MICROPROCESSOR FOR CATV SYSTEMS

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ABSTRACT

The advent of microprocessor techniques has provided a means of flexible and economic automated control of switching functions.

A programmable switching unit has been developed by Tele-Engineering Corp. which permits an operator to implement a switching program which will control 16 switching functions in 196 time slots.

The system is so designed that programming is accomplished with simple techniques which can be mastered with about one hour of instruction.

The versatility of application of the system permits it to be used simultaneously for network protection, program selection and local origination programming.

This paper describes the unit, how it is programmed, and results in operational environments.

1. Introduction

Recent advances in microprocessors have resulted in the feasibility of performing operations associated with CATV systems by using such devices. The attractive feature is that many functions can be done automatically without having to have a large amount of expensive and complex equipment. This paper describes a device that was tailored to meet specific requirements existing in CATV systems.

Switching problems were analyzed to provide the necessary inputs to the design of the microprocessor as indicated in section 2.

Possible approaches to the solution of switching problems were evaluated. The advantage of the use of multiprocessors for these real time applications are discussed in section 3.

Specific ways in which the microprocessor could be used effectively were evaluated as shown in section 4.

In section 5 a detailed description is provided of a microprocessor to accomplish certain switching functions.

The operational procedures and methods of programming to accomplish specific functions is contained in section 6.

2. Switching Requirements

CATV systems have evolved to the point that switching requirements are an essential and sometimes complex aspect of system operations. Selection of a channel for distribution from a number of available off-air signals on a scheduled basis is a major source of need for suitable switching techniques. The increased use of satellite transmissions with more programs being carried on a single satellite results in requirements for preprogrammed switching between channels at the earth station receiver.

Local origination programming and remote pickup involves switching at IF or video.

The more vigorous enforcement of requirements for network nonduplication and program exclusivity mandates are other areas which impact on the need for improved switching techniques.

For many years most switching requirements could be satisfied by making personnel available, at the appropriate times, who would manually operate either IF or video switches, or in some cases change connections on a terminal board. As the requirements increased, however, it was found that personnel would have to be on-call for periods well beyond their normal work schedule to effect required switching.

The changes of programming from day to day and week to week required constant changes in the switching that was required. Satisfactory switching could be brought about only if a detailed schedule was established in advance and appropriate assignment of responsibility for specific actions be made sufficiently in advance to assure switching was accomplished. Along with advanced scheduling some mechanism had to be developed to accommodate scheduling changes.

3. Digital Techniques

In view of the above consideration, application of digital techniques were considered to be a feasible solution for switching.

There are two possible approaches to

digital application, one using mini-computers and the other using microprocessors. The minicomputer involves a memory, input and output devices, a software package and interface devices. Although hardware costs have been steadily decreasing, the software costs have remained steady, thereby causing the basic software cost to be a significant factor in the implementation of a digital system. In addition, programmers must be made available on a continuous basis.

With recent development of integrated circuits and memory chips microprocessors become a feasible method to perform intricate functions. The processor consists of a memory, input/output devices, interface devices and program logic units. The basic function to be performed are designed into the unit with allowable ranges of values to be inserted. The programming then becomes a simple operation which can be mastered after a few hours of instruction. The design of the processor can provide for adaption to a wide variety of interface devices with a minimum of restrictions.

4. Switching application

There are a wide variety of applications in which the microprocessor can be an effective device. One application involves the selection from various satellite signals on a preprogrammed basis. For example, HBO/Channel 17/ and HBO delayed are all transmitted from the same satellite in addition to PTL/TRINITY/ and Christian Broadcasting. Selection of programs from these sources with the use of a switch can add to the variety of pay and religious programs that can be offered without a substantial additional investment in hardware.

When there are more off-air signals available than the system can distribute with its hardware complement selection of best programs can be accomplished with the microprocessor consistent with the carriage allowed by FCC.

The processor will also allow the switching in of independent stations after midnight.

Local origination involves switching at video. The use of the microprocessor will allow automatic selection from a number of sources on a scheduled basis.

In case of a multihub system different programs may be distributed to various parts of the system. Use of the microprocessor would provide the necessary switching function to accomplish this flexibility in offering programs.

