmit the digital information to the terminal for addressing and program control. With the use of a baseband converter, data can be encoded in the standard video format and transmitted in the vertical interval.

The capacity of the vertical interval is sufficient to support a very flexible control algorithm plus a large number of additional services. When appropriate formats are utilized, a highly reliable system is created. Theft of service or addressable terminal security, must be considered as a point of primary concern in the design of the system.

This paper will illustrate the TOCOM 55 PLUS™ system, which is designed to take advantage of the benefits of addressable terminal technology utilizing vertical interval addressing.

Addressable Terminal Design Objectives

The 55 PLUS™ system was developed with foremost consideration given to the following design objectives:

1. High quality RF conversion performance with 400 MHz capability.

Obviously, the primary product delivered to the customer is television pictures, and with performance tradeoffs caused by 400 MHz systems, the performance of the terminal becomes a critical link which can substantially effect plant costs.

2. Flexible control of premium services.

Due to the rapid expansion of premium services and the use of new marketing methods, considerable additional capacity should be provided. The provision for rapid reconfiguration of the system is a necessity to promote additional sales. An individual control mechanism should be provided to permit sales of single and repeated special events such as a single course on an educational channel.

3. A high security, low distortion video scrambling technique.

Using baseband technology, an effective but economical decoding system must be provided.

4. Theft and tamper resistant.

The system design of the addressable terminal must contain various mechanisms to assure that the subscriber can not compromise the enclosure and internal circuits, nor effectively utilize a stolen terminal.

5. Reliable hardware.

The addressable terminal design, and quality of the component parts, must assure long term reliable operation in the environment of a typical consumer's home.

6. Economical pricing.

Although the initial cost per subscriber may be higher with addressable termi-

nal technology, the revenue potential is also much higher. To insure that this occurs, each feature of the addressable terminal should be studied on a cost to provide versus revenue obtained basis.

7. Upward compatability.

The system should be designed to permit substantial upward compatability to fully interactive versions with internal character generators and upstream data transmitters.

8. Wireless remote control.

Provision should be made for an optional wireless remote control which is capable of operating all modes of the terminal including volume and muting. The remote should be economical enough to be replaced at the subscriber's expense when damaged.

9. On-screen display.

The channel number and time should be superimposed on the displayed video, eliminating the need for separate channel number readouts and providing a clock feature for almost no incremental cost.

10. Parental access coding.

The terminal should test the incoming vertical interval data to determine the parental access rating of the video program. If beyond the threshold, it should automatically block the picture and sound while requesting the parental access code. The rating threshold and the access code should be addressable. Although this feature generates little revenue, it is a very powerful franchising tool.

11. Attractive appearance.

The appearance of the set top and remote control should blend well with the typical home television environment.

ADVANTAGES OF BASEBAND CONVERSION AND VERTICAL INTERVAL ADDRESSING

The principle advantages of baseband conversion are as follows:

1. No extra system data carriers.

This feature is particularly important when up to 110 video channels must be controlled and descrambled independently, especially in systems which have virtually all bandwidth occupied.

2. Economical data receiver.

The data receiver is simply a comparator which strips non-return-to-zero data from lines of video. The digital control portion of the terminal determines when actual data is present and disregards other video and noise. It is also possible ble to read data anywhere on the video signal, permitting entire channels to be converted to data use.

3. Internal baseband video input.

This is useful for versions of the product which contain internal character and graphics generators. It also makes on-screen display of channel number and time possible.

4. Control of volume and picture blanking.

This feature permits the remote control to be a true replacement for existing remote controls. The digital control portion of the terminal also utilizes these features to prevent the consumer from seeing or hearing unauthorized programs.

5. Baseband video output.

To prevent unnecessary distortion, an optional baseband video and sound output is available for direct connection to video tape recorders or newer televisions which have baseband video inputs.

