MR. KRUSE: With the load isolator, I believe, although I have not had any test in this direction, that the load isolator would absorb the reflected signal from the missmatch at the antenna and dissipate it. The result would generally be a change in amplitude response only. That is what I believe should happen. I'd be glad to discuss it further with anyone as far as perhaps some future testing in this direction.

MR. COOLEY: I thank you very much. Let's give him another hand, gentlemen. (Applause)

Our next subject on today's agenda is entitled, "Problems in Using Line Powered CATV Systems", and the gentleman that's going to provide that information is the Plant Manager for CAS Manufacturing Company in Irving, Texas; formerly served as production manager for Johnson Service Company, Electronics Division; also was production manager for Fishbach and Moore. A native of Dallas, he attended the University of Texas and Southern Methodist University and has nine years of management background. Gentlemen, Mr. Preston Spradlin is going to give us a little story on using line powered CATV equipment. Let's give him a hand as he comes up. (Applause)

MR. PRESTON SPRADLIN: Thank you very much, Mr. Cooley. I'd like to express my appreciation in being able to participate in this technician's session.

The title of my presentation is "Problems in Using Line Powered CATV Systems." Since the miracle of electronics, namely the transistor, enables us to use line powering but at the same time it creates problems, the question of why transistors for CATV should be answered first. May I have the first slide, please. (Illustrations next page)

I. AC vs DC Line Powering Line powering, the natural and economical way to power transistor amplifiers in cable systems, is in reality, a relatively simple matter and consequently, not too much thought has been devoted to this "life-line" of CATV. Yet, through experience, the majority of transistor failures and associated maintenance problems may be traced directly to problems in line powering.

CAS Manufacturing Company, as a result of several years of experience in line powering, has determined that adherance to the following procedures make possible maximum transistor performance.

The necessary power requirements of a conventional CATV system utilizing transistors is between 15 and 20 volts DC. In earlier systems, and as recently as 1960, CAS, like other manufacturers, used pure DC for line powering. This approach, being quite easily attainable, simplified standby systems and required little or no filtering networks in individual amplifiers.

The power supply was conventional and a wet cell could be used as a standby reserve.

Using pure DC, no problems were foreseen in the planning stage. However, in actual operation, continuous trouble caused by electrolysis and AC hum made it obvious to switch to AC line powering. A simple experiment demonstrating electrolysis is to fill a fitting with water and apply first AC and then DC and observe the action of each current. The application of DC builds up a carbon path and shorts the fitting or causes a high resistance leakage path. Even a small amount of moisture is sufficient to cause electrolysis when DC voltage is applied.

II. Regulated vs Non-Regulated Supplies In tube systems, constant voltage transformers became a necessity to prolong tube life and to furnish some degree of protection from lightning surges. In transistor systems, a constant voltage supply is normally built into each amplifier by using constant current transistor power supplies. Since this feature is inherent in transistor systems, the importance of having constant transofmrer voltage, although desirable, is not as important as in tube systems. Also, fast transients that may be destructive to transistors can pass readily through a regulated transformer diminishing afforded protection enjoyed so in tube amplifiers.

Basically, there are two types of constant current transformers - a sinusoidal and a normal harmonic. The sinusoidal type normally produces only a 3 percent harmonic

WHY TRANSISTORS FOR CATV?

1. Constant gain characteristics
2. Low power consumption
3. Feasibility of line powering
4. Compactness
5. Theoretically maintenance free