5. Programmable Switcher

A processor has been developed which provides programmable switching functions for the applications cited above. A functional block diagram is shown in Fig. 1. All inputs to the memory are made through a 12 button keyboard. The memory is an 8K com-

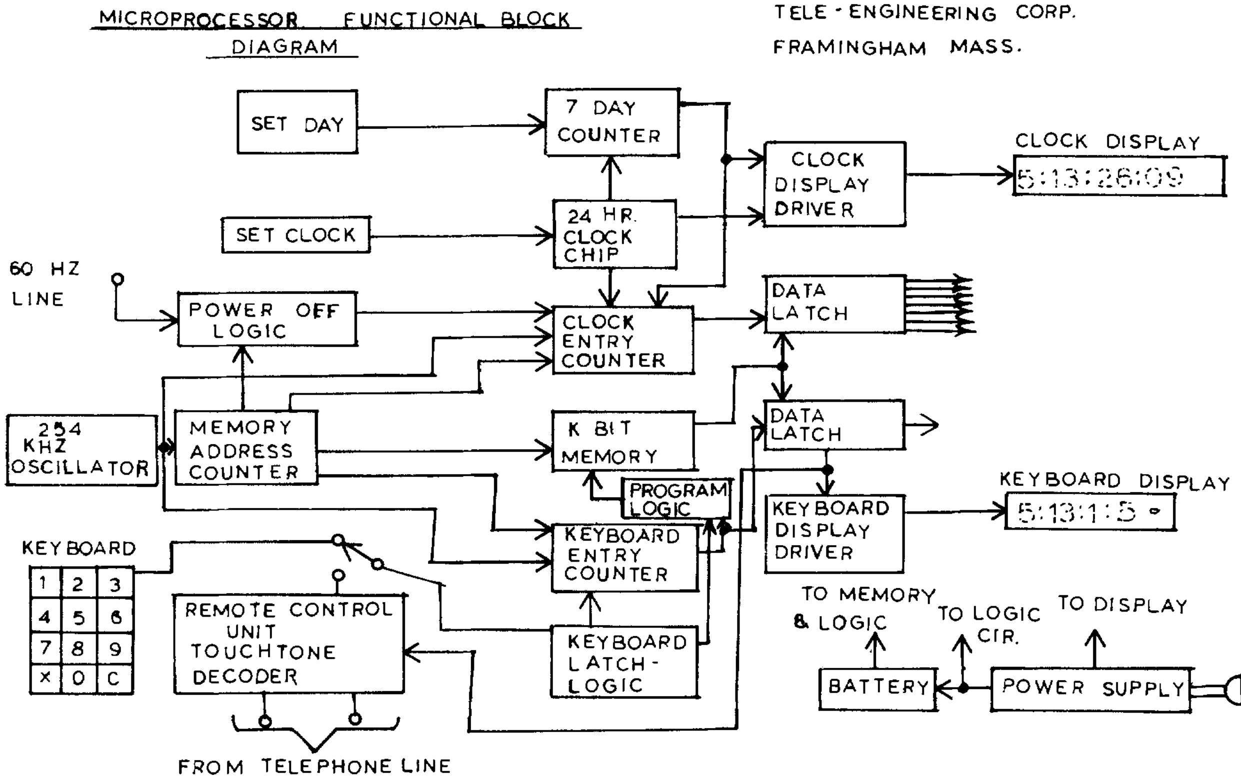


Fig. 1.

ponent and accepts all program information. The unit is designed to perform all required functions at the beginning half-hour time slots (48 per day, 7 days per week) and of carrying out 16 command functions for each time slot. The clock is set by external control for day, hour, minute and second. LED display are used to indicate the running time and a time slot that is addressed. The clock entry provides logic for activation of relay closures through a data latch. A key switch is provided which prevents the changes in the memory unless activated. When the unit is set to remote access is accomplished through a security unit and then program changes can be effected by operation of a touch tone telephone set.

The design of the unit is modular with each of the major components manufactured on its own printed circuit board. Each of the functions are accomplished by the hardware configuration of the corresponding PC board. The interconnection of the board is illustrated in Fig. 2.

