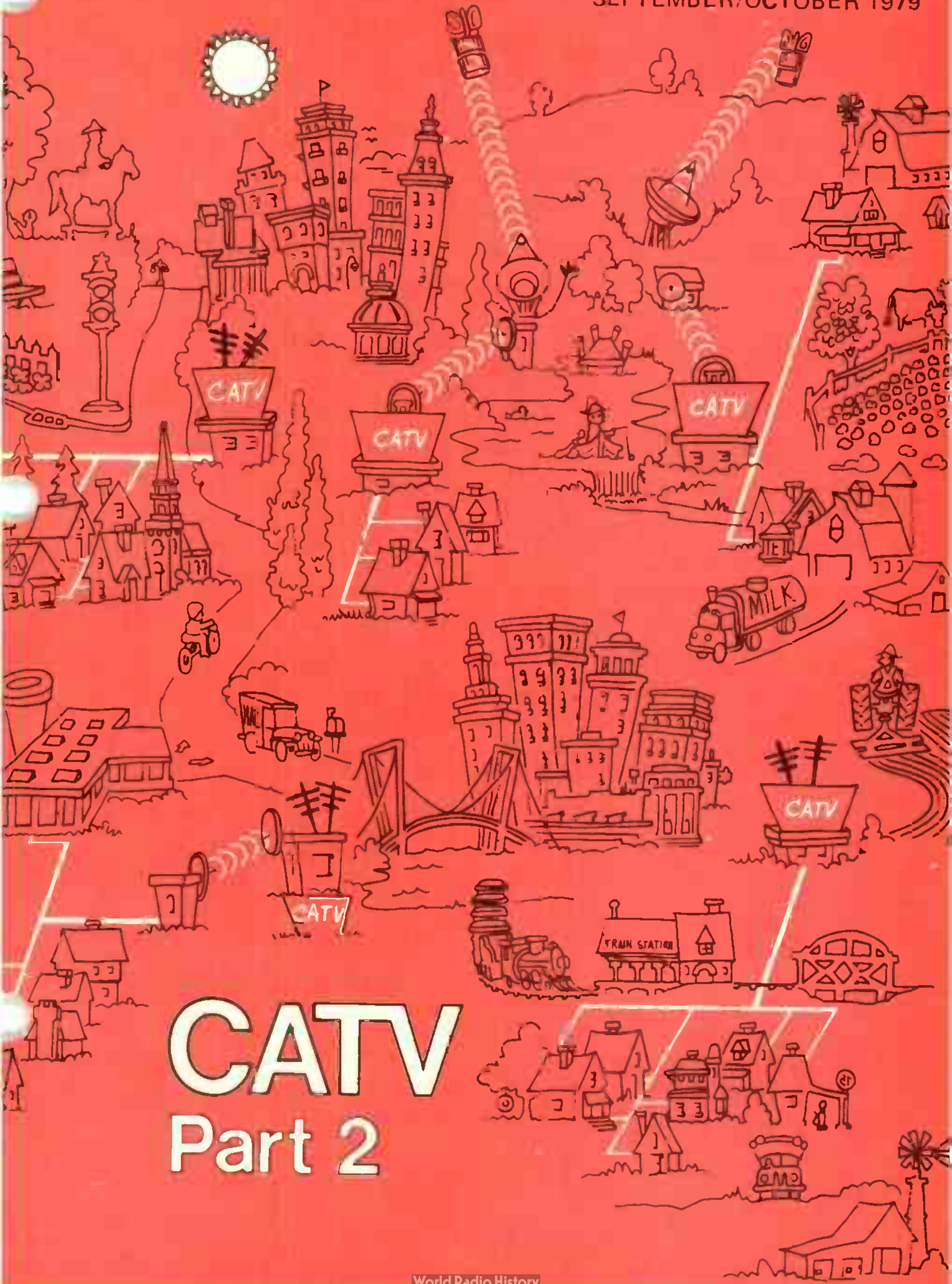
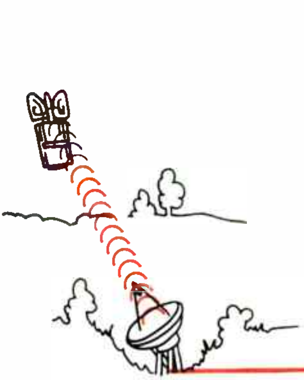
GTE LENKURT

DEMODULATOR

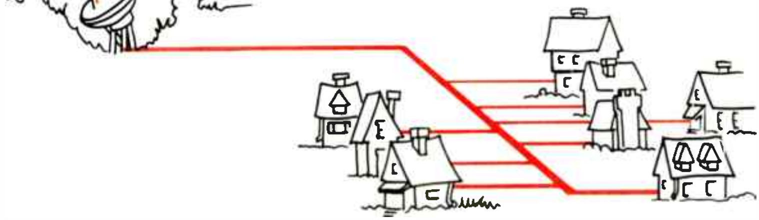
SEPTEMBER/OCTOBER 1979



CATV Part 2



This second, concluding part of our CATV series discusses cable TV from a system design viewpoint. The use of computer control is also described and some indications of possible future trends are examined.



Part one of this two-part, CATV series contains a detailed description of how the cable transmission portion of a CATV system works. The following paragraphs describe how a system designer lays out a cable subsystem and translates performance specifications into hardware requirements.

Generally, when he sits down to lay out a system, a designer already has certain information at hand. This includes a basic description of the system in terms of the number of channels to be carried, the signal strength and performance requirements for each subscriber and often the type and size of trunk cable to be used.

The designer will also have acquired a city street or road map and a set of strand maps. A strand map shows streets, pole locations, distances between poles, underground routings and a house-count from each pole. The average annual ambient temperature and the range of seasonal extremes is also useful information to the designer.

The first design step is to determine the trunk cable routings. The designer makes a careful study of the street and strand maps. There may be several feasible routes but the designer is looking for the one route that best meets the system's economic and electrical requirements.

Once the distance covered by the longest trunk route has been established, the trunk amplifier cascade can be calculated. The cascade is simply the number of amplifiers required to overcome the cable losses.

This is an important number because amplifiers are the principal cause of system performance degradation. The choice of cable has a direct effect on the number of amplifiers required. It is advantageous to use low-loss cable. This is particularly true for long trunk routes.

