STATUS MONITORING SYSTEM

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One of the most pressing problems in the CATV industry today is the lack of trained technical personnel.

With the wiring of major market systems, size has become a major consideration as it relates to system maintenance.

The major market system demands that "normal" system maintenance has now become "super maintenance" and to try and supply technical competence simply by numbers as relates to personnel required to maintain a 1,000 mile system using the same formulas as required to maintain a 100 mile system will not work.

Therefore, it was felt essential that electronics become the maintenance tool of the major system.

System status monitoring can be one of the answers to the manpower crunch.

The two items that seem to be in shortest supply in the CATV industry are money and trained technical personnel.

These two problems are magnified exponentially when you start talking about major market systems, particularly major market systems that exceed 2,600 miles of electronics and four hub locations.

A study was made of the very few systems that fall into this category and/or are planning to be in this area of magnitude. Based on this study, it was determined that you could anticipate a minimum of one "maintenance technician" for every 200 strand miles of plant. This technician's sole function is that of trunk line maintenance.

Using this as a (conservative) estimate, it was felt that the time had come to start using electronics instead of manpower to insure constant maintenance of CATV systems.

It seemed apparent that if we could eliminate the need for some of this (almost impossible to find) manpower and possibly save money over the long run that we would be doing our industry a good service.

CDI, at the request of one of its major clients, Buckeye Cablevision in Toledo, Ohio, (actually it was more akin to insistence) started working with several manufacturers to try and achieve a positive status monitoring system. Jerrold Electronics was chosen as the prime contractor to work on the proposed system.

As in many pioneering efforts, early attempts were shot full of arrows, however, it was determined that status monitoring is:

1. Technically feasible.
2. The cost could be maintained at a reasonable level.
3. That it could replace manpower.
4. That in addition to system monitoring, it could be used as an outstanding maintenance tool.

It was determined that by the use of a status monitoring system, Buckeye Cablevision could eliminate a minimum of eight maintenance technician slots in their Toledo, Ohio system. This amounted to an approximate savings in salaries alone of over $100,000 a year. In addition, it was felt that the cost savings realized in not having to equip these eight men for trunk line maintenance would save an additional $120,000.

The cost to implement the status monitoring system for Buckeye Cablevision has now been reduced to below $130 per strand mile of system, and that the total cost for status monitoring will not exceed $200,000 for the entire system. It does not take an accountant to see that the status monitoring system was not only economically feasible, but almost a necessity.

In addition to the dollar savings and manpower availability problems, the status monitoring system is an excellent diagnostic tool and offers almost instant response to any system problem, which of course, has an incalculable value to any major market system. CATV in a major market must offer outstanding picture quality as well as outstanding reliability, and a system that is self-monitoring assures the latter.

The status monitoring system that was developed by Jerrold and ourselves is a relatively simple system. Its simplicity is arrived at in that our information is not encoded.

The status monitoring transmitters are installed in selected mainline stations (usually in every third amplifier and preferably following an AGC station and at the extremity of each trunk line). These selected stations have the capability of indicating the actual levels (±.75db) of one low band and one high band carrier. We have found that we can maintain this accuracy throughout a temperature range of -40°F to +95°F.

The status monitoring transmitters themselves require 50 milliamps at 27 volts, and measure the carrier levels at 65.25 and 199.25 MHz. (The measured carriers can be changed to fit system requirements). This is accomplished by developing a DC voltage that is proportionate to the amplitude of the selected carriers. This voltage in turn controls the frequency of an audio tone. Since there are two selected downstream carriers, each has an assigned audio tone (451.6Hz and 43.6Hz). The DC voltage developed from the downstream carrier is fed into an integrated circuit voltage to frequency converter. Variations in the amplitude of the downstream carrier therefore result in the variation of the frequency of its comparison audio tone. The output of the status monitoring transmitter is a crystal controlled RF carrier generator in the 4 to 6 MHz region. The two audio tones are applied to a varicap which is part of the frequency determining network and operates in conjunction with the crystal. Thus the FM modulation system consists of a carrier and two audio tones.