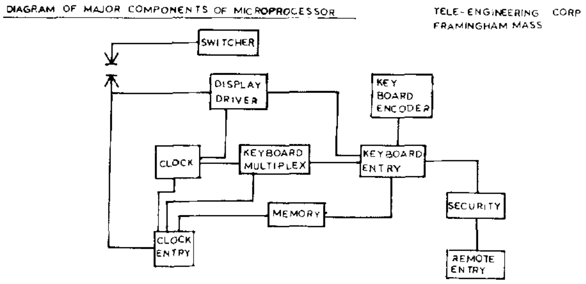


Fig. 2

Instructions are entered either locally using keyboard or remotely. The output of the keyboard entry is displayed and fed to memory. The clock provides the pulses that activate commands through the logic contained on the clock entry board. The display and driver supply appropriate level to activate LED. The remote control board decodes tones and converts them into appropriate signals for the keyboard entry. The security board denies access until cleared with the proper security code signal.

The complexity of a typical board is illustrated by Fig. 3 which indicates the component layout of the memory board. The two components identified by slanted cross-hatching are the memory element. A total of eight other integrated circuits of the CMOS type are included on this board. The boards are mounted vertically in the chassis and held in place as illustrated in Fig. 4. This arrangement of PC boards facilitates maintenance and repair

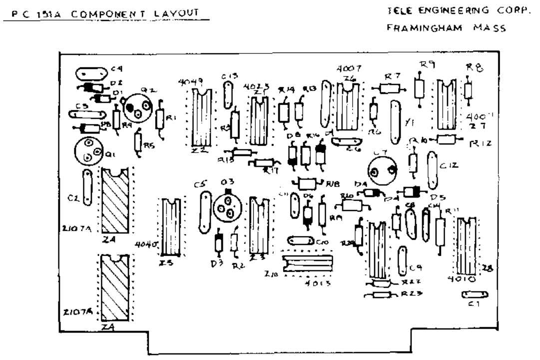


Fig. 3

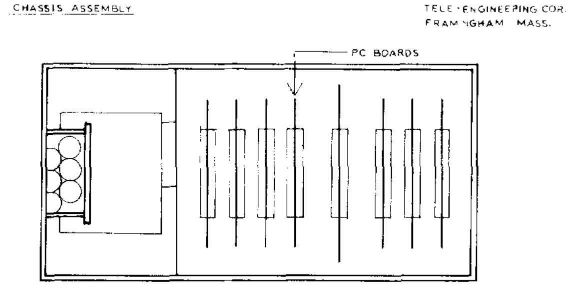


Fig. 4

A photograph of the microprocessor is shown in Fig. 5. The unit which can be rack-mounted in a standard 19" rack has a height of 5". All inputs are accomplished by action of the keyboard. Setting the clock is controlled by the first row of keyboard buttons when the "set" lock switch is turned on to set. The other key switch controls access to the memory from either local or remote station. Programs are entered with the keyboard when the key position is on local.

6. Operation and Programming

After the unit is installed, the first step in operation is to set the clock to correspond to the correct day of the week and the exact time.

"Run/Set" switch is set to "set". The clock is set to the proper date and time by use of buttons "1","4","7", and "8" of the keyboard. To set "day", button "1" is depressed until the proper day appears in the appropriate location of the clock display.

Hour and coarse minute set is accomplished by depressing "fast" set and depressing button "4" of the keyboard. When the time in the display approaches within 10 minutes of the correct time, the Button "4" is released. The slow set is then

