ADVANCED STATUS MONITORING AND CONTROL OF FIBER OPTIC SYSTEMS

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Abstract

Advances in fiber optic systems now allow the development of new system architectures, frequently utilizing combinations of modulation formats and multiplexed wavelengths to allow optical signals to be carried deep into the system. As these systems become more complex and to insure the reliability that the system promises, the CATV operator requires a method to monitor and control the various system components and operating parameters. This paper describes such an integrated system, MM-Net.

INTRODUCTION

Fiber optic systems are rapidly becoming one of the most effective tools used by CATV operators to provide improved quality and reliability within the subscriber delivery system. From super trunking between headends to the latest uses of AM systems to extend optical signals deeper into the system, fiber is rapidly integrating with the other elements of the CATV system.

One of the key reasons for incorporating this new technology is increased reliability. A single fiber optic system can frequently replace a dozen or more amplifiers, thereby reducing the number of system components that might cause a subscriber outage. While reliability may increase because of a numerical reduction in the system, that alone does not guarantee the operator a good night's sleep.

Unfortunately, fiber optic systems are still built out of the same parts as any other electronic device, namely power supplies, ICs and transistors, capacitors and resistors. While the life of the laser and detector may be long, the rest of these parts have lives of their own. Any one can be the source of failure, just as it could have been in the amplifier cascades the optical systems have replaced.

As the architecture of a typical cable system expands to encompass more fiber plant, the operator faces a real challenge in finding a suitable method of monitoring the fiber system to assure high standards of reliability.

At the same time, consolidation of headends and changes in programming methods may also require the operator to have control over programs and channels sent to various areas of the system or even to different towns that are now linked by fiber.

The purpose of this paper is to present the details of a system that provides both status monitoring capability and control of many of the individual pieces of the system.

Of course, neither status monitoring nor system control is new to fiber optic systems. Many operators today utilize one of the status monitoring systems currently available to keep tabs on their system.

However, fiber systems may present a different set of problems. In the near future, an operator could have a system that encompasses several different types of modulation schemes over fiber and maybe even several wavelengths of light on the same fiber.

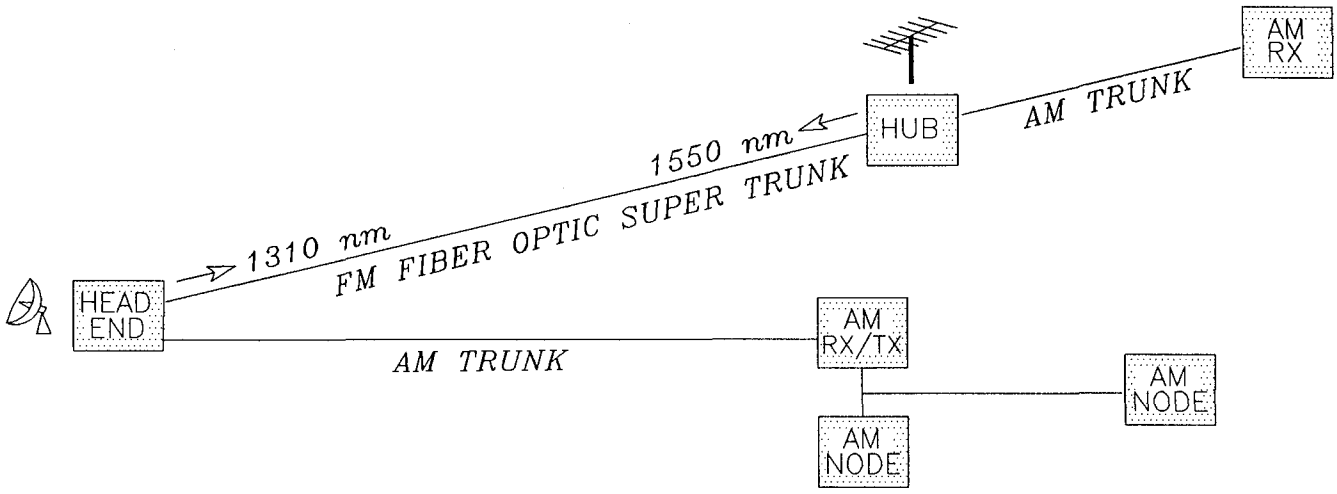

Figure 1 CATV Fiber Optic System

Figure 1 illustrates what a future cable system might look like, containing FM modulated trunking from the main headend to a hub in another town, AM modulated trunking using the new externally modulated AM system, and standard AM modulated fiber nodes. The FM portion uses 1310 nm and 1550 nm signals, wavelength division multiplexing both over the same fibers. Because of the distance, there is also a repeater in the super trunking system.

In developing MM-Net, it was necessary to plan ahead, so that not only would it take care of today's needs, but would also look forward to systems like the one shown in Figure 1.

WHAT MM-Net DOES

To borrow some words from the computer industry, MM-Net is an interactive status monitoring and control system that operates as a token ring network. Within the constraints of current personal computer technology, the system has been designed to be simple to operate. The system is menu driven, with all screens in plain English (Figure 2). It can be learned quickly and easily.