The concept of using frequency modulation in the return path removes any sensitivity to amplitude variation caused by gain changes in the return path. (An extremely important feature). It is important to note as mentioned before, there is no encoding nor is there any interrogation responder relationship between the status monitoring transmitter located at the selected trunk line stations and the status monitoring receiver. The status monitoring transmitters are all "talking" simultaneously and carry back only analog information.

The status monitoring receiver consists of an FM receiver whose first mixer injection is frequency controlled by reference to a 4kHz precision carrier and a divide by N counter. (Drawing I)

The recovered audio tones from the discriminator in this frequency stepped receiver passes through a frequency to voltage converter, and these recovered voltages operate the two meters in the front panel on the status monitoring receiver. These meters indicate the discrete carrier level of the two selected downstream carriers. The system is specified to an accuracy factor of ±.75db. This accuracy is of course as good as most of the meters currently available and in general system usage.

The digital portion of the system starts from a micro processor which developes three octaves of binary coded decimal numbers. This micro has three manual inputs. The first input limits the lowest three digit number the micro will seek. The second sets the high limit and the third can be set to provide continuous readouts of any specific mainline station location. Normally the micro scans from the three digit number on the low limit to the three digit number on the high limit.

The rate of scan in the system is adjustable for a matter of operator preference and is not a function of system performance. The three octaves of binary coded decimal information developed by the clock and within the preset limits controls the operation of the divide by N counter in the receiver local oscillator loop. Under control of the clock in the divide by N counter, the receiver local oscillator scans in frequency from the low preset limit to the high preset limit in 4kHz steps. These steps are accurately controlled because of the phase lock reference to a precision 4kHz source. It is in the receiver that a specific identification to a given status monitoring transmitter is generated.

The indicator path through all stations is identical. The only way one station can be distinguished from another is by its incoming carrier frequency. As the receiver steps in 4kHz increments, the three octave digit display indicates the transmitting location being monitored.

Each status monitoring transmitter in the system has its own assigned RF carrier frequency. Because of the nature of the scanning, which is sequentially numbered, should there be a gap in the numerical assignment of stations, the receiver will scan past and will indicate an alarm as it scans the unassigned station.

There are five alarms normally displayed on the front panel of the status monitoring system. These alarms are:

1. Low band carrier level low.
2. Low band carrier level high.
3. High band carrier level low.
4. High band carrier level high.
5. No return carrier.