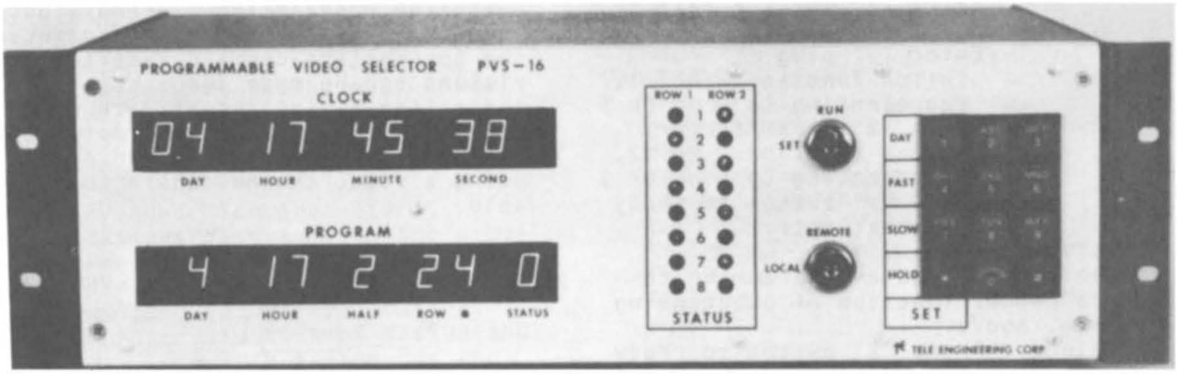


Fig. 5

used to set the nearest minutes and second. This is accomplished by depressing button "7". If time is "overshot", depress "*" button to hold clock until the actual time coincides with the displayed time. Once the time has been set, the run/set switch is turned to the run position.

Programming can be done either locally or from a remote location. When programming the unit locally, set program switch on local position. For initial operation, first clear memory by operating "clear" button in the rear of the unit. The unit is now ready for programming by time slots. An entry has to be made for any time slot in which a switching action is required. The first step for programming is to clear the display by depressing the "#" button. The following sequence is used to program a given time slot for a 2-position switch:

Day of the week - use button "1"-"7"
Hour of the day - use "00"-"23"
Half Hour - use "1" for 1st half hour
use "2" for 2nd half hour
Switch Position
Row - 1 or 2
Number - "1"- "8"
Switch Condition - use "*" for on
use "0" for off

When a matrix switch is used, it is programmed by a combination of inputs. Appropriate function numbers and status indicators must be entered 3 successive times for a given position of the switch to be activated. The built-in logic prevents two incoming channels from being simultaneously switched to the same output in the event of an error in programming.

This procedure, beginning with clearing display, is repeated for each half-hour increment. After the unit has been programmed, the lock switch is turned to remote and the program cannot be changed locally.

If a change is to be made, the following procedure is used:

Set Remote Local Switch to "local".
Enter day, hour, half-hour and switch which is to be changed.
Activate or deactivate by pressing "*" or "0".
Return switch to remote.

For remote operations the "Remote - local" switch is set on "remote". Telephone number of line to which programmer is connected is dialed. After connection is made, the unit is signalled with a two-digit security code from a touch-tone instrument. If code is correct, steady tone will be heard. Time and switch which is to be addressed is entered in the same manner as in local mode.

If for this time slot, the switch is programmed "on", signal will be grouped as follows: - - - -   - - - -   - - - - If switch is programmed "off", signal will be: - - - - - - - - - - - - - -.

OPERATIONAL EXAMPLE

Switching Function Selection

A Programmable Video Selector has been installed to provide switching for
channel 5 on channel 6
" 5 on " 9
" 5 on " 6 and 9
" 4 on " 10
" 7 on " 12.

The switch functions of the IF switching unit have been selected as follows:
Switch 1 represents Ch 5 on Ch 6
" 2 " Ch 5 on Ch 9
" 3 " Ch 4 on Ch 10
" 4 " Ch 7 on Ch 12.

Operational Routines - Local Mode
(a) Programming
Problem: On Monday Ch 5 shall be carried on Ch 6 and Ch 9 from 6:30 pm to 7:00 pm
Execution: -Press "#" button to ready

for entry
-Enter "1" for Monday
-Enter "18" for 6:00 pm
-Enter "2" for 2nd half hr.
-Enter "1" for Row 1
-Enter "1" plus "*" for switch function - No. 1, representing Ch 5 on Ch 6
-Enter "2" plus "*" for switch function - No. 2, representing Ch 5 on Ch 9
-Press "#" button to ready for next entry

(b) Verification

Problem: Interrogate programming to assure proper function of programming example, above.

Execution:
-Press "#" button to ready for sequence
-Enter "1" for Monday
-Enter "18" for 6:00 pm
-Enter "2" for 2nd half hr.
-Enter "1" for interrogation of switch function No. 1 and observe function light "ON" and lit
-Enter "2" for interrogation of switch function No. 2 and observe function light "ON" and lit
-Press "C" button to be ready for next entry or interrogation.

7. Additional Features

While the original concept was to provide for switching between two possible channels; other switching combinations are feasible.