What does MM-Net do? The system diagram in Figure 1 illustrates some of the tasks that it will accomplish.

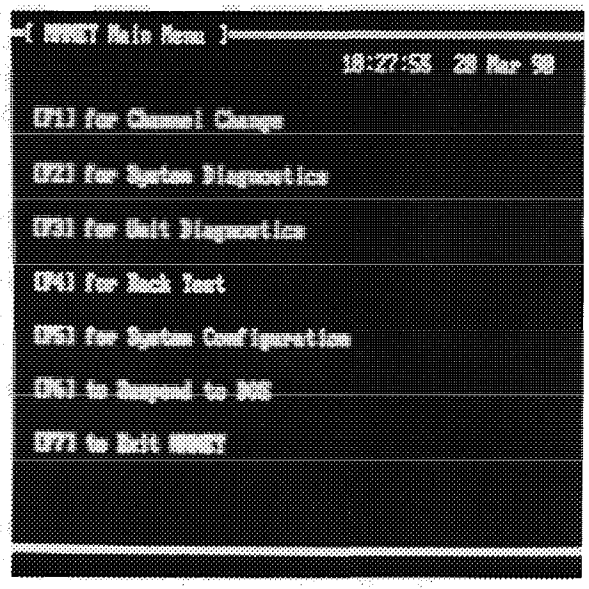

Figure 2 MM-Net is Menu Driven and Easily Mastered

System Diagnostics

To start, when the system is activated, the software will poll each location to find out what kind of hardware resides there. From this information, it develops an inventory of all the units in the system by location (Figure 3). By performing this task, the software automatically learns the configuration of the system.

While the software identifies each piece of equipment by a unique address, it also knows what kind of equipment it is, such as a transmitter, receiver, modulator, etc., and provides that information along with the address. An editor built into the software allows the operator to assign a plain English name to the unit. For instance, the system might identify address 0 as a transmitter. For easier identification by personnel, the unit could be named Headend TX 1. That way, each unit can be identified in the simplest and most direct terms possible.

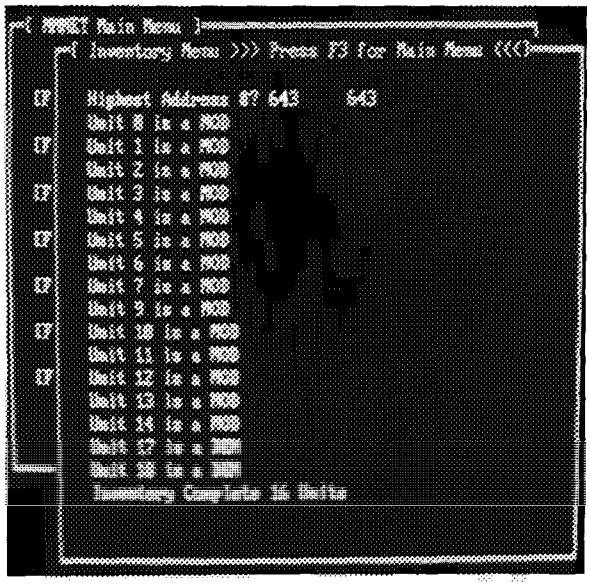

Figure 3 Screen Displaying System Inventory

Once the software has "learned" the system configuration, it is ready for operation. Using the system for diagnostics or status monitoring is as easy as selecting the Automatic Diagnostics feature on the main menu. In this mode, the software continuously polls the entire system, so that any change of status in any piece of equipment will provide an immediate alert to the operator that there is a problem.

The system identifies the equipment experiencing the problem by both location number and name. Using the Manual Diagnostics menu selection, the operator can ask the software to display, in detail, what fault has occurred (Figure 4). Therefore, the operator knows what has happened and where before dispatching a repair truck to the site.

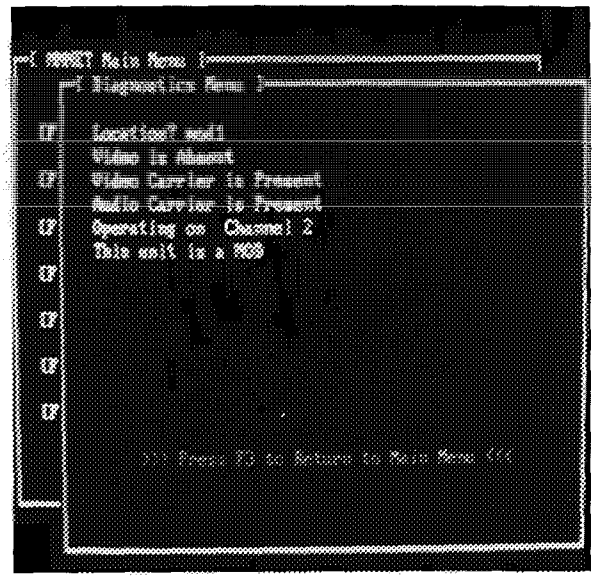

Figure 4 Screen Displaying Diagnositics for a Unit

Because the system has been designed with an eye to the future, the software functions not only with existing FM technology, but is also compatible with emerging technologies, such as the new externally modulated AM schemes or digital systems. In each

case the necessary parameters of the equipment are measured and accurately reported.