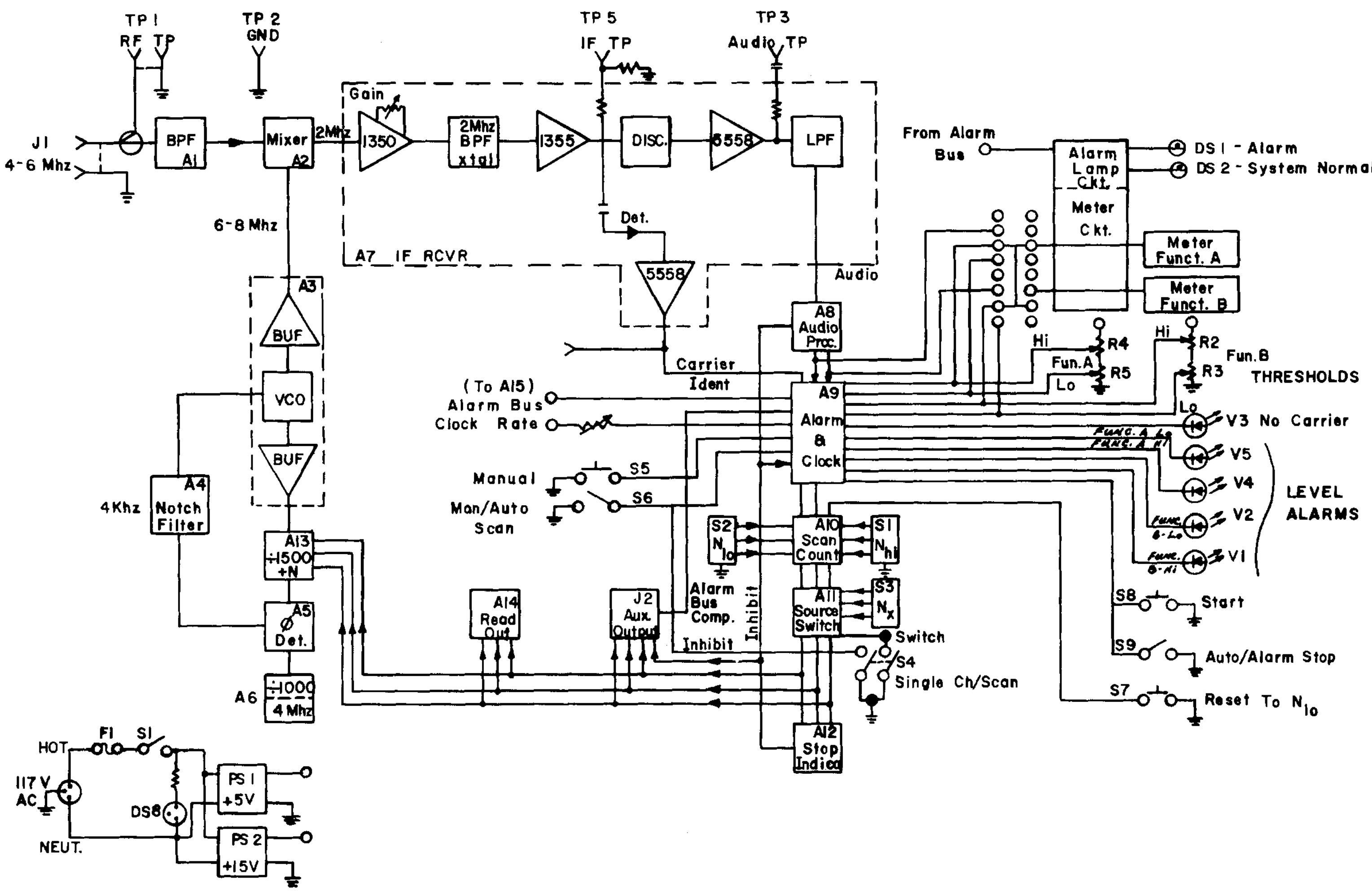
The status monitoring's receiver front panel meters indicate the absolute level of the two selected downstream carriers and their preset alarm limits. The purpose of these limits is of course to preclude arbitrary alarming at some random point in the system. The operator can adjust the low and high level points at which an alarm will be generated. The return carrier level is not measured and the status monitoring receiver merely senses its presence (or lack thereof). The purpose of this last alarm is to avoid operator problems which could be created by false downstream alarms caused by misadjustment or failure of the upstream or return path system. Of course downstream and upstream information could both fail due to mechanical cable separation and/or power pack failure in an individual amplifier. The exact location of this of course can be determined by the status monitoring receiver.

In addition to the receiver, it was felt that an active display would facilitate the use of untrained personnel as "system monitors". Therefore, CDI has developed a system that goes from the transmitter to a map display of the entire system. (It is interesting to note that the map display in a 1-600 scale covers and area in excess of 15 x 13 feet). [Drawing II]. This analog information from the transmitter is transferred to a logic board. The logic board (Drawing III) operates as binary coded decimal information center which singles out and identifies each amplifier location as the receiver it is scanning. A light emitting diode with a time delay latch will be used to indicate an out of specification transmitter location. Of course the map operates at the same scanning rate as the receiver so any trouble in the system can be located immediately as the logic board used as the interface between the receiver and the readout board is designed to lock on an amplifier that is out of its specified range.

This will immediately alert the operator that a condition out of specification is existing. He can then determine that condition immediately by the use of the status monitoring receiver. In addition to the above, CDI is currently working on a system that will give a digital and printed readout of the amplifier number and exact street location in the system. The advantages of this technique are of course obvious, and in addition, we are working on the interface that will be fed directly to a computer center that will allow permanent data storage for all system failures and variables that should be of great assistance in future design concepts.