The use of the microprocessor with a matrix switch is illustrated in Fig. 6. The control function for 2 matrix switches is shown under command of the programmer. The design was to provide for any one of eight input signals to be switched to 4 outputs.

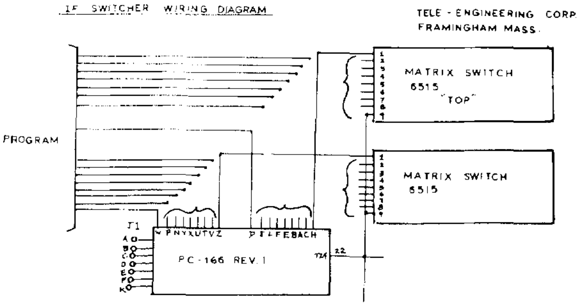


Fig. 6

When the switching action takes place remotely from the control area, a remote unit is used. A typical installation is indicated in Fig. 7. A conventional telephone line is used for a link and a touch tone phone is used to access the memory. The command condition of a given time slot is indicated by different audio tones. Using the programming procedure outlined in section 6 a time slot is addressed and the appropriate command inserted. Provisions can be made for a scope display indicating the status of each time slot. The data is presented as a dot matrix and can be displayed on a conventional TV set using a video channel where such is available.

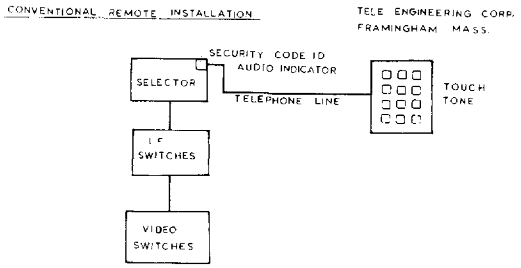


Fig. 7

As mentioned previously, a security unit can be provided which denies access to unauthorized personnel. The functioning of this unit is illustrated in Fig. 8. The security code is inserted with a microswitch using BCD code. When the unit is addressed through the telephone the first two digits are compared with the code in memory. If these numbers correspond to the preset code, the latch is activated thereby allowing access to the keyboard entry.

The following binary settings are used for the security code:

	SECOND DIGIT				FIRST DIGIT			
SWITCH	8	7	6	5	4	3	2	1
0	1	0	1	0	1	0	1	0
1	0	0	0	1	0	0	0	1
2	0	0	1	0	0	0	1	0
3	0	0	1	1	0	0	1	1
4	0	1	0	0	0	1	0	0
5	0	1	0	1	0	1	0	1
6	0	1	1	0	0	1	1	0
7	0	1	1	1	0	1	1	1
8	1	0	0	0	1	0	0	0
9	1	0	0	1	1	0	0	1

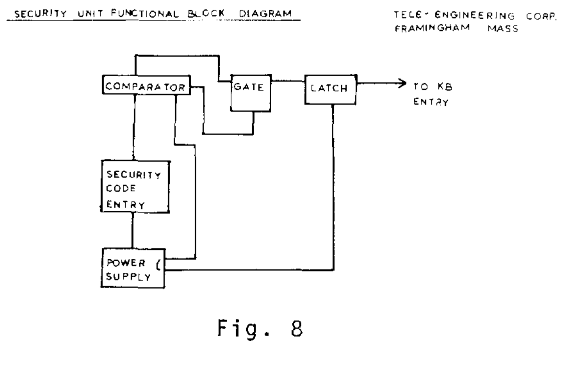
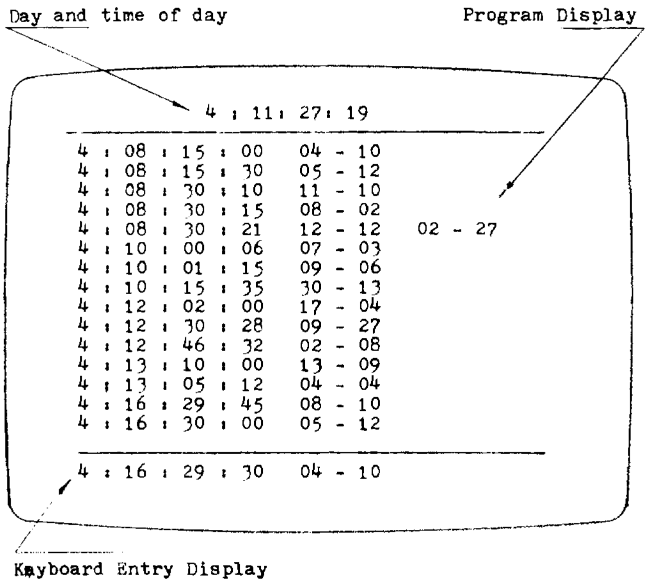