Diagnostics, though an important function of the system, is only one of the tasks the software can accomplish.

FM Channel Selection

In addition, it is possible to assign channel selections for the FM modulation equipment at either headend or hub locations. This flexibility in selecting channels allows the program lineup to be varied by area or town. For instance, to allow a town council meeting of local origination to be shown only in the areas interested and not system wide. This feature also allows spare equipment to be assigned in the event of a failure, or as a replacement unit during routine maintenance.

Scheduled Automatic Switching

Another feature allows for scheduled automatic switching. This feature allows advance scheduling of channel changes that may be required as a result of shared services, SYNDEX, or other reasons. The scheduled switch times may be entered in the system for multiple events over any time frame from 1 minute to well over a year.

In addition to the automatic system, the operator has control over channel selection and switching on an instantaneous basis at any time.

Additional Features

Access to MM-Net is password protected. In addition, the system can be set up to provide varying levels of access, for example, allowing system maintenance but not scheduling or switching activity.

All commands issued by the MM-Net software are verified by a return signal from the equipment, notifying the master controller that the event actually occurred. This can be critical in areas such as channel selection or scheduled switching. All information can be routed to a printer to provide a permanent record of daily events.

In addition to direct control from a master computer, the system can be interfaced to a modem and controlled from a remote location over conventional telephone lines. A feature such as this allows personnel not on location, but authorized to access the system, to obtain immediate information on system performance and status. It also allows corrections and switching information to be entered from a remote location.

HOW MM-Net DOES IT

The MM-Net system is a small software package, designed to operate from an AT-class personal computer that has a color monitor, 640K of memory, a serial data port and a parallel port if a printer is used. In short, a simple computer.

While the computer need not be dedicated to the MM-Net system, the use of the automatic diagnostic feature does demand a dedicated computer. The complexity of such a system certainly makes a dedicated machine desirable.

What is this computer and its software communicating with? Beginning with the individual pieces of equipment, each unit in the system contains a microprocessor capable of monitoring up to 8 analog or digital inputs. Analog measurements are converted to an 8 bit approximation and are compared to an average parameter to reduce the volume of data traffic on the system. As long as the approximation stays within a window, no communication is required.

Each unit, designated a transponder, is capable of 8 ON/OFF control outputs. The transponder contains non-volatile memory, so that in the event of a loss of power, the system

parameters are immediately restored when power is reapplied.

The unique address for each unit is field programmable using a DIP switch located on the unit's processor card. This switch is located inside the unit to prevent unauthorized or accidental changes.

Each transponder, in a group of up to 32 units, reports to a group controller device. The group controller communicates with its respective group of transponders over an EIA-485 interface operating at 9600 baud. Each group controller also has a unique address. Group controllers at any one location are chained to provide a single input/output port. This port communicates with the master PC through a full duplex modem. Signals for the modem can be carried by the fiber optic system or by conventional telephone lines.

The basics of the system network provide for communication using an EIA-485 communications interface, operating at 9600 baud. The system is capable of addressing up to 65,504 unique addresses.

The network controller is capable of issuing commands to the entire system, to an individual group controller, or to an individual transponder. In practical terms, the system operates as a token ring. Status requests originate at the controller and are sent to all group controllers in the system. If the status of the group controller's transponders is normal, the system continues to the next group controller for interrogation. If any group controller responds indicating an abnormal indication, then all of the transponders in that group are polled to find out where the abnormality is. When there is no abnormality in the system, the information flows from the controller in a ring. The ring is opened when a group controller indicates an abnormality and that information is added to the flow of information as it is returned to the network controller.

The total time for a command/reply sequence is approximately 25 milliseconds. In an average fiber system, the poll time would be less than 10 seconds. In a system using all 65,000 addresses, the full poll cycle time would be less than 1 minute.

Interfacing Other Equipment

In addition to the equipment and system described, MM-Net has a general purpose interface (MGPI), developed to provide input/output control and monitoring for various types of devices in the system, such as power supplies with status monitoring capability.

An external unit as described will appear to the MM-Net system as a normally addressable device. The interface outputs provide a range of standard input/output protocols, including EIA-232C, EIA-485, 16 bit parallel control lines and on/off contacts. Most devices in a cable system are capable of operating within the parameters of one of these protocols.

SUMMARY

As can be seen, the use of fiber optics to enhance reliability in cable systems can be improved through the use of a high quality, computer controlled diagnostic and management system.

The system described can provide full automatic diagnostics of all elements within the system, regardless of the modulation scheme being used, providing the basis for both current and future equipment additions.

In addition to the automatic diagnostic features of the system, MM-Net provides for scheduled program switching and allows immediate operator intervention to override commands or create late changes in scheduling.

A general purpose interface provides for integration of other devices that use status monitoring or command controls. This allows management of multiple pieces of equipment within one software system.