AN AMPLIFIER STATUS MONITORING AND CONTROL SYSTEM

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A trunk amplifier status monitoring and control system is described. Its features include an addressable receiver, a variety of control functions, including reverse feeder switching, and an independent upstream status signal. Addressing is done by means of an FSK'ed signal similar to a sound carrier. The status signal carried information on various aspects of the station status. The status signals are all on a common frequency, occupying minimal bandwidth, and are addressed exclusively, only one replying at a time. The command functions are described in detail, both as currently implemented, and possible future applications. Also described in detail is the status information returned, both as currently implemented and possible alternatives. A simple control unit is described and a more sophisticated means of control is discussed.

INTRODUCTION

With the growing complexity of CATV distribution systems, the need for a way to monitor the system's operation is becoming acute. The traditional status monitor, subscriber complaint, is clearly inadequate for today's systems carrying dozens of channels, premium services, and security data. In addition, the ability to control signal flow, particularly in the reverse system, has emerged as a very desirable feature.

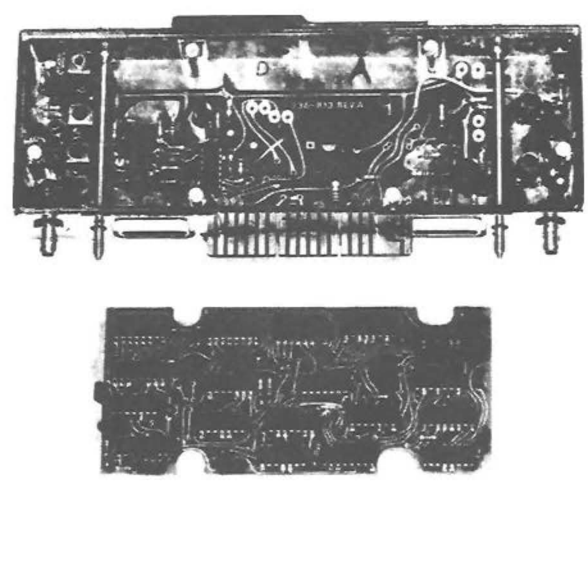
These functions can be accomplished by the system described in this paper. Reliable, low-cost integrated circuitry, both linear and digital, is used in a simple and straightforward system for monitoring and control.

The heart of the system is a transceiver mounted within a trunk amplifier, which receives a downstream control signal, and generates an upstream status signal.

Addressability is an essential feature of this system. Each amplifier that is to be monitored or controlled is assigned a unique digital address. Any command intended for this station, including the command which causes transmission of an upstream status signal, is accomplished by modulating the control carrier with the proper address, and desired command.

CONTROL FUNCTIONS

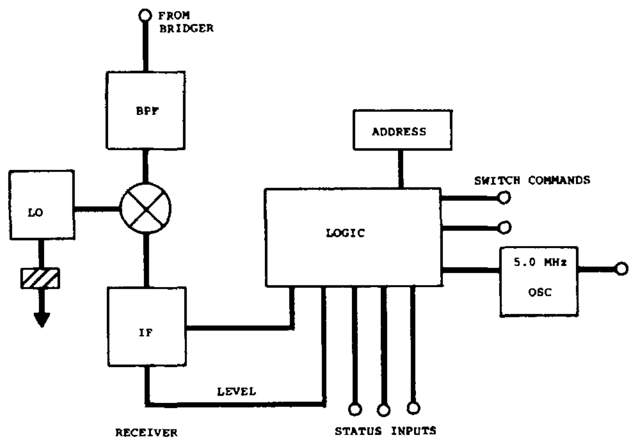
Control is accomplished by means of a frequency shift keyed (FSK) carrier at 53.75 MHz. The digital data is Manchester encoded for easy detection. This signal is in effect a lower adjacent sound carrier to Channel 2 and is run at least 15 dB down from the Ch. 2 video carrier. It is not likely to cause problems on the system or, more importantly, to subscriber sets. (In HRC or other non-standard channel systems, the control carrier is adjusted accordingly). The frequency shift is 30 kHz, which occurs at a 19.2 kHz rate. The transmitted word consists of 16 bits, of which 9 bits are for the address, 5 bits are for 5 independent commands, plus start and stop bits. Words are transmitted asynchronously, each word taking slightly less than 1 millisecond. A nine-bit address allows 512 (2^9) possible addresses, which seems adequate to accommodate the number of trunk amplifiers which might be served from one headend or hub. With this number of addresses and the bit rate above, all stations can be addressed within a half second.