Fig. 8

In order to protect from memory loss resulting from power failures, a standby power supply is provided. This will allow the unit to continue operation for up to 48 hours without primary power. In order to save energy, no display is shown during power outages. When power is restored, the clock display will indicate an error signal, however no error will exist in the clock. The display error indication is removed when the set switch is activated.

8. Use of Advanced Microprocessors

The applications discussed in the previous section have been accomplished with a microprocessor designed for the specific parameters outlined. Other applications required more sophistication of design and more complexity. One such system has the capability of 2000 program changes per week. The time slots can be adjusted in length to the second. The matrix 2000 can control a matrix switching system of up to 400 switching functions. The programming is displayed on a cathode ray as shown in Fig. 9. A section of the program of up to 15 lines can be displayed at any one time. One line is reserved for most recent keyboard entry. A printer is provided which records each executed command. It can also record program that is in storage.



CATHODE RAY TUBE DISPLAY

Fig. 9

Another processor development is the control of switching at a number of locations remotely from one central facility. This involves the basic 2000 unit with encoders that convert switch commands to a VF signal that can be transmitted on telephone line or a channel of the system. The confirmation of the command is encoded and transmitted on a return path. The layout of such an application is indicated in Fig. 10.

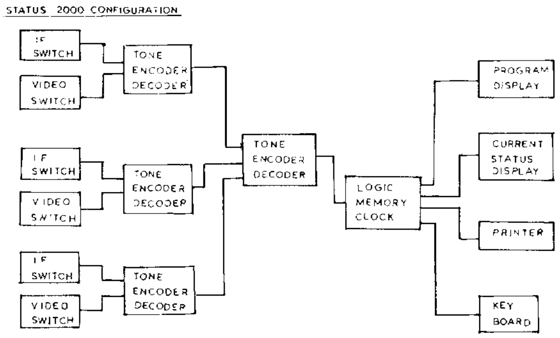


Fig. 10

This miniprocessor was also employed in a status monitoring application. This involves polling of status elements and selectively allowing access of an individual branch indicating the status. The resulting indication of current status is displayed on a CRT as shown in Fig. 11.

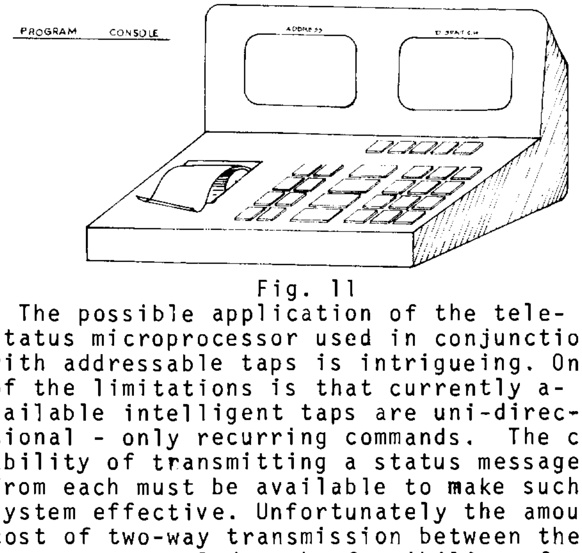


Fig. 11

The possible application of the telestatus microprocessor used in conjunction with addressable taps is intrigueing. One of the limitations is that currently available intelligent taps are uni-directional - only recurring commands. The capability of transmitting a status message from each must be available to make such a system effective. Unfortunately the amount cost of two-way transmission between the processor precludes the feasibility of this application at this time. One of the available possibilities is the use of this system in an application where there are more than 20 subscribers at one location such as apartment complexes. Such a cluster can be cost effective for telestatus control of taps.

CONCLUSION

In this paper we have indicated how microprocessors can be effectively used to enhance the operation of a CATV system. With further development and more refinement of IF and video switches, there can be an even greater realization of advantages.