FIGURE 1

CAS TRANSISTORIZED TRUNK SYSTEM

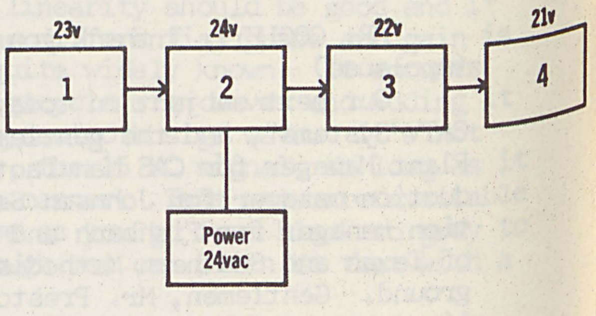


FIGURE 2

WAVE SHAPES BEFORE ADDING EXTENDER

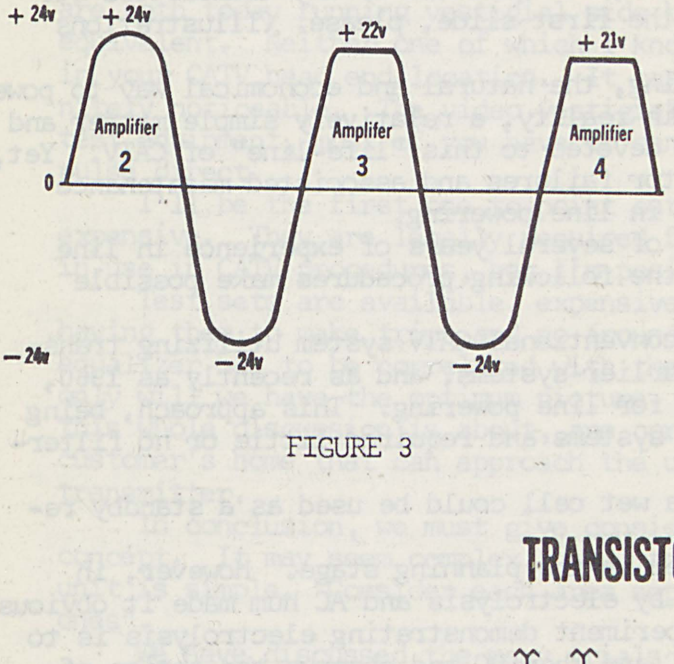


FIGURE 3

TRANSISTORIZED TRUNK SYSTEM

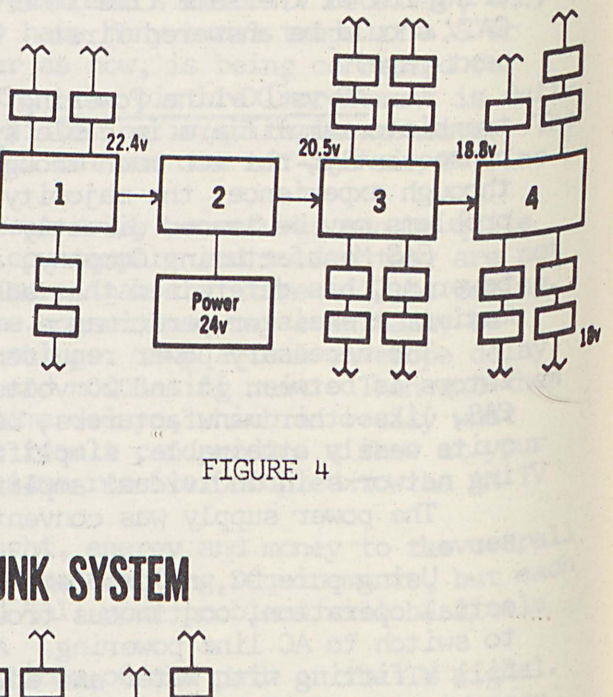


FIGURE 4

TRANSISTORIZED TRUNK SYSTEM

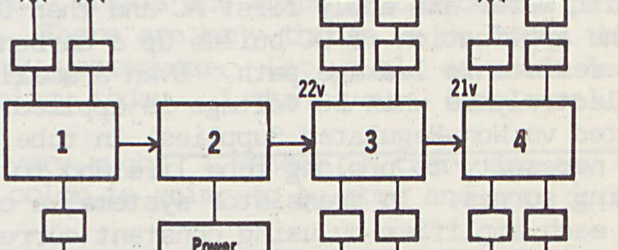


FIGURE 5

content and is particularly well suited for applications involving rectifiers and other equipment affected by harmonics in the supply voltage. Special electronic types which are sinusoidal are used for filament and plate regulation circuits. The normal harmonic type provides the same regulation, ± percent, and is a reliable voltage source for electrical loads such as filaments, relays, solenoids and other loads not affected by harmonics in the supply voltage. All types of transformers provide filaments with stabilized voltages which contribute greatly to reliable operation, longer life, thus reducing service costs. Another advantage of using a constant current transformer is the elimination of extra capacitors and chokes.