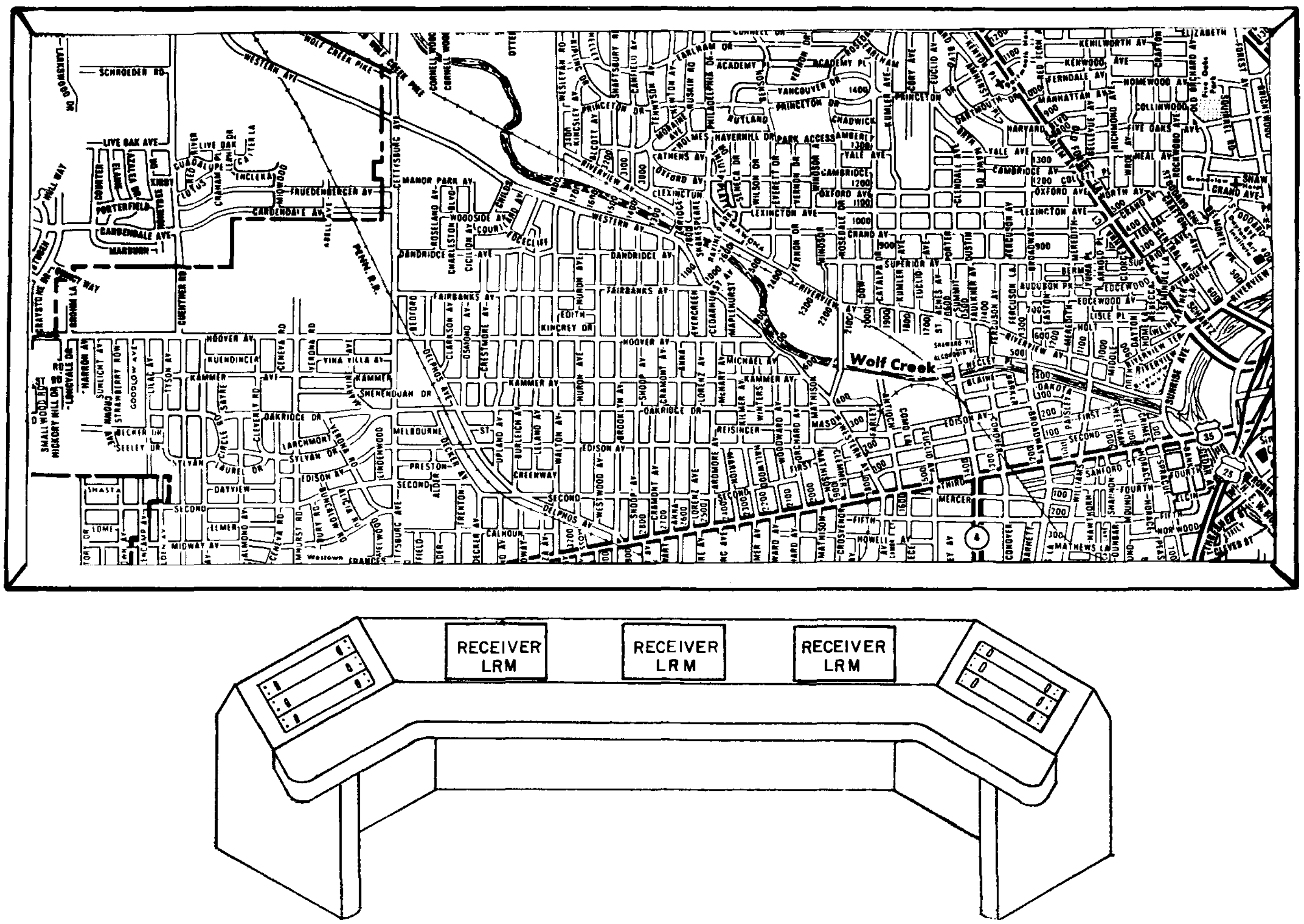
As in all systems, some items were compromised. However, we feel that this system as a technical trade off to dollar cost has very few shortcomings. The principle one is that the transmitter unit is mounted inside the standard mainline station. Since generally there are three different devices fighting for the same space in the mainline housing (downstream AGC, upstream AGC and the status monitoring transmitter), we are restricted to locating a status monitoring transmitter at approximately every third mainline station. We are currently working on an auxiliary housing arrangement for status monitoring transmitters, so that we can eliminate this problem and place the transmitters at any predetermined point in the system. This of course will allow any CATV system (with bi-direction capability) to insert and use the status monitoring system.