The best year-round operation will be obtained if the amplifier spacings are optimized at the mean annual temperature of the area where the system is to be installed. This also holds true for the selection of pads, equalizers, gain settings, output levels, etc. In other words, calculations of cable attenuation, for the frequencies of interest, are made at the mean temperature and serve as the basis for determining the other parameters.

The seasonal variations from the mean temperature are used when considering what type of amplifier to use; manual gain, automatic level and slope, or a mixture of the two. The affects of temperature changes on cable attenuation are discussed in Part I of this article. One type of ALS amplifier is also described. However, a full treatment of the subject, including the engineering trade-offs involved in amplifier selection, is beyond the scope of the Demodulator. Readers who would like more information will find several references listed in the bibliography at the end of this article.

After the performance requirements for the longest trunk cable have been established, calculations are made to determine the output levels at which the bridging and distribution amplifiers can be operated, without violating the system's performance specifications. The higher the output levels, the greater the number of subscribers an individual amplifier can supply or conversely, the smaller the number of amplifiers required to serve a given number of subscribers. However, the higher the output levels, the more distortion each amplifier contributes. The designer must consider signal losses due to cable lengths, line splits and multitaps. He must take into account the channels carried, since cable attenuates high frequencies more than low frequencies.

The location of the amplifiers is critical. They must be placed where the required input signal is available and where they can most economically serve the surrounding subscribers.

Back-feed is an interesting technique for reducing the number of distribution amplifiers required for a system. It requires high-gain, high-output amplifiers for its implementation.

When a designer is using the back-feed principle, he stops tapping the cable before it is necessary to start using low-value (high-insertion loss) taps. At this point, the signal level is still sufficient to drive several hundred feet of untapped cable, with the exact length determined by the signal strength and cable attenuation. When the signal is attenuated to a level within the input range of the distribution amplifier-an amplifier is installed.

A portion of the amplifier output is taken off through a directional coupler and "back-fed", to the bypassed subscribers, through a cable which parallels the untapped sections of the main distribution cable. The balance of the amplifier output drives the distribution cable which supplies subscribers further down-stream.

Figure 1 compares straight-feed and back-feed systems. Figure 1A shows a conventional, straight-forward distribution, with a single distribution amplifier. The amplifier is adjusted to provide an output of +46 dBmV using the highest gain possible, without exceeding 23 dB. The total span distance is 2,880 feet from the trunk station. Twenty-five four-way multitaps are served.

Figure 1B shows a straight-feed system with two distribution amplifiers cascaded. The amplifiers have been derated 3 dB, to maintain the same distortion characteristics as the configuration in 1A. The gain settings are ad-

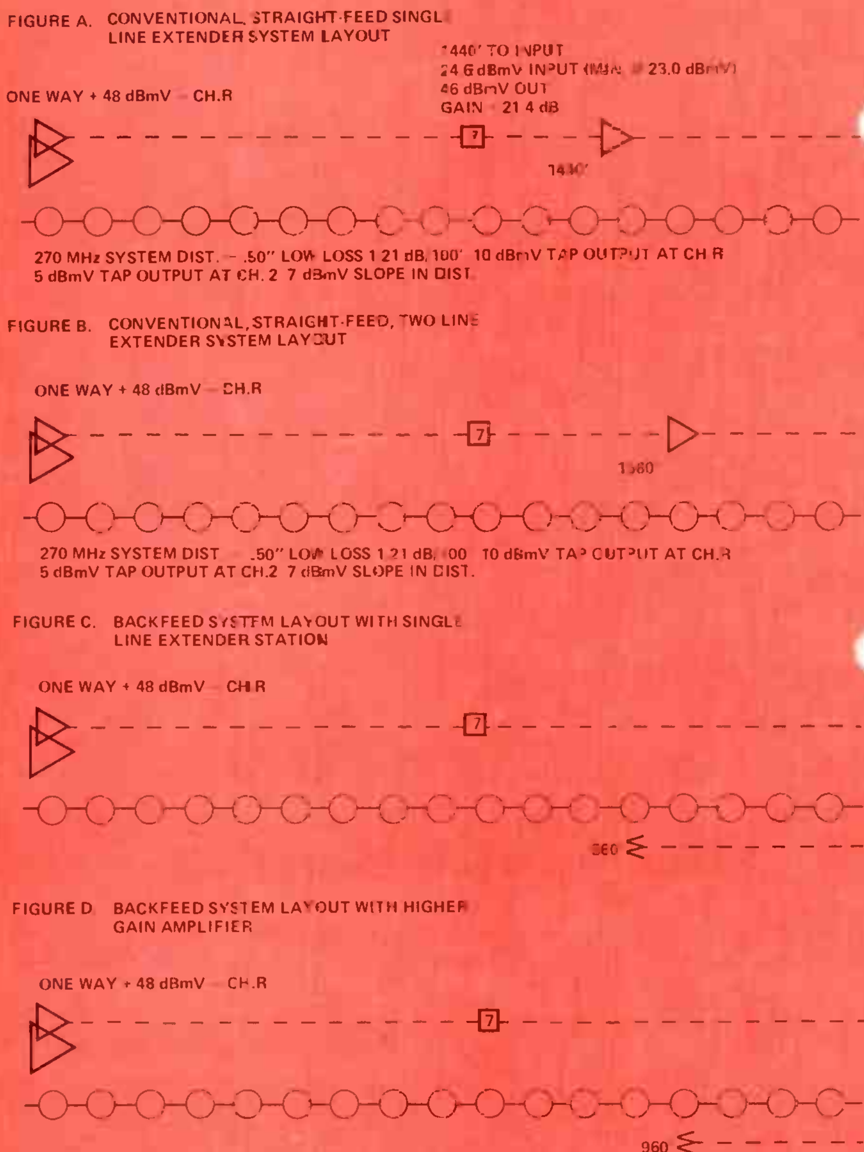
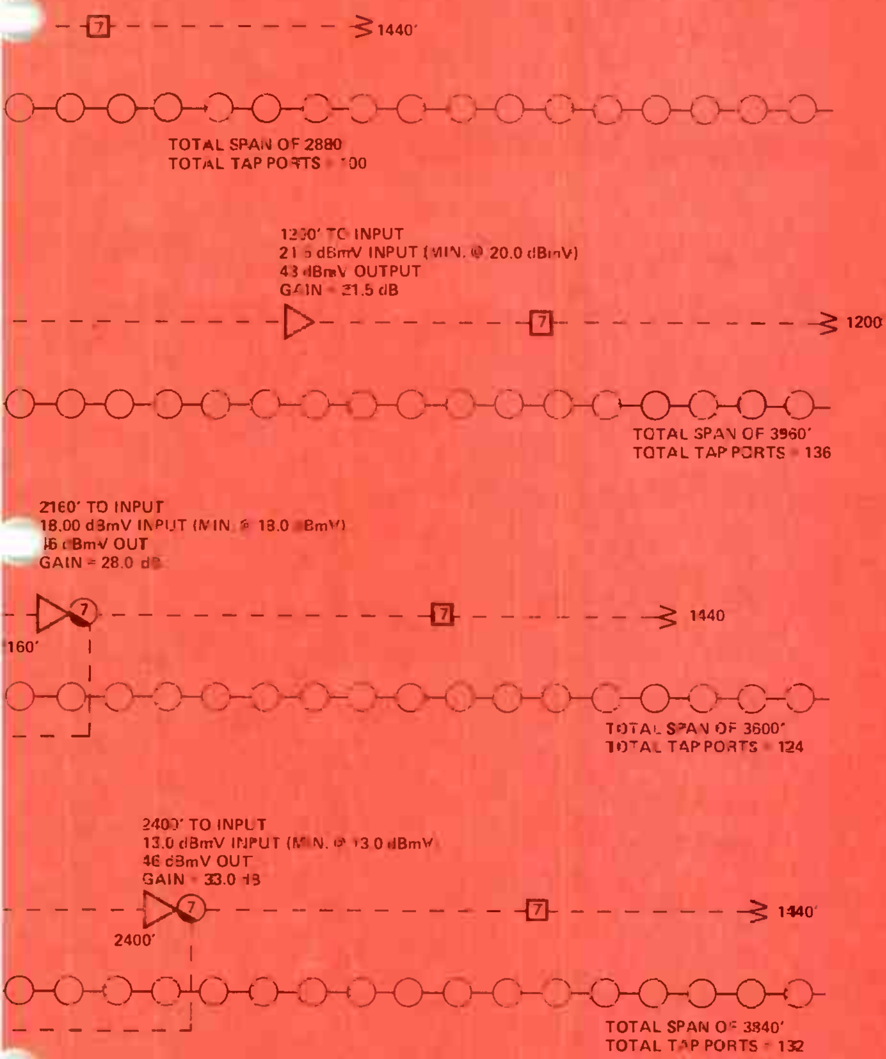