In a conventional transistor regulated supply, normally the base voltage of the transistor is held constant by a zener diode and since the voltage existing from the base to the emitter is inherently constant, a regulated supply is easily obtained. The physical size is such that an individual regulator may be conveniently placed in each amplifier.

Negative output voltages are obtained through the use of germanium power regulators and positive outputs by the use of silicon transistors. CAS currently is using both silicon and germanium power regulators. Silicon, although more expensive, offers greater protection against lightning surges. Obviously, line powered systems with transistor regulators offer many advantages over non-regulated systems. Consequently, the widespread use of transistor regulators is common.

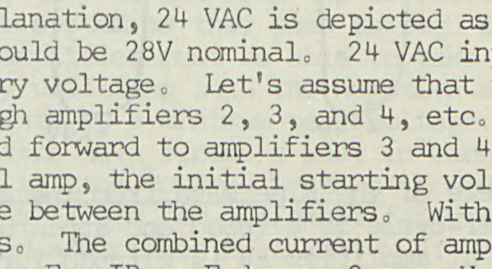
III. Half-Wave Line Powering In using a single center conductor for line powering, it is impossible to use other than a half-wave power supply without the use of bulky, inefficient isolation transofmrers. Therefore, all manufacturers, to our knowledge, use a half-wave rectifier to develop the necessary positive or negative supply voltage for the transistors.

Until recently, available power transistors have dictated the use of a negative supply. The half-wave rectifier, since it utilizes only one-half of the AC cycle, is necessarily only 50 percent efficient. Thus, a circuit requiring .5 amperes DC will require a source capability of approximately 1 ampere AC.

For reasons I will explain later, CAS decided to positively power the trunk system. This lends itself nicely to biasing the transistors, although a more expensive silicon transistor was required for power. An inherent bonus feature of the silicon power transistor is its ability to better withstand surges and etc. in the rectifying circuit.

Using a positive trunk system, CAS lays out 4 trunk amplifiers like this:

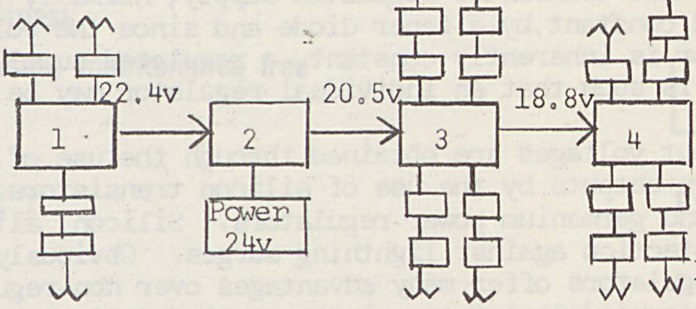
CAS TRANSISTORIZED TRUNK SYSTEM



For purposes of explanation, 24 VAC is depicted as the supply input. In actual practice, this voltage would be 28V nominal. 24 VAC input would be a minimum input due to general low primary voltage. Let's assume that the voltage is traveling from amplifier number 1 through amplifiers 2, 3, and 4, etc. The 24 VAC is fed into the system at amplifier 1 and forward to amplifiers 3 and 4. Let's further assume that each amplifier requires 1 amp, the initial starting voltage 24 VAC and one ohm resistance per length of cable between the amplifiers. With this assumption, amplifier 2 will be supplied 24 volts. The combined current of amplifiers number 3 and number 4 is 2 amps and by Ohm's Law E = IR or E drop = 2 amps X 1 ohm is (equal to 2 volts drop) the voltage at number 3 amplifier is 22 volts since the supply was 24. By use of the same formula, amplifier number 1 has 23 volts available. Amplifier number 4, due to the line resistance, has a further drop of 1 volt and therefore, the voltage at amplifier number 4 is 21 volts, the bare minimum.