Remote Module

In the amplifier station, the control signal is picked off at the bridger output. A hetrodyne receiver is used, with a crystal controlled local oscillator, converting to a 10.7 MHz IF. Standard automotive specification components are used, which are well suited to the CATV amplifier environment, readily available, low in cost, and of proven reliability.

The detected signal is converted to a digital waveform, and processed by logic circuitry. CMOS integrated circuits are used here, where their low power consumption and wide supply voltage range make this logic family ideal for the application. The logic circuitry checks the received signal for address. If the address matches that which is programmed into the module, then the associated commands are stored by the logic circuitry.



Remote Module

What control functions are desirable or feasible? Certainly the transmission of an upstream status signal should be done on command, and this is done. Since the status signals are transmitted on a common frequency, it is important that no more than one station reply at a time, and this is provided for in the logic.

Reverse feeder switching has come to be considered almost essential in CATV systems making substantial use of two-way transmission. In this system, this is accomplished with a diode switch, which controls insertion of the reverse feeders onto the reverse trunk. The ability to switch individual feeders is attractive, but this is not readily achieved in a conventional bridger station.

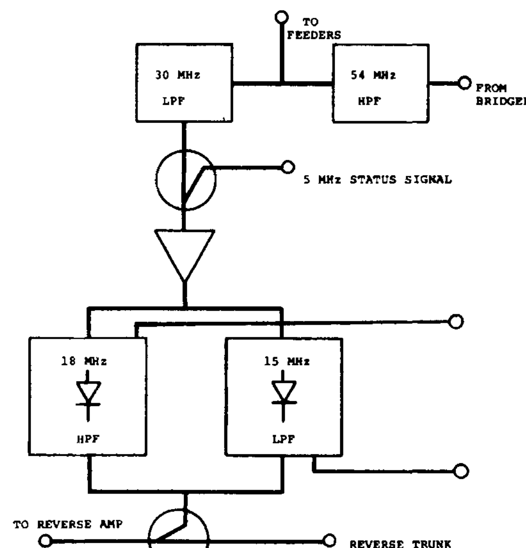
The use of reverse systems for data collection from subscribers is growing rapidly. At the same time, increasing use is being made of reverse video transmission, a rather different type of service. Several considerations may be stated:

1. Addressable type subscriber data terminals are generally believed to be tolerant of the electrical environment typically found on two-way systems without feeder switching, but switching is a valuable troubleshooting tool.

2. Feeder switching is almost essential if video is to be carried on a fully implemented two-way system.

These considerations have motivated the design of a bridger filter in which the 5-30 MHz band is further split into 5-15 MHz, 18-30 MHz sub-bands. These are independently switchable by the control module.

In normal operation, the 5-15 MHz switch is normally closed, allowing speedy response from any subscriber. The 18-30 MHz switch is normally open, and is closed only when video is to be originated in that bridger service area. Thus, the reverse trunk is kept relatively clean in the 18-30 MHz range, for video, and switching overhead is minimized in the 5-15 MHz range, in which data is more tolerant of noise. Alternatively, the 5-15 MHz switch may be normally open and closed only when data is to be collected from that bridger service area.



Bridger Filter

Since the system is digital in nature, any control function which could be digitized could be accommodated.

Under consideration, but not yet implemented, is a facility for switching the reverse trunk path. Other possibilities would include some control of the station's powering, and control of the forward path. Automatic gain control by remote control is a somewhat distant possibility.

MONITORING FUNCTIONS

The upstream status signal consists of a crystal controlled 5.0 MHz carrier, which is frequency shift keyed, with a 3 kHz shift, at a 2 kHz rate. The signal carries Manchester encoded data, including the 9-bit address of the station, 5 status bits, and start and stop bits. This 16-bit word is 8 ms long. In practice, about 20 ms is alloted to read the status word from a station. This allows reading all 512 signals in about 10 seconds.

What aspects of the station's status should be monitored? Again, any parameter which can be reduced to digits can be accommodated by this system.