Figure 1. Straight Feed Versus Back Feed.



1440'
TOTAL SPAN OF 2880
TOTAL TAP PORTS
1200
TO INPUT
dBmV INPUT (MIN. @ 20.0 dBmV)
43 dBmV OUTPUT
GAIN
21.5 dB
1200
TOTAL SPAN OF 3960'
TOTAL TAP PORTS
136
2160' TO INPUT
18.00 dBmV INPUT (MIN.
18.0
46 dBmV OUT
GAIN = 28.0
1440
160'
TOTAL SPAN OF 3600'
TOTAL TAP PORTS
124
2400' TO INPUT
13.0 dBmV INPUT
46 dBmV OUT
GAIN
33.0
1440'
2400'
TOTAL SPAN OF 3840'
TOTAL TAP PORTS
132

justed to provide maximum output without exceeding the 23 dB gain limit. The total span distance is 3,960 feet and 34 four-way multitaps are served.

Figure 1C illustrates the back-feed principle. This layout uses an amplifier with 28 dB gain. Although the same design parameters are used as in 1A & 1B, this single-amplifier, back-feed arrangement covers a span of 3,600 feet and serves 31 four-way multitaps; a 24% increase over figure 1A.

Figure 1D shows a back-feed system using a single amplifier with a nominal gain of 34 dB. The design parameters are the same as in the previous figures. This configuration covers a span distance of 3,840 feet and serves 33 four-way multitaps, a 33% increase over figure 1A and only one multitap less than the two-amplifier system in figure 1B.

From the foregoing it is apparent that, in many cases where normal design requires two distributions amplifiers, the back-feed technique can be used to cover the same area with one high-gain amplifier. Of course, a directional coupler and some additional cable are required.

However, these costs are certainly justifiable when the benefits are considered. Using one active amplifier, instead of two, doubles the reliability and halves the power requirements for the particular distribution leg, as well as saving the cost of the second amplifier. It is apparent that the back-feed principle could provide even greater coverage, if it were applied to the two amplifier cascade in Figure 1B.

Power Requirements

Once the number and type of active units is established, the system primary power requirements can be determined. The total power required is the sum of the power consumed by the active devices, the power dissipated in the cable and the power losses due to pole-mounted power supply inefficiencies.

In CATV work, the term "power supply", is often applied to the device used to reduce commercial 60 Hz 120 volt power to 30 or 60 volts ac. This reduced voltage is carried on the coaxial cable, along with the television signals, and is the primary input source for rectifier power supplies in the amplifier housings. The rectifier supplies provide the dc operating voltages for the amplifiers.

The following factors should be considered in the design of the power portion of a CATV system:

- Loop resistance of the cable
- 30 or 60 volt power
- Current drawn by each active device
- Real power consumption per active device
- Number of active devices per unit length of the system
- Effects of input voltage level on equipment operation, current drain and power consumption
- Loading of the pole-mounted, supplies
- Location of the pole-mounted, ac supplies

Essentially, the loop resistance to 60 Hz is the dc resistance of the inner conductor and the outer conductor connected in series. Loop resistance is a function of the cross-sectional area of the cable, the material used and the length of cable. The resistance of the inner conductor is far greater than that of the outer conductor. The loop resistance of a length of cable can be measured by shorting the inner conductor to the outer conductor at one end and using a low range ohmeter to measure the resistance between the conductors at the other end.