BASIC ADDRESSING FORMAT AND RELIABILITY

The addressable terminal must obtain data from the vertical interval at a modestly high data rate, qualify the data as valid, and process the data. Vertical interval data is transmitted on lines 17 and and 18 in place of the broadcaster's VITS (vertical interval test signals). All other signals in the vertical interval are transferred through the system intact, permitting proper operation of VIR (vertical interval reference signal) and other present and future services. The data rate is set at the fastest possible speed which is also a sub-multiple of color burst, in this case 3.579 MHz/4 was selected. This data rate is limited by the speed of the control processor used in the TOCOM 5504A™ and is referred to as the half speed data rate. The TOCOM 5510A™ uses a bit time of 3.579 MHz/2 but can also read and process half speed data. The full speed data permits 92 data bits per line while the half speed data is limited to 46 bits per line. At this speed, the control microprocessor can read data as it arrives, eliminating expensive buffer memories, and process the data during the remainder of the video field. Transmission reliability is assured through the technique of sequenced redundant transmission. All addressing information is sent twice

and in sequence, and must be received this way, or it is considered invalid data and ignored. Also, a configuration checksum is transmitted to give a longitudinal check. The specific addressing data is stored in an EEPROM (electrically erasable programmable read only memory) which retains data, even with no power applied. The addressable terminal is actually addressed on only one channel called the home channel. The vertical interval of the other channels are free to be used for text transmission and for the Program Control Word (described later). When the terminal is turned off, it automatically tunes to the home channel and receives any new addressing information as well as a configuration checksum of what the addressable terminal's EEPROM memory should contain. The checksum method is much faster than actually re-addressing each unit. If the checksum does not match, the addressable terminal will disable and show an error code on a blank screen. The error code is useful to the system operator since it will indicate the reason why the addressable terminal has ceased to operate. Except in the case of terminal failure, operation can be restored by re-addressing the unit without a service call.

PROGRAM CONTROL WORD AND THE ADDRESSABLE TERMINAL RESPONSE

Program control is implemented through the use of a digital series of information called the program control word (PCW). This data is sent 3 times per second from the headend and is continuously monitored by all addressable terminals tuned to that channel. The PCW contains the following data:

1. Service Class Identification.

The program may belong to any or all of up to 32 different service classes, each represented by an individual bit.

2. Program Indentification.

An 8 bit number is used to identify the specific program that is being transmitted.

3. Channel Type

A 4 bit value is used to identify the use of the viewable video portion of the channel. In some cases this indicates that full field data is present and the addressable terminal automatically switches to a blank screen. Even channel types are used for A cable, while odd types are used for B cable in an A/B cable system. It is also used for control of the descrambler.

4. Parental Access Control.

A 4 bit value represents the parental control rating of the current program.

The addressable terminal uses the information contained in the PCW to determine if the user is qualified and if so, it releases the video and sound and descrambles the picture for the subscriber.

55 PLUS™ ADDRESSING CAPABILITIES

The addressable terminal must be initialized with its actual address, system number, and home channel, before it accepts commands. This is accomplished by depressing a certain key combination on the terminal while the new address data is loaded. One key combination is utilized for HRC format head ends while another is used for the Standard format. In either case, the terminal listens to the respective channel 3 and accepts the next new terminal initialization sequence. All subsequent commands directed to this address, on the home channel, will be accepted by the terminal. This feature is particularly useful because the actual address can be used to specify a physical location or section of the cable plant with no excess inventory problems or "missing" address codes.

The basic initialization sequence is sent in sequence in 14 transmissions on the home channel. The following information is carried in this sequence:

1. Service class enables.

A 32 bit word is stored in the addressable terminal which defines which service classes it may permit the customer to view.

2. Per-event enables.

Up to 4 different events are stored in the format of a program identification and channel number.

3. Emergency alert group enable.

An 8 bit word is stored which defines any of 8 emergency alert groups to which the addressable terminal belongs.