It is Cable Dynamics' opinion that a status monitoring system technique is an absolute necessity in major markets and as more status monitoring techniques are developed, it could become economically feasible for even the smallest system.

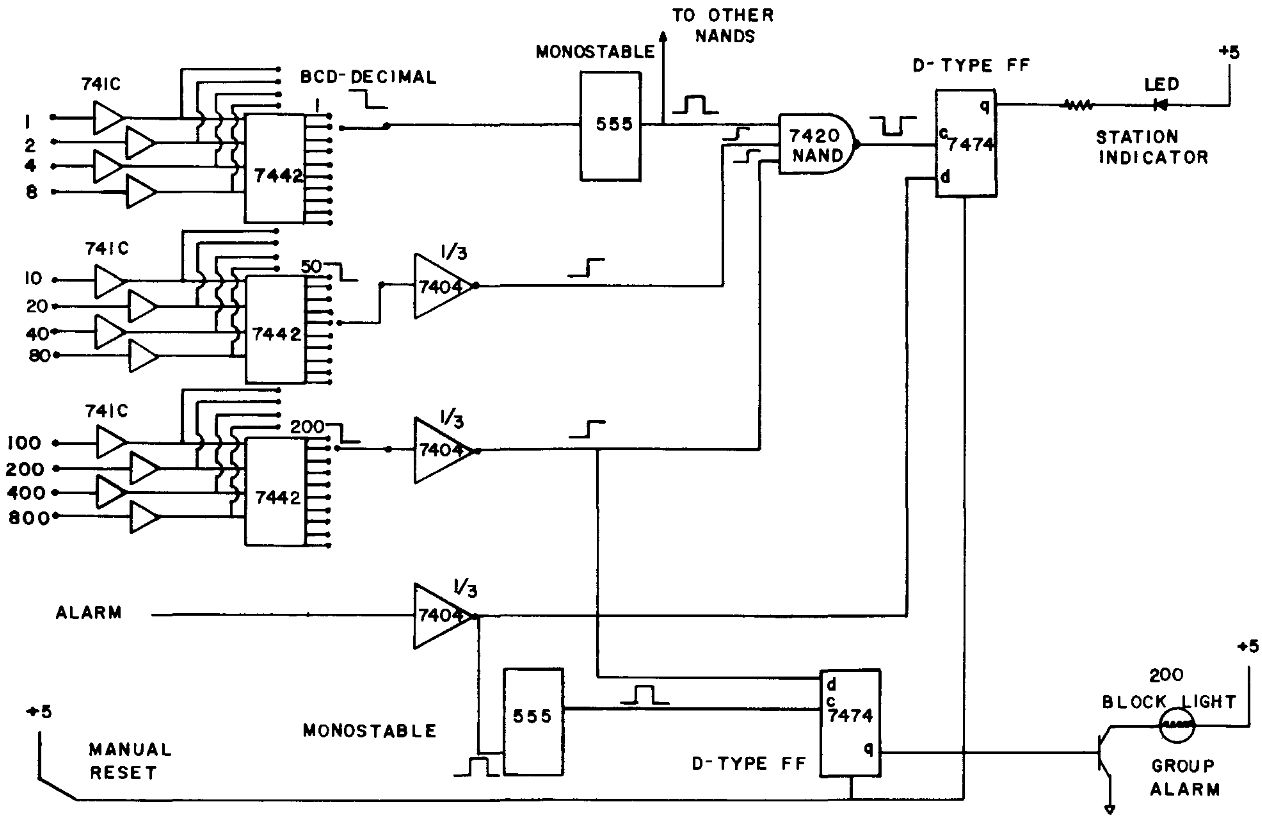


STATUS MONITOR RECEIVER

MODEL LRM



STATUS MONITORING
CONTROL PANEL



LOGIC BOARD INTERFACE