The first article in this series stated that a copper-coated, aluminum center conductor could provide substantial weight reduction without excessive increase in signal attenuation. This is true. However, a penalty is incurred in the form of increased dc resistance. The dc resistance of a 0.75 inch diameter cable with a copper-clad center conductor is about 0.98 ohms per 1,000 feet. The same size cable, with a solid copper center conductor, has a dc resistance of about 0.68 ohms per thousand feet. As a rule, the center conductors of larger sized cables have a greater cross-sectional area and less dc resistance than smaller cables.

Designers of modern CATV systems will almost always prefer 60 volt to 30 volt operation. The 60 volt choice is almost mandatory for two way systems.

The apparent power dissipated by the CATV load is equal to the product of the voltage across it and the current through it *(E·I)*. This apparent power is constant, so, if the voltage is halved the current must double. In other words, a 30 volt supply must provide twice as much current as a 60 volt supply. The load is composed of the rectifiers in the amplifiers housings. The current flows through the coaxial cable.

The power dissipated by the cable resistance is equal to the current squared times the resistance (I^2R). It is apparent that doubling the current increases the cable's I^2R losses by a factor of four.

The voltage (IR) drop in the cable is possibly more important because the regulators, in the dc supplies for the amplifiers, may not work properly if the input ac voltage is too low. For example, one manufacturer specifies ±4% output voltage regulation over input voltage ranges of 20 to 30 or 40 to 60 Vac.

Let us assume we have a system using this manufacturer's amplifiers. We are supplying the ac through 2,000 feet of the 0.75 inch, copper-coated, center-conductor cable previously described. The cable resistance is 2 x .98 ≈ 2 ohms. Assume the current draw is 3 amperes for 60 volts. Automatically the draw will be 6 amperes for 30 volts. The IR drop for the cable at 60 volts is 3 x 2 = 6 volts. The voltage applied to the rectifier will be 60 – 6 = 54 volts. This is well within the 40 to 60 volt specification.

Now consider the 30 volt application. The cable IR drop equals 6 x 2 = 12 volts. The voltage applied to the rectifier will be 30 – 12 = 18 volts. This is below the minimum 20 volt specification.

Most CATV amplifiers can be arranged for either 30 or 60 volt operation by strapping the input power transformer. The strapping may be in the primary or secondary winding.

Figure 2 shows a transformer with two primary windings. For 30 volt operation, the windings are connected in parallel to provide a 2:1 voltage step-up at the secondary output. For 60 volt operation, the windings are connected in series to provide a 1:1 voltage transformation. Note that the

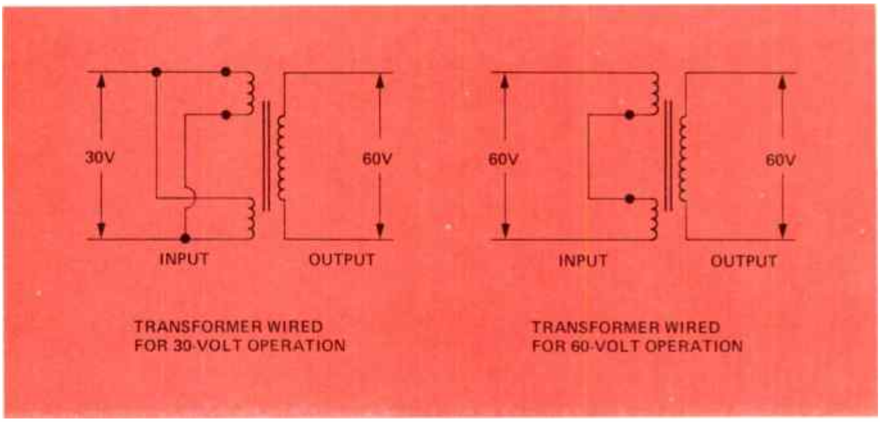


Figure 2. DC Power Supply Transformer Connection for 30 and 60 Vac Powering.

rectifier "sees" a 60 volt input in both cases.

As previously stated, the product of the voltage and current at the input to the rectifier power supply is the "apparent" power consumed. If the rectifier presents a purely resistive load to the ac, the apparent power is also the "real" power.

However, the dc power supplies for most CATV amplifiers have an input impedance with a reactive component. The input voltage is out of phase with the input current by several degrees. Consequently the real power is less than the apparent power.

Manufacturers usually provide curves for their products, which show the relationships between input current, input voltage and real power. Designers should use these curves to calculate the real power consumed by their amplifiers.

To determine the location for the first pole-mounted ac supply, the designer starts at the last distribution amplifier in the system. He consults the amplifier manufacturer's curves to determine the input current to the last amplifier at the minimum input voltage permitted by the system or manufacturer's specifications. This current is used to calculate the voltage drop of the cable between the last amplifier and the next upstream amplifier.

This voltage drop is added to the input voltage for the last amplifier to determine the input voltage to the next to last amplifier. The current for that amplifier can then be determined and added to the current drain of the last amplifier and used to calculate the voltage drop in the cable between the second to last amplifier and the next one upstream.

This process is continued and the voltage drop of each successive upstream cable section is calculated. At trunk or splitting locations, the total current flowing into the junction point is used to calculate the voltage drop in the cable-section upstream from that point. The location for the first pole-mounted ac supply is the point where the sum of the voltage drops equals the voltage output of the supply.

Similar calculations are performed as a first-cut approach to establishing the location for successive, upstream ac supplies. As the design proceeds further upstream, establishing the power supply locations becomes more of a trial and error process.

When the designer calculates the current drain for each amplifier station, he should also determine the real power consumption. When the location of the ac supply is established, the total real power consumption should be compared to the output power capacity of the supply. A 50% capacity utilization is average for a good design.

The design ideal is to have 100% utilization when the system is completely filled out and loaded. In other words, in establishing a power supply location, the designer keeps in mind all present and planned options for the stations served by the supply. When these installations are completed, the current drawn should be slightly less than the supply's capacity.

This ideal cannot be achieved but the closer it is approached the more efficient the system will be. The efficiency of the ferro-resonant supplies, commonly used for ac power, improves as their operation approaches their rated output. The relationship is shown in Table 1.

Emergency Power

Localized commercial power-outages may affect only a few square blocks as far as the power company concerned. However, cable reception can be disrupted at all subscriber locations downstream from the fault, because the trunk amplifiers are connected in series.

