PROGRAMABLE CALCULATORS AS AN AID IN SYSTEM DESIGN

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An accurate layout in a cable television system has become an absolete necessity, now that CATV involves a highly sophisticated communications network. We now have to consider all FCC rules; we are talking about carrying 30 channels; and, we need to allow for return signal considerations. In short, we can no longer do the electronic design as we do the actual construction. The "best guess" method of system design worked when we were only carrying low band channels or even up to 12 standard channels, but these days are over.

Now that we are talking in terms of 20 channels and up, cable design should be done by a knowledgeable and skilled engineer. Naturally, the more knowledgeable and skilled this person is, the more valuable his time becomes. He may also be running an existing system and have many other duties in addition to the layout and design, so time becomes more critical.

Even if the design is done by outside engineering concerns, the work should be checked. There will always be several changes required in even a correctly designed system; for example, there will be several field changes that a design company cannot be aware of, and of course, once the actual construction begins, there will be many field changes that could not have been anticipated. Sometimes these changes will require major reroutings. These design changes must be done quickly and of course, with complete accuracy.

The design itself is becoming very complex in terms of concepts, but the actual method of arriving at the end product is generally just a combination of simple mathematics, such as addition, subtraction and multiplication. Why not let a machine do the automatic and simple calculations for you?

Programmatical calculators can greatly increase the speed and accuracy of design or checking layout. Depending upon how large a machine you buy, you can increase the speed anywhere from 2 to 10 times over adding machines or non-programmatical calculators. The accuracy is also much improved, because more potential errors, such as those in human addition, subtraction or multiplication are eliminated, and the need to check charts or special attenuation slide rules is also removed. All attenuations can be figured by machine.

Basically, a programable calculator is a mini, or micro, computer that can closely resemble a standard calculator. It can be programed to follow a series of steps to preform many different mathematical functions. It can even interpret its answers and make logic type decisions.

The machine that we use at Warner Cable Corp. is a Wang 60014. It is capable of following up to 1847 commands or have a 246 data storage registers, or any combinations of the two, as they are intertradeable. The printer and tape cassette units are optional. The peripheral memory is also an option, which doubles the size of the memory to approximately 3700 commands or 500 data storage registers. In comparison to computers, this would be considered approximately a 4 k memory. As a comparison, an IBM System 3 is a commonly used business computer. It is generally considered a full computer, and its base model has an 8 k memory. So you can see that this Wang is not to far from being classified as a small computer. The total price of this unit with options is $5,500.

The machine as described can do all layout in a cable system. It can do the trunk lines, feeder lines and power supplies. It can figure the optimum operating levels for any type amplifier. It can provide a complete bill of materials. It can also be used for checking layout done by others. It can check anything associated with system design, and it can do it all in a matter of seconds.

The calculations that are the most time consuming, because of the quantity, are those for feeder lines. The first step is to input the raw date from a strand map. (See Figure 1)

The data the machine will need will be the house drops required at each pole and the footage between the poles or pedestals. After this has been entered, (See Figure 2) the machine will then start its calculations.

FIGURE 1