Since amplifier number 4 has 21 volts available, it will operate. If extenders are added to the line as shown, we can obtain the following results:

TRANSISTORIZED TRUNK SYSTEM

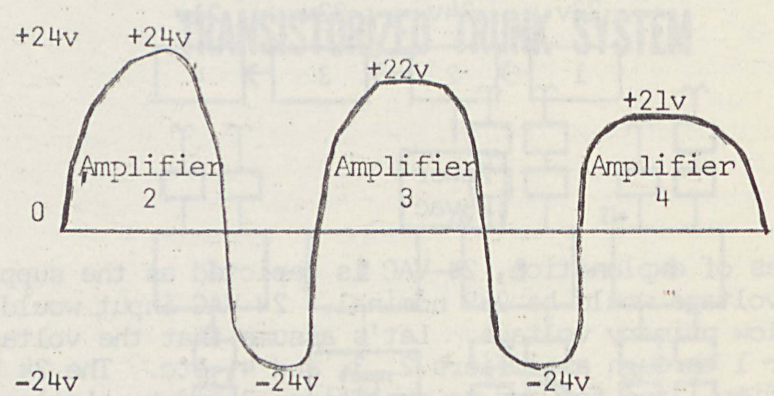


Assuming that each of the fifteen extenders added on #3 and #4, as shown, require .1 amp, the total current requirements for the extenders are 1.5 amp, the total current requirements for the extenders are 1.5 amps. By Ohm's Law, a 3.5 volt drop exists between the supply and amplifier #3 and a further drop of 1.7 volts exists between amplifiers #3 and #4 which results in the line voltage of 20.5 volts at amplifier #3 and 18.8 volts at amplifier #4. Keep in mind that each amplifier requires 1 amp. Now, note that the 18.8 volts at amplifier #4 is below the required voltage, and due to further drops in the extender lines, the last extender has a bare 18 volts from which to operate. The obvious answer in making this system work is to up the supply voltage from 24 to 33 or 34 volts. The disadvantages of this solution are:

1. The voltages exceed the safety limits specified by the National Electrical Safety Code.
2. The first amplifiers #1 and #2 have to dissipate more power, resulting in over heating, etc.

There is another solution --- Looking back to the AC supply, the output voltage appears like this before the extenders are added:

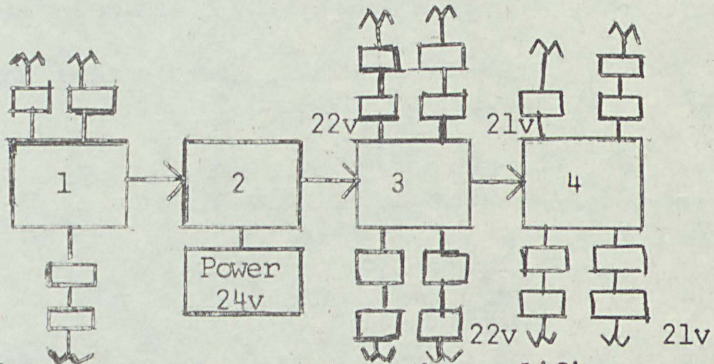
WAVE SHAPES BEFORE ADDING EXTENDERS



Note that the first cycle of the sine wave from the supply is symetrical. At amplifier #3, the positive half-cycle is clipped and appears on the scope as shown at a 22 volt level. The voltage at amplifier #4 is clipped further and is at a 21 volt level. Notice that the negative half-cycle remains symetrical and is at a higher amplitude than the positive half-cycle. At the level of 22 and 21 volts sufficient voltage is present for proper regulation and we have a workable system without the additional loading of the extenders.