Two types of emergency supplies are commonly used to prevent service disruptions caused by power-outages.

Table 1. Efficiency as a Function of Rated Output-Ferro Resonant Supply.

% RATED OUTPUT	% EFFICIENCY
100	90
80	85
50	80
30	70

The first type has been available for some time. It is a pole-mounted, standby supply containing a battery driven inverter. If a power-outage occurs, the input to the ac supply is automatically switched to the inverter output and power continues to be furnished to all parts of the system.

The principal disadvantage of this emergency supply is the weight of the batteries required to drive the inverter. This weight is sufficient to preclude pole-mounting in some areas.

The disadvantage is a result of the method's inefficiency. The dc battery power is inverted to ac. This ac is transformed to the 60 or 30 Vac line voltage. The line voltage in turn is converted back to dc by the amplifier power supplies. The end to end efficiency is about 40%. Heavy, high-capacity batteries are used to compensate for the inefficiency. These batteries require substantial maintenance, in addition to charging.

A newer type of emergency supply is available. It uses sealed batteries to provide dc power directly to the amplifiers.

The sealed batteries require no maintenance other than charging, which is accomplished automatically. The use of a separate charger for each battery is recommended to prevent overcharging, should one battery have a higher internal resistance than the other. This second type of emergency supply is light enough to be strand-mounted.

A disadvantage of this second method involves the cable voltage drops which limit the number of amplifiers that can be powered by one emergency unit. The voltage is 24 Vdc so cable losses soon become a problem, particularly on distribution legs which use smaller cable.

Some systems use this method but only provide emergency power to the trunk and bridging amplifiers. If the distribution amplifiers are included, the method becomes fairly expensive.

Our discussion has highlighted some of the factors involved in designing to power requirements. More detailed information is needed for an actual system design.

Computer Control

System automation, through computer control, appeals to many large system operators. One such system is Gill Cable TV, San Jose California.

Gill serves about 73,000 customers with a nearly 1,500 mile distribution system. The system contains about 11,000 amplifiers powered by 1,300 pole-mounted power supplies.

The system has two "head-ends": Hubs I and II. Each one serves roughly half the distribution area through independent distribution networks.

Signals processed by the head-end and fed to the distribution come from four sources:

1. Local signals received directly at the head-ends.
2. Distant signals received directly and by terrestrial microwave and transmitted by 12 GHz, fm microwave to the head-ends.
3. Direct-feed satellite programming received at a receive only earth-station and fed by 12 GHz microwave to the head-ends.
4. Locally generated programming fed from Gills' studio to Hub II by dedicated cable and from there to Hub I by 12 GHz am microwave. The programming includes:

   - Automated character generator outputs.
   - Studio outputs.
   - Tape playback of movies.
   - Tape playback of sports events recorded by Gill's mobile van.
   - Satellite programming fed from the earth station to the studio by 12 GHz, fm microwave.

Gill has long used computers for system management and control. This usage has been expanded over the years and new features are presently being incorporated.

Two computers, and IBM System 3 and an IBM Series 1, are used. The System 3 maintains complete demographic and subscriber files. The subscriber files include billing records and technical information including original signal levels. The number of trouble calls and how they were resolved is included. The computer also issues work orders and tabulates the information to provide statistics for purposes of reliability and system history. Thirty-one line terminals can access the computer, to input and retrieve information. The System 3 is operated by a separate division, Gill Management Services which also offers its services to other cable companies.

The Series 1 computer is used for a number of tasks within Gill Cable itself. When the current systems update is completed, in December 1979, it will have immediate control of 30,000 addressable descramblers. Using these devices, the computer is able to instantly and individually turn 16 levels of pay TV on and off.

The System 3 will input control information to the Series 1 computer. The Series 1 machine is used for hardware control. One of its outputs is connected, through an RF modulator, to the cable. It continuously addresses all descramblers in the field and sets their status.

When a subscriber selects a pay channel, the descrambler compares a scramble level code, transmitted along with the video information, with the list of allowed levels received from the Series 1. If a match is found, the program is descrambled.

A few minutes reflection makes it apparent that it is technically feasible for this system to provide pay-by-view services. Users could dial-up pay channels and be billed for actual viewing time. The service would be similar to the direct-dial, automatic toll-ticketing service phone companies offer long-distance users.

Pay-view service need not eliminate subscription service. Several levels of subscriptions as well as pay-view could be accommodated. Gill's control of addressable descrambler operations requires less than 30% of the Series 1 computer capacity.

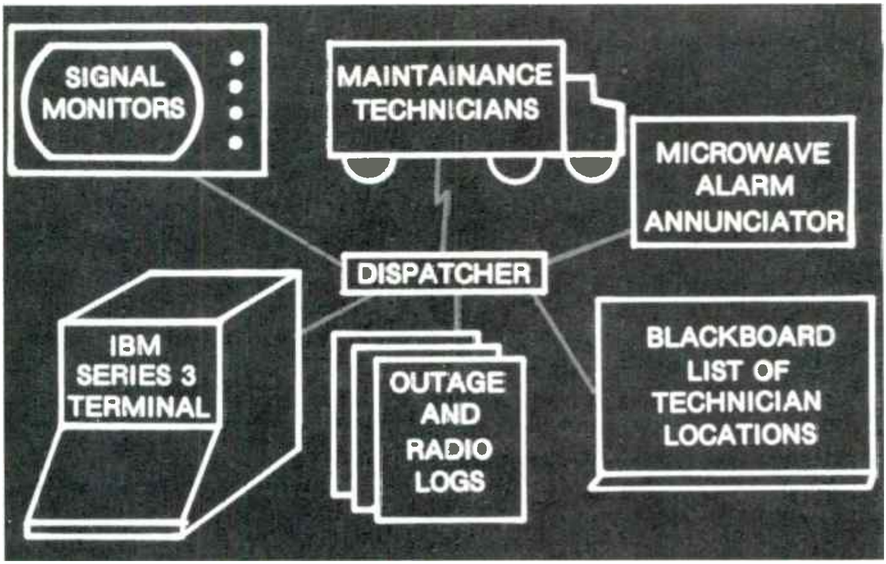
As an extension of its capability to control premium services, hardware and software are being developed to allow the Series 1 to control basic service in multiple dwelling installations. This ability will eliminate the necessity for connect and disconnect service calls at these locations.

