IMPROVING CATV SYSTEM RELIABILITY WITH AUTOMATIC STATUS MONITORING AND BRIDGER SWITCHING

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ABSTRACT

Insight into the extent of status monitoring systems and their impact on cable systems is required by cable operators. While these systems have been suggested as a means of providing early warning and failure location to improve maintainability, their usage is yet to be widespread.

An approach to a status monitoring system with reverse disconnect features will be discussed. Design tradeoffs will be examined. System results will be studied to relate benefits and possible disadvantages.

With the extension of cable system usage beyond entertainment services, reliability and ease of maintenance have increased in importance. Marketability of cable services can be enhanced through proper monitoring of distribution plant.

INTRODUCTION

Status Monitoring Systems had been around all through the seventies while never genuinely becoming popular. Due to them being niceties rather than necessities, interest waned while cable systems grew. This growth and increasing concern in efficient maintenance has seasoned the serious developments seen in the past few years. The fact that many leading equipment manufacturers offer Status Monitoring Systems is evidence that the necessary technology and interest is here.

JUSTIFICATIONS

A cable operator locates a system fault by responding to customer complaints followed by a station to station search for the problem. His maintenance costs, personnel requirements and records of unhappy subscribers explode as his system expands. He needs a Status Monitoring System.

Status Monitoring minimizes fault location to the nearest station or cable span. It provides pre-fault detection by uncovering non-fatal yet out of tolerance conditions. In addition, since the system is automatic, it provides an around the clock vigil, detecting possible intermittent problems. With the advent of Data Business Communications over cable, what better way is there to monitor perfect transmission of data than by a system based on those principles?

Supplemented with reverse switching capability, Status Monitoring can isolate points of ingress to the reverse band. Noise can be limited by turning off unused feeders.

Naturally, all of this does not come easily. There are initial constraints which must be met. Nevertheless, there is testimony to the resulting success with the proper installation of a Status Monitoring System.

CABLE SYSTEM REQUIREMENTS

A station with both forward and reverse capability is required for the installation of Status Monitoring. All amplifiers must be set at correct operating levels. Otherwise, you will begin with faults. This may seem to be a simplistic point, but has however, significance. A system ordinarily appearing in top notch condition, relies heavily on the forgiveness designed into distribution electronics. By the nature of Status Monitoring, these areas of reprieve will be questioned and duly noted on the Status Report.

Margins must be allowed for the additional power requirements of Status Transponders in each Trunk Station.

Available bandwidth must be provided for both a forward and return data carrier. This varies among all equipment manufacturers and can significantly impact programming versatility. While some limit bandwidth to several hundred kilohertz, others occupy a full television channel bandwidth of six megahertz.

STATUS MONITORING COMPONENTS

In the headend, there are three major building blocks to a Status Monitoring System: Input-Output display and interface, Processor Controller, and Digital to Analog cable system interface or simply RF Subsystem. In the distribution plant are the many modules referred to as Amplifier Status Transponders.

The Input-Output display and interface is easily achieved through the use of a CRT display and keyboard. This connects to the Processor by a standard interface allowing flexibility and remote locatability if desired. The typewriter keyboard input eases operator interface.

The Processor is basically a "bit-pusher" providing parallel input and output. Data bits are available for output and ports are open for input at times specified by the internal software of the Processor. Commands and responses need to be written in simplified language to minimize operator confusion. The hardware must be reliable and provide non volatile memory for retention of important information in the event of a power failure. The advantage of a separate Processor permits the flexibility for future growth and expansion of a system.

The RF Subsystem can be subdivided for ease of explanation and maintenance. These separate modules are as follows: POWER SUPPLY, parallel to serial data converter or ENCODER, serial data TRANSMITTER, signal combiner or DIPLEX FILTER, serial data RECEIVER, and serial to parallel data converter or DECODER. The purpose of these modules is to take data from the Processor, transmit it to the Transponder, receive information from the Transponders and supply it as information to the Processor. In addition, they check to be certain that the polled address is indeed the same as the received address. Figure 1 is a block diagram showing the headend connections.

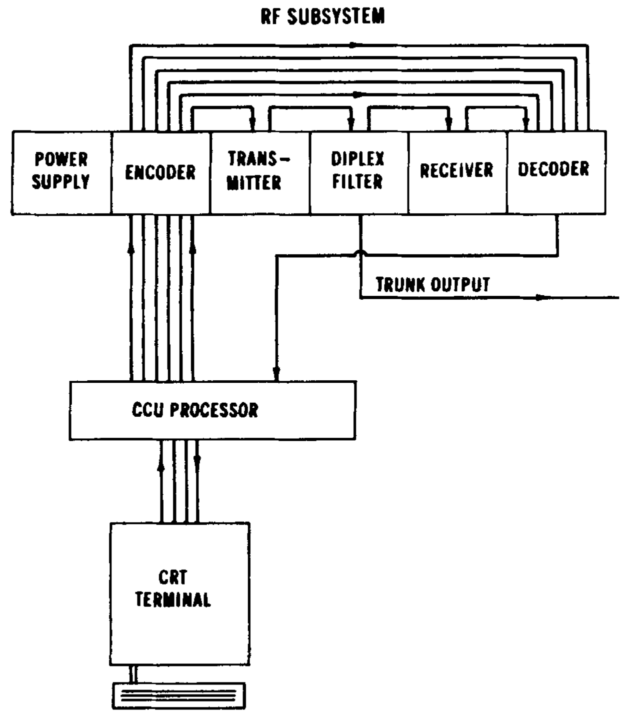

Figure 1: Block diagram showing signal connections of the Headend portion of the Status Monitoring System.