IV. Positive and Negative Approach to Line Powering Suppose that the extenders are designed to operate on the negative half-cycle of the AC wave. Since additional loading will not be added to the positive half-cycle, the voltage on a combined trunk and feeder system will appear like this:

TRANSISTORIZED TRUNK SYSTEM



Proper supply voltages are now present at the amplifiers, as if there were no extenders present, and equally good voltages appear at the extenders. Ten extenders may be powered through each amplifier without loading the supply to a point where inadequate voltages would be present at the extenders.

By utilizing both halves of the AC wave, the following additional features become apparent:

1. We can accurately predict the number of trunk amplifiers per power supply as well as distances without regard to the number of extenders to be added either now or later.
2. The supply voltage level may be kept well within the limits prescribed by the National Safety Code. It is no longer necessary to boost the supply level beyond 30 volts to compensate for drops and to raise the low extender voltages. The lower voltage reduces the shock hazard.
3. Transients on both the positive and negative cycles are suppressed by the dampening effect of the transistor power supply loading.
4. Efficiency of the system now approaches 90 percent as opposed to 50 percent efficiency when using only one-half of the AC cycle.

AC line powering provides the ultimate in flexibility. The added advantage of utilizing both the negative and positive method of line powering should be strongly considered when planning new systems or modernizing existing ones.

V. Lightning and Transients Probably the greatest maintenance problems in CATV are the ever present lightning discharges and transients which can cause nightmares for servicemen.

CAS protects all power supply circuits with lightning arrestors and circuit breakers. When fast transients or over-loads appear due to the inherent time lag characteristics of breakers, they do not open the circuit. These transients must be absorbed by the amplifier system as they pass through power supply transformers, regulated or not. Each amplifier must be able to take a peak voltage on the order of 100 volts or more. By utilizing both the negative and positive cycles, we damp both and keep the transients to a minimum peak voltage. Power transistors with high peak voltage characteristics have become a must in each individual amplifier.

VI. Short Circuits in Line Powered Systems Accidental shorting of the CATV cables by technicians, installers, or equipment failures is commonplace. Naturally, the power transformers and associated equipment must be protected by fuses or some other means. It is very time consuming and frustrating for the technician to accidentally short the cable, causing him to have to climb down the pole and replace a fuse in some other remote location before finishing his job. This can very easily be prevented by the use of automatic overload relays which remake after the short is removed. No fuses are used in CAS line powered systems. Relays are used throughout.

In summarizing, for a successful line powered system with few maintenance problems we suggest the following:

1. Full use of both negative and positive cycles of the AC source.
2. Automatic overload protection for line powered shorts.
3. Adequate lightning arrestor usage and high peak voltage power transistors in each amplifier.

Thank you. (Applause) May I answer any questions you may have at this time?

QUESTION: When you're using regulated transformers and only using half the cycle does this disturb the regulation of the transformer?

MR. SPRADLIN: No, it does not. There are two types of constant current transformers. A sinusoidal type and a normal harmonic type. If you use the sinusoidal type, you wouldn't have any problem with regulation.

QUESTION: How about the normal harmonic type?

MR. SPRADLIN: The normal harmonic type does provide the same regulation as a s sinusoidal type, but normally you'd find the normal harmonic type used in filaments. relays and solenoids. Since the sinusoidal type normally produces only 3% harmonics you would use this one for power supply circuits. Each constant voltage transformer has different characteristics. You may find one that puts out a square wave works b better in some places and not as well in others. It depends strictly upon the load.

QUESTION: Does each amplifier that your company makes have a built in regulator and is it AC or DC powered?

MR. SPRADLIN: Yes. CAS Manufacturing Company has all transistor regulator supplies built into each individual amplifier. There is AC going into the amplifier proper. It is converted to DC by a regulated circuit inside each individual amplifier. The AC power continues down the cable until it is converted to DC to power each individual amplifier.