4. Parental access code and parental control level.

The customer provided control threshold and up to 8 digit access code are stored. These may be set to a null value which removes any requirement for the sub-

sciber to enter the access code.

5. Cable plant configuration information.

Several status bits are loaded to indicate the tuning format HRC, ICC or Standard, Home Channel, A/B cable option, and bit enables to tune the FM band. This information can be changed only when the actual address is loaded.

6. System number.

The system number identifies the original point of programming and is used to prevent theft of service in other systems, and to aid in identification of stolen terminals.

Several other command sequences are recognized by the addressable terminal and are itemized below:

1. Configuration check.

A checksum transmission that is used to verify that the addressable terminal and control system agree on the current configuration.

2. Emergency alert.

An 8 bit word which is compared to the previously stored Emergency Alert Group enable, used to initiate or stop an emergency alert cycle.

3. Addressable terminal individual disable.

This command is sent to deactivate the addressed terminal. It is usually sent to all invalid addresses not accessed by the block disable command.

4. Addressable terminal block disable.

This command disables blocks of 4096 addressable terminals, and is sent to all invalid addresses as a feature to prevent stolen boxes from successful operation.

The Program Authorization Cycle

The process of changing channels is a function of the control microprocessor. When the user selects a new channel, the microprocessor compares the PCW and the subscriber service class enables. If any two corresponding bit pairs are set, then an enable results. If no pairs are found, then a test is made for channel and program identification match to the stored per event enables. If these match, then it is also enabled. When enabled, the terminal then checks the parental control level and requests the access code if necessary. Once this operation is complete, the video and sound are released to the subscriber. The channel tuning and authorization cycle typically takes about one half second if no access code is required.

Service Class Control

Addressable terminal control using service classes provides one of the most flexible methods of premium channel control. The method is best demonstrated by a typical use example as shown in Figure 1A.

In the example, some bits represent a package of channels while others represent a channel during part of a day for a partial service or promotional material reception. A program can belong to any or all service classes simultaneously while the user also can be enabled for any or all service classes. If any corresponding bit pairs are set the subscriber will be enabled. To give a specific example, if subscriber #3 tunes to premium channel #1 during transmission of partial service, bit pair number 7 will be set and the subscriber will be enabled.

Per-Event Control

The per-event enable portion of the addressable terminal is operated by a simple match between the channel numbers and the program identification numbers. A typical use of this type of enable is for the sale of a sporting event, or an educational show such as driver education for a semester. Each channel can be sold with up to 255 special events, and each addressable terminal can store enables for any 4 special events.

Emergency Alert Control

Emergency alert control is operated in the same manner as service classes except that there are only 8 bits or classes instead of 32. The terminals receive the command from the vertical interval and if any bit pair is set, turn the television on if off, tune to the channel specified in the command, and raise the volume to maximum. When the alert is complete, the power will restore to the previous state and the addressable terminal will tune to the home channel. In a typical system each class will represent different groups of people such as: police, fire, auxiliary fire, general population, etc.

TERMINAL SECURITY

An addressable terminal can be circumvented in one of two ways: by compromising the terminal or by directly connecting

Service Class Bit	Typical Channel	Content
1	4,5,8,11,13,21,33,39	Off Air Channels
2	10,14,15,16,17	Economy Premium Package
3	All Premium Channels	Promotional Material
4	50	Premium Channel #1
5	51	Premium Channel #2
6	52	Premium Channel #3
7	50	Partial Service Premium Channel #1

Figure 1A

Channel Control Word Service Class Bits							Channel Use
1	2	3	4	5	6	7	
1	0	0	0	0	0	0	Off air channels
0	1	0	0	0	0	0	Economy premium channel
0	0	0	1	0	0	0	Premium channel #1
0	0	1	1	0	0	0	Premium channel #1 Showing promoted material
0	0	0	1	0	0	1	Premium channel #1 Showing partial service
0	0	0	0	1	0	0	Premium channel #2

Figure 1B

Subscriber Service Class Enable Bits							Subscriber Number	Subscriber Enable Capability
1	2	3	4	5	6	7		
1	0	0	0	0	0	0	1	Enabled only for off air reception
1	1	1	0	0	0	0	2	Off air, economy premium and promotional material
1	0	1	0	1	0	1	3	Off air, promotional material, partial service premium channel #1, premium channel #2

Figure 1C

a "black box" to the plant which descrambles the encoded video.