In an application unique to a large operating system such as Gill, which produces a significant amount of its own programming, the Series 1 will also be used to "computerize" the video output operations. A complete file of available program material will be developed on the computer. Information on movies will include such particulars as type, leading roles, play out rights, etc. From this file, detailed play out schedules will be developed with time accuracies approaching one second. When the computer reads this schedule, it will directly control video routing switchers, character generators, remote satellite receivers (via a microwave telemetry link) and cue the video operator. It will also generate a log of events played and may even generate billing for advertisers.

Maintenance and Dispatch

Distribution system maintenance is performed by about 25 technicians. Their operations are directed by a dispatcher. The dispatcher maintains radio contact with head-end technicians and installation crews as well as the 25 maintenance techs. Portable radios as well as vehicular installations are used for this purpose. Keeping track of the portable radios is also a part of the dispatcher duties.

At present Gill is using a "personal type" microcomputer to improve the accuracy and efficiency of the dispatch operation. An explanation, of how the dispatch office used to work, will help in understanding how the operation has been improved by the microcomputer.



Courtesy Gill Cable TV

Figure 3. Original Dispatch Operation.

Figure 3 illustrates the original operation. As previously stated, the IBM System 3 generates and clears trouble calls. Twin, remote-control, TV signal monitors allow a direct comparison of off-air and off-system signals. The dispatcher maintains contact with the technicians by both vehicularly installed and "handi-talky" radio.

Alarm and control devices, in the microwave system, monitor system parameters and items such as building temperature, emergency power generator status, etc... If an alarm occurs, audible and visual indications are presented by the alarm annunciator.

Formely, the dispatcher was expected to visually note any alarms and keep an outage log containing all information. Immediate outage information was also physically carried to the Customer Service Area where service complaints are received.

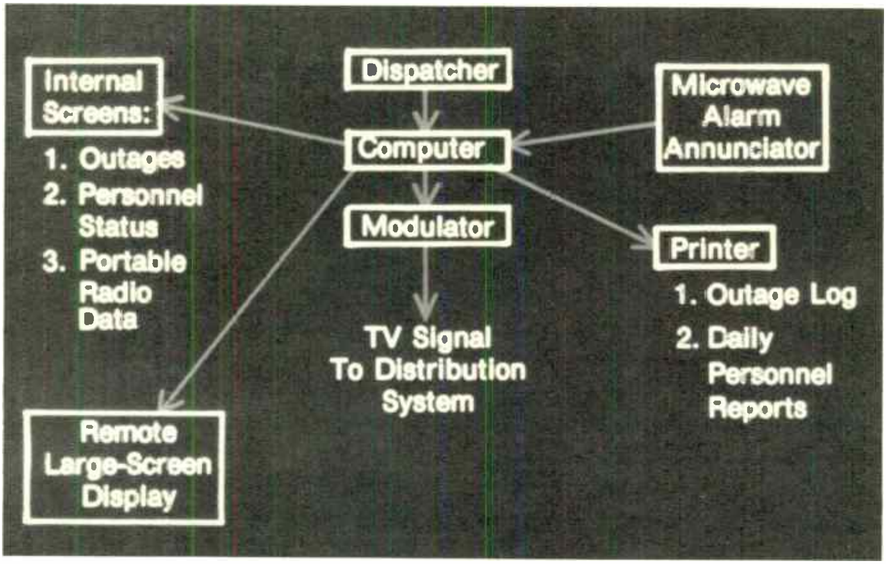
To efficiently dispatch personnel, the dispatcher kept a blackboard list of the status and location of the technicians. Finally the dispatcher logged the "handi-talky" radios in and out on a daily basis and was expected to keep accurate written records.

The problem was that too many manual operations were required. As a result, records were not accurately kept and expansion was virtually impossible.

Microcomputer System

The microcomputer system is shown in Figure 4. This system makes the dispatch operation more efficient and adds significant capabilities.

The information input sources to the dispatcher are still the same. However, the microwave alarm annunciator indications are connected directly to the computers central processing unit through an input/output port.



Courtesy Gill Cable TV

Figure 4. Present Microcomputer System.

Three screens are available to the dispatcher. One screen lists all outages by channel and service area. Microwave alarms are also listed and there are provisions for future expansion.

The second screen lists the status of all maintenance technicians, with the time that status became effective automatically appended.

The third screen lists all portable radios with appropriate information.

Automatic Logging

A daily outage log is automatically generated. Entries occur whenever a channel or area outage is entered or cleared. The same thing occurs when microwave alarms are entered or cleared. Portable radio transactions are also logged. Free-form entries are also permitted. An internal, real-time clock automatically appends the time of day to all entries. Table 2 is a portion of a typical daily log.