The Amplifier Status Transponders are basically small RF Subsystems with limited intelligence. The building blocks of these may be listed as: receiver, decoder, acknowledge determination, status determination, encoder and transmitter. A possible scheme for connecting RF to a transponder is shown in Figure 2.

PHILOSOPHY OF DESIGN

There are various tradeoffs which become apparent in the specification of a Status Monitoring System. Response time to a change in status should be as fast as possible while not sacrificing reliability. The amount of status data should be sufficient to provide an effective system while not causing operator confusion. Circuit simplicity is of paramount importance for reliability considerations but limits the capabilities of the system.

System timing is based on available bandwidth and software. Minimum signal bandwidth is preferable in order to limit infringement on revenue gathering signals. Elements leading to increased bandwidth are: increased data rate to speed up system response, and increased carrier deviation to desensitize receiver drift with temperature.

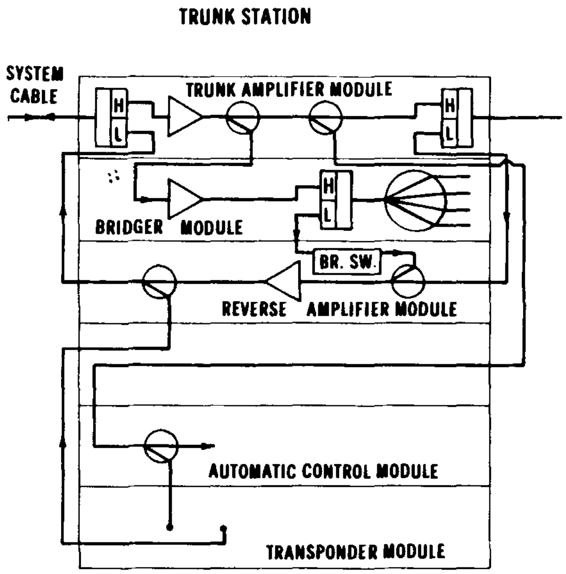

Figure 2: Block diagram showing RF signal through a trunk station with a Transponder module installed.

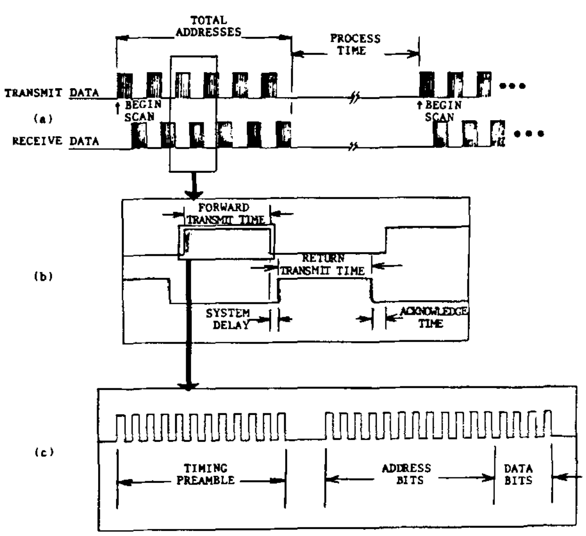

Figure 3: Timing Diagrams of Serial Data. A complete repetitive scan is shown (a) and relates process time to total address scan time. An expanded portion (b) uncovers contributions of system delay and headend acknowledge time compared to transmit time. This transmit time is expanded (c) to detail the makeup of this data stream.

Further understanding of timing constraints can be acquired from Figure 3. Figure 3(a) represents a portion of the continuous serial data streams output from the Encoder and input to the Decoder at the headend. The total number of activated addresses will lengthen the time for each cycle. In figure 3 (a) only six addresses are activated.

With a data rate of 7.5 KBPS, each address burst is approximately 4.2 msec. For this example, the total address time would be 4.2 msec repeated 12 times, or 50.4 msec.

The process time is governed by the speed and complexity of the software. Basically, this is the comparison between past and present status to determine if a change has occured. A time for this processing would be 280 msec.