Since a "black box" can always be built, and sold as a kit, the objective is to make it so expensive to sell that the average consumer finds legitimate purchase of premium television much cheaper. The TOCOM 55 PLUS™ encoding technique requires a special demodulation to baseband which raises the cost of "black box" equipment substantially. The actual baseband descrambling process requires line counting circuits, a special sync stripper circuit, automatic gain control timing circuits, and actual video processing circuits. Most of these parts are not extra cost items in the TOCOM 55 PLUS™ since it's basic design is optimized for these features; however, convential "black box" designs will be relatively expensive.

The TOCOM 55 PLUS™ has a number of internal system security features to protect the addressable terminal from compromise. They are itemized below.

1. Tamper switch.

An internal tamper switch detects when the addressable terminal has been opened and disables the terminal. The subscriber will see a blank screen with a special code displayed in place of the channel number. If a correct configuration check is subsequently received the addressable terminal will be restored to normal operation, otherwise it must be re-programmed by the system operator. The tamper switch will operate even if the addressable terminal was not powered at the time of intrusion.

2. Three day configuration check timeout.

This feature may be enabled to deactivate any addressable terminal not receiving a configuration check for three days. This prevents external or internal blocking of the home channel addressing information after ordering premium services. This disable will clear if a valid configuration check is received and also displays a special code in place of the channel number during the disabled period. Note that when the addressable terminal is turned off by the subscriber it automatically tunes to the home channel and receives configuration checks.

3. Checksum verification.

If the internal checksum does not verify with the programmed checksum the addressable terminal will become disabled until the system operator re-programs the terminal. Again a different special code is displayed on a blank screen while the terminal is disabled.

4. No jumper to cut or simple rewiring to enable the descrambler.

The decoding of the addressing information and the source of the real time signals for descrambling, originate in the control microprocessor. Since decisions and real time control come from one part, there are no jumpers to cut. The algorithm of the control microprocessor is not easily extracted and all critical parts including the microprocessor and EEPROM memory are soldered in place. This makes it difficult to develop and install foreign components that would permit the addressable terminal to operate without system control.

5. Individual and block disable.

The disable commands prevent stolen addressable terminals from operation elsewhere in the same system. This feature is also useful for service disconnects since most customer's will not remove the addressable terminal on moving day if it was deactivated when he called in to have the service disconnected.

6. System identification match.

The system identification is compared during a configuration check, and a stolen addressable terminal from another system will be disabled. This will occur even if the address of the stolen terminal is the same as a legitimate customer in the foreign system.

7. Reversing A/B cables.

The TOCOM 55 PLUS™ does not control on a channel basis, but on a program basis. Therefore, switching cables in a dual plant will make no difference. The terminal still decodes the program control word and enables service based on service class or per-event authorization.

8. New terminal initialization done only at the headend control point.

The actual address of the terminal and cable plant parameters are loaded at the headend only, under supervision of the system operator. This prevents identical addresses in which one subscriber pays for all services and the others operate with his address code.

CONCLUSION

The baseband approach to addressable terminal design provides many important advantages over other techniques. Video format data encoding eliminates additional data carriers and is easily expanded to full field data transmission. Valuable product features such as volume control and on-screen displays become part of the basic design. Pay security is enhanced through more secure baseband encoding techniques. The TOCOM 55 PLUS™ product family proves that sophisticated baseband technology can be economically applied to addressable terminals.