At the simplest level, the addressable nature of this system provides a path continuity test, both downstream and upstream between the headend and any station. It might not be necessary to return the entire address on the status signal, since parity or some portion of the address might be adequate, but in the interest of keeping the system simple, the entire address is carried.

In this system, the level of the control carrier reaching the receiver is converted to a voltage by a tuning meter circuit and this is compared to a preset threshold. The result of this comparison controls one of the status bits; if the signal is lower than that threshold the bit is 0, otherwise it is 1.

The receiver will function over at least a 30 dB range of control carrier. This allows a simple routine for determining system gain to any station; the control carrier is gradually increased to the point of this threshold at that station. This level serves as a reference point for the gain of the system from the headend to that station. A record is made of these reference levels at the time of installation. One would hope that these levels would henceforth be the same, regardless of time, temperature, etc. Since this is unlikely, the system profile that does result each time these measurements are repeated, provides a very useful tool for system maintenance.

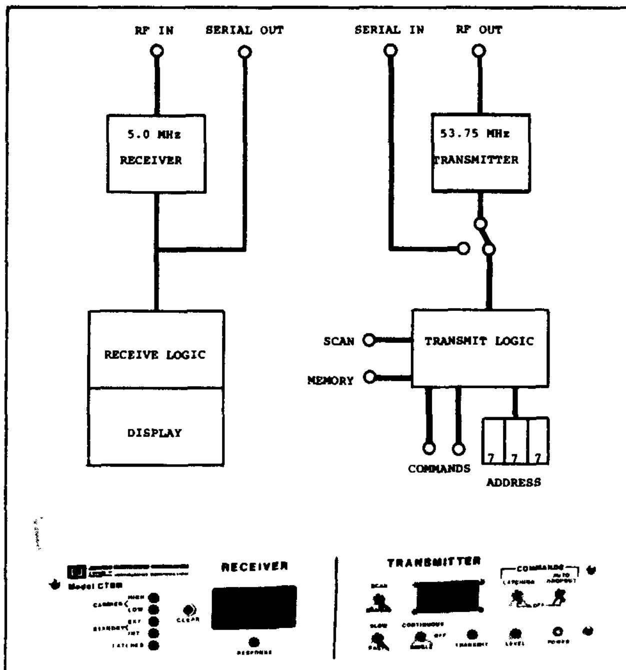
The module can also be provided with two thresholds, spaced typically 6 dB apart. Then, if the control carrier is within this window, no alarm indication is returned, and if the carrier is either lower or higher than this window, the condition is reported. This is especially suited to more elementary level monitoring systems.

One of the most attractive features of this system is its ability to monitor AC standby power supplies. Consider the case in which a standby supply cuts in for some reason other than a brief power outage. Without knowledge that this has occurred, the only benefit afforded by the standby power is a grace period of several hours as the batteries discharge.

To monitor a standby supply, one of the status bit inputs is connected to an accessory port on the housing. This is connected to the standby supply, in which the manufacturer must provide a closure to ground to indicate cut-in. This closure is transmitted upstream on the status signal. Note that this bit could be used to monitor any external parameter that can be presented as a closure to ground.

In stations equipped with a backup DC power pack, one of the status bits is used to monitor its activity. Additional bits have been used to monitor amplifier bypass modules in a failsafe system. Again, any internal parameter which could be converted to a closure to ground could be accommodated by this system.

The suitability of a computer as a control unit for the remote module is obvious, and computers are already in use in some CATV system headends. But, no two CATV systems are alike, and for this reason the control unit which has been designed for this system is a manual unit, which includes a serial computer interface. The unit serves as an RF modem, generating the 53.75 MHz control carrier under computer control, and demodulating the 5 MHz status signal for processing by the computer.



Control Unit

In its manual mode, the address and commands are dialed in, using thumbwheel and toggle switches. "Scan" and "Memory" functions are also provided. In "Scan", all 512 addresses are sent in sequence, and the "Memory" mode allows sending different commands to different addresses. The receiver decodes the upstream status signal, and displays the received address and status on front panel LED's.

CONCLUSION

A versatile status monitoring and control system is made feasible by readily available IC devices. Addressability is a key feature and the digital nature of the system ensures flexibility in the functions controlled and monitored.