Table 2. Sample Portion of One Day's Log.

```
------------DAILY PERSONNEL REPORT------------

SICK

SCHEDULED DAY OFF

VACATION

UNEXPLAINED ABSENCE

MAINT DEPT NIGHT CALLS

MAINT DEPT STANDBY
64


--DAILY SYSTEM LOG FOR 05-06-----------------
MP: RF POWER/FREQ ALARM                      0252
MP: RF POWER/FREQ ALARM CLEAR                0252
RADIO P9 ISSUED TO 76       * - 1            0801
RADIO P7 ISSUED TO 41       * - 1            0802
RADIO 015 ISSUED TO 89      * - 1            0815
RADIO P5 ISSUED TO 55       * - 1            0825
MP: STBY REPEATER ON                         0832
RADIO P14 ISSUED TO 36      * - 1            0833
RADIO P16 ISSUED TO 91      * - 1            0837
38 TRACT 5107 AMBERWOOD AND MORRIL           0905
MP: STBY REPEATER ON CLEAR                   0922
AREA 05 OUTAGE                               0945
21 MA 05 OUTAGE                              0946
85 AMBERWOOD                                 1001
72 SERVING COURT DUTY                        1014
56 HELPING 21 WITH OUTAGE                    1018
22 DENTIST APPOINTMENT                       1024
SP WORKING ON 4B/7A/8A/9A                    1040
MP: AC GENERATOR RUNNING                     1346
AREA 05 CLEAR                                1404
MP: AC GENERATOR RUNNING CLEAR               1408
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When a microwave alarm occurs, the dispatcher is alerted by a cue-tone and a text message automatically appears on the system's outage screen and on the log. This function operates 24 hours a day, even while the dispatch office is closed.

Portable radio check-outs and returns are entered with a few key strokes. The information is stored in random access memory for immediate recall and transferred daily to disc for backup.

A large, wall-mounted screen in the customer service area displays immediate service area and channel outage information from the dispatchers outage screen. This enables telephone operators to give more accurate information to callers and prevents scheduling unnecessary service calls when the problem is in the system.

Remote Status Display

The video signals to the dispatchers display are also connected through a video distribution amplifier to a VHF modulator. The modulator output is connected through the dedicated cable to Hub II and through the 12 GHz microwave radio to Hub I.

At these head-end stations, the signals are converted to a non-standard TV channel and inserted into the system. Any technician can monitor the system status, using an ordinary television receiver equipped with a special converter. This capability reduces the volume of radio traffic. It also enables night standby technicians to monitor system and microwave alarms, even though the dispatch office is closed.

At midnight each day, a subroutine is automatically initiated to search the personnel files and summarize pertinent data in a brief report. The report is displayed on the personnel status screen.

Computer Selection

To select a microcomputer for this application, Gill first listed what they wanted the computer to do: then translated this list into the following computer requirements:

1. Multiple, flexible digital I/O ports.
2. Standard NTSC video input port.
3. Printer.
4. Disc storage.
5. At least 20 kilobytes random access memory beyond that required for language and disc operating systems.
6. Resident high-level language.
7. Readily available service and good documentation.

As configured, the system has 48 kilobytes of RAM, a special clock, special ROM, disc storage and a printer.

System Performance

Gill's experience with the microcomputer has been generally satisfactory. They find software development and modification very straightforward. Interfacing is also relatively simple.

The problems they have had result from the fact that the computer was designed and constructed for the consumer electronics market. Therefore, its reliability was below par for 24 hour a day operation in an industrial environment. Today, Gill is pleased with the capabilities and cost/performance ratio of their installation. It has significantly improved efficiency in the dispatch area. This application could not have justified a full minicomputer, from a cost effectiveness standpoint.

It should be pointed out that since Gill made its purchase, some "home" computers have been targeting the small business market. Presumably, this fact is reflected in the design and construction of their newer models.

CATV in the Future

Cable television is firmly established as an entertainment medium. Its future expansion in this market has been predicted by trade publications, professional journals and the mass-media. The possible entry of CATV into the subscriber wideband and special services markets has not been as well publicized. This subject is discussed in the following paragraphs because we believe it is interesting to Demodulator readers.

Wideband services include TV, CATV, Videophone, 64 Kb/s data and carrier signals, PCM or FDM. These services all require transmission facilities with a bandwidth greater than the 300 to 3,000 Hz nominal voice channel bandwidth.

Special services include health care, viewdata, energy management, facsimile, TWX and Telex. Terminal devices using CRT's, keyboards, microprocessors and special input/output devices are substituted for the telephone set. Practically all of these services can be accommodated by voiceband facilities.

Figure 5 shows the broadband capabilities of different transmission facilities. At the high-end is the coaxial cable system as used in CATV. Theoretically, these systems can simultaneously handle 40 analog TV channels.

Currently, fiber optic systems can handle only a few TV channels, due to component linearity problems. When these problems are solved, fiber optics will equal or surpass coax in channel capacity. The optical/electrical conversion step adds to the cost of fiber optic systems but they have the advantage of a much greater distance between repeaters.