QUESTION: You said the amplifiers were AC powered but do you mean because it is halfwave rectified it is DCpowered?

MR. SPRADLIN: On the line proper, you have AC voltage but past the transistorized regulator direct current is used to power the transistors.

QUESTION: But you have DC current in the cable. You're on an alternating voltage system but a direct current system.

MR. SPRADLIN: No. Remember the AC for line powering is by-passed back into the cable for further line powering while the DC is blocked.

QUESTION: How do you block the DC from the next amplifier?

MR. SPRADLIN: We block the DC by means of capacitors.

QUESTION: Who manufactures a reliable resetting overloading relay?

MR. SPRADLIN: CAS Manufacturing Company is using a line of circuit breakers manufactured by Klixon which is a branch of Texas Instruments Supply Company in Dallas.

Klixon is a very good unit.

QUESTION: You stated that DC line powering caused electrolysis. You have further stated that there is DC in the amplifier. Why doesn't this cause electrolysis in the fittings?

MR. SPRADLIN: Since the DC component is blocked by capacitors it does not go through the fittings.

MR. COOLEY: Any more questions, gentlemen: Well, I thank you very much, Mr. Spradlin. (Applause)

The next paper is entitled, "The Effects of Coaxial Jumpers". Our speaker is the director of Research and Quality Control for Superior Cable Corporation. He was educated at Lenore Ryan College in Hickory, North Carolina. He has a BS degree, major in chemistry, physics and mathematics. He has 3 years in the United States Army in classified work on the Security Agency. Two years in the Shepherd Enterprises, Inc. as a chemist. Ten years in the Superior Cable Corporation as a technician, research and laboratory development engineer. He is presently Director of Research and Quality Control. Gentlemen, Mr. Walter Roberts. (Applause).

MR. WALTER ROBERTS: Thank you. Does everyone have a copy of this paper? "Impedence Discontinuities and CATV Cables". The paper itself, which I hope you'll have time to read in more detail later and which I won't try to discuss in complete detail, begins with an introduction of why uniformity in CATV systems is important. And, I'm sure you folks can tell me more reasons it's important than I can tell you. In fact, I was in the transmission line of business quite a while before I found out broad-banded didn't have anything to do with an all-girl orchestra.

But, in this little paper some of the factors affecting uniformity and coaxial cable plan are discussed. There is no attempt made to at least directly describe the effects of non-uniformities in associated electronic equipment, except for some graphs which I hope to show you on combined effects.

Demands for improvements in signal transmission uniformity have probably been experienced in every CATV system operating today. The need for upgrading existing service through additional channels has oftern exposed system non-uniformities which were not at all obvious while carrying only a few channels. Similar problems have become evident only after initiation of color transmission. In recent years, new systems involving longer cable trunk runs have shown effects from irregularities which would probably have gone undetected in shorter runs.

Some of the factors affecting uniformity in coaxial cable plant are reviewed in this paper. Except for the effects on cable impedance characteristics, no attempt is made to describe nonuniformities in associated electronic equipment inserted into the cable system. Most of the descriptions are based on the effects the discontinuity produces on a transient pulse along the line. These are much easier to visualize than in the case of steady-state alternating currents and, anyway, the two modes are completely correlated mathematically.

the effect of impedance discontinuities on steady-state operation is best determined through input impedance measurements (and calculations). Input impedance of the line may be measured at a particular discontinuity or it may be at a point along the cable remote from the location of the nonuniformities. The performance of the line, or its deviation from normal, is determined by the impedance it exhibits at a frequency or band of frequencies.

Also presented are charts showing relationships between cable impedance uniformity and attenuation uniformity. These are shown both for the case of discrete discontinuities and for the case of periodic, distributed discontinuities along the cable. These two sources do not result in equivalent impedance deviation attenuation relationships.

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