Figure 3 (b) is an expanded portion of 3 (a). The system delay (possibly .3 msec worst case) and acknowledge time (typically 1.5 msec) are shown relative to the transmit time (4.2 msec as previously indicated). Other than the scan time for the total number of addresses, and the process time of the software, the next largest contributor to system timing is the data burst transmit time. Figure 3 (c) expands Figure 3 (b) further and indicates the various contributors to transmit time. The timing preamble is used to establish a clock frequency for the following data. The total number of address bits determines the largest number of possible activated addresses. In this system it is eleven bits, or 2048 addresses. The following four data bits complete this data burst. As a result, one can recognize the tradeoffs involved in address and data handling capability as well as total data burst time.

Other contributors to scan time delay are error prevention schemes. Reliability is significantly increased when two consecutive changes in status reports are received before updating the status record. Therefore, report of a change is delayed by an additional scan cycle.

Software complexity can both add and subtract cycle time. Those subroutines that add to the frills of a system naturally delay the system if they are in constant use. Those that permit limited scans for the aid of distribution fault troubleshooting can significantly add to the flexibility and speed of operation. If a situation of numerous intermittent faults developed, the operator would be overwhelmed with continuous changes in status. The ability to scan the entire system yet monitor a small portion is a time saver. Observing individual or blocks of station data in a large system becomes a mandatory software tool. In systems with reverse switching capability, automatic rather than manual switching control can add to the value of a more complex software package.

In both designing and specifying a Status Monitoring System, all of these aspects must be considered to optimize that system for the particular operation.

INSTALLATION

Perhaps never before have instructions been so important to the cable operator.

Access to a two-way cable and visibility of all distribution trunk stations requires a headend origination of Status Monitoring signals. Remote terminal location is possible through the use of modems.

A multiple hub site system requires hub bypassing for both forward and return carriers. The simplest approach is a dedicated bypass cable with bandpass filters for the carriers. This scheme is shown in Figure 4.

Amplifier status transponders need access to both forward and return RF paths as well as AC and DC powering and reverse switch control. Locating the transponders in the station housing is most convenient. Otherwise, strand mounting an additional housing and interfacing all these connections is required.

In this system, since these transponders are factory preset, and merely plug into the trunk station housing, installation is simple. The only requirement is to set the proper address for that station.

A map is a necessity to maintaining order to address numbers. Assignments should begin at the origination site and be in sequence for each trunk run, not to be interrupted until the complete length of trunk terminates. Splits can then be accommodated in the same manner. Confusion arises when an rf failure in one station is corrected by the following automatic station thus driving it out of its normal operating windows. This would indicate a failure of both stations. Repairs need to be directed starting at the first reported station, which is easily recognized in an efficiently numbered system.

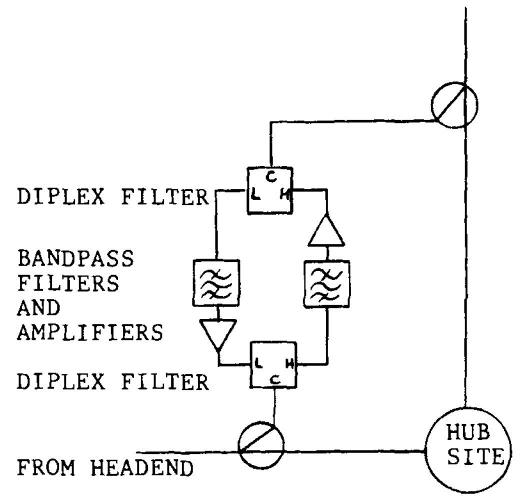

Figure 4: Block diagram showing scheme for bypassing a hub site for Status Monitoring.

CONSEQUENCES

Installed in an existing system, Status Monitoring will uncover faults in what seemed to be a working distribution plant. Intermittents, unbalanced stations out of AGC ranges, and out of tolerance powering are some possible faults previously left undetected. Initially, the process of eliminating these problems will cause additional burdens on a staff of field technicians. Only those who can use the system after the installation will appreciate the effectiveness of it.

There is a long term consequence which must be accepted with this system. This individual module adds to the complexity of the trunk station. The different and unfamiliar technologies of digital and high impedance circuitry will initially frustrate the field technicians' seventy-five ohm rf concept of cable distribution. Normally, failure does not interrupt service, but does prevent monitoring capability, and must be serviced.

Another potential cause for concern is the ultimate integration of the headend and distribution plant. Faults will be detected and reported to headend personnel. In large systems where the two are indeed segregated and approach factions of competition, the teamwork required by the Status Monitoring System will be thwarted.

Nonetheless, Status Monitoring has the capability of providing a means of perfect system maintenance. The operator is furnished with advanced warnings and immediate fault locations. There is nothing quite like the warm feeling radiated by a CRT displaying no faults in an entire cable system.

CONCLUSION

Various aspects of a Status Monitoring System have been described. Justifications, requirements, components and installation have been treated. Some insight into the philosophy behind design tradeoffs has been given. Hopefully, the reader is in a better position to not only pass judgement on various manufacturers versions of equipment, but better assess the impact of such a system on any particular cable system.

ACKNOWLEDGEMENTS

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