Terrestrial and satellite microwave systems are used for wideband communications. This usage is expected to increase over the next several years, as data transmission and video tele-conferencing increase. Even paired cable can support 1.5 megabit per second transmission, as in T-1 systems.

Against this background of competitive services, CATV entries have been

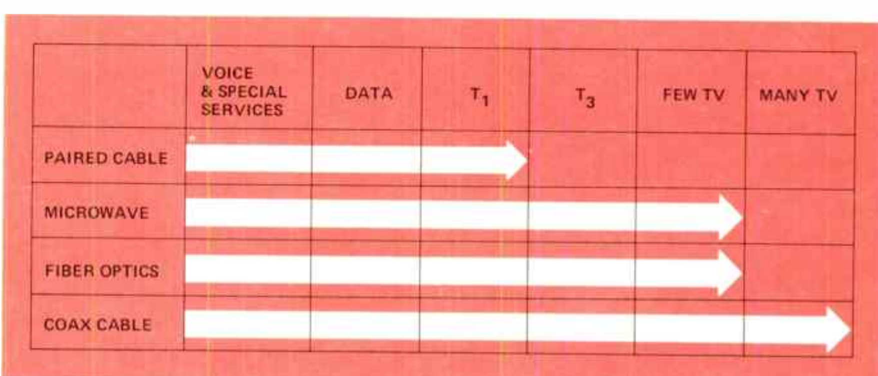

Figure 5. Transmission Facility vs Broadband Capability.

more of an exploratory nature than an attempt at market penetration.

QUBE Experiment

A typical example is Warner Communications Company's QUBE experiment in Columbus, Ohio. The QUBE is a two-way system wherein subscribers use simple, hand-held transponders to reply to opinion-type questions.

Frequency shift keyed, sub-channel modems are used to send the eight-bit word replies. Extra reply capacity is available for additional service such as meter reading, burglar and fire alarms, etc... but is not presently being used.

Responses are collected by computer polling. The station reply also provides information as to whether the TV set is on or off, the channel being viewed and the received signal level.

Warner's system is bidirectional. A 30-channel, addressable converter, a head-end controlled descrambler and a reply encoder are located on the customer's premises. The downstream path uses the 50-300 MHz spectrum and the upstream path uses the 5 to 30 MHz portion. "Pay-view" service is available. Experts believe the "QUBE" approach will be adopted by other CATV operators.

Rippling River Project

Rippling River is a planned community and convention center near Wemme, Oregon. Eventually, 980 residential units will be constructed.

Individual residences will be equipped with CATV controllers. Four and eight unit condominiums will be served by a more sophisticated controller. The CATV system will offer:

1. TV and FM broadcasting including five off-the-air channels and a satellite channel.
2. Pay-per-view, premium movies, via satellite.
3. Security system including: entry alarms, fire alarms, emergency alerts and a light cycling outlet.
4. Energy conservation including: temperature turndown, water-heater control, sprinkler controls and load leveling.

Other services provided are a message waiting light system for rented rooms and a Closed-Circuit-TV surveillance system covering the golf courses, swimming pools, tennis courts and night-parking areas. The system design calls for an emergency standby power system with a minimum capacity of four hours operation.

Home Terminals

Industry experts are predicting that the 1980's will be the introductory period for home terminals. The major growth in this market will be coupled to the growth of cable television. However, a large market will also develop around information retrieval systems using the dial telephone network or similar services provided by specialized common carriers.

Figure 6 shows a design for a subscriber terminal for use with a coaxial cable or optical fiber system. The figure shows separate blocks for each function but many of these would be combined by very large scale integrated circuits. Microprocessors and codecs would be used extensively.

Video Teleconferencing

Video teleconferencing is another potential market for CATV. Confer-

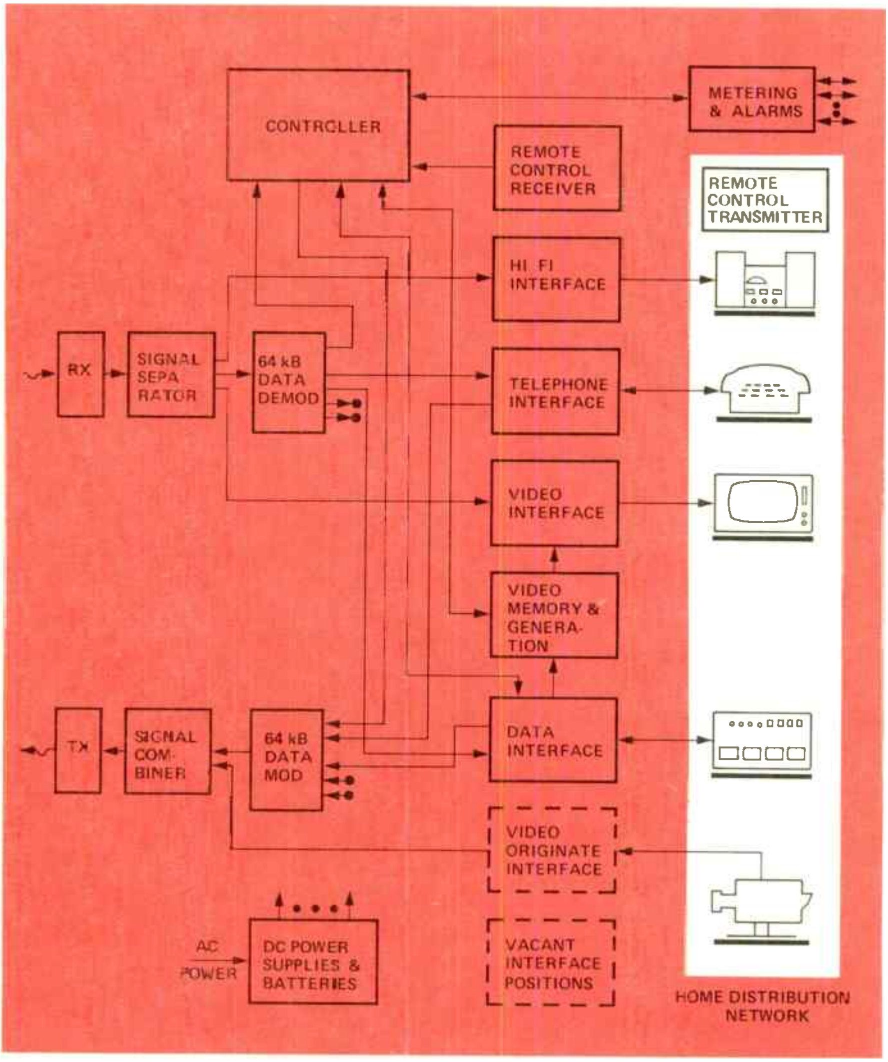

Figure 6. Subscriber Terminal.

ence sites within a 50 mile radius could be linked by a combination of cable and terrestrial microwave facilities, including mobile stations.

Distant sites could be linked by satellite. Teleconferencing video could be transmitted simultaneously with entertainment video or the transponders could be used for teleconferencing during the hours when they are not relaying entertainment.

The teleconferencing video could be relayed from the receive only earth station to the conference sites by portable microwave. As far as the satellite portion is concerned, the networking cost is independent of the number of conference sites.

RCA has conducted teleconferencing tests between San Francisco and Anchorage with receive only participation at locations in Montana and Nevada. Video teleconferencing with two-way video for each conference point is expensive. Up-link transmission is costly in itself and additional expense is incurred because a terrestrial link is usually required to connect the conference site to the up-link site.

Bandwidth requirements are another limiting factor on the use of high-quality color video for teleconferencing. Today's ordinary satellite technology requires the use of an entire transponder for each direction of transmission. This is the equivalent of 1500 voice circuits. Black and white television requires about one half the bandwidth of color. Slow-scan television requires even less. However, these last two types of transmission, particularly slow-scan, have not gained widespread user acceptance.

Several research and development efforts are in progress to provide quality color video transmission with a substantial reduction in bandwidth. Generally, these efforts involve digital encoding and compression techniques.

The use of CATV satellite facilities, with video origination at one or two locations and two-way audio between all sites, is a possible alternative to currently available video teleconferencing systems. The audio transmission could use any combination of the wide variety of available telecommunications systems. Security beyond simple scrambling is required.

The CATV industry is in an expansion mode. Cable systems operators, transmission systems operators, equipment manufacturers and program suppliers are all enjoying a booming business. This situation could well continue through the mid-1980's.

The Demodulator will continue to monitor this industry and report developments. In particular, a more detailed discussion of wideband subscriber services will be presented in the near future.

We would like to express our sincere appreciation for the expert help we received while writing the CATV articles. Mr. Joseph Van Loan, Director of Engineering for Viacom Cablevision and Mr. David J. Large, Engineering Manager, Gill Cable TV, were particularly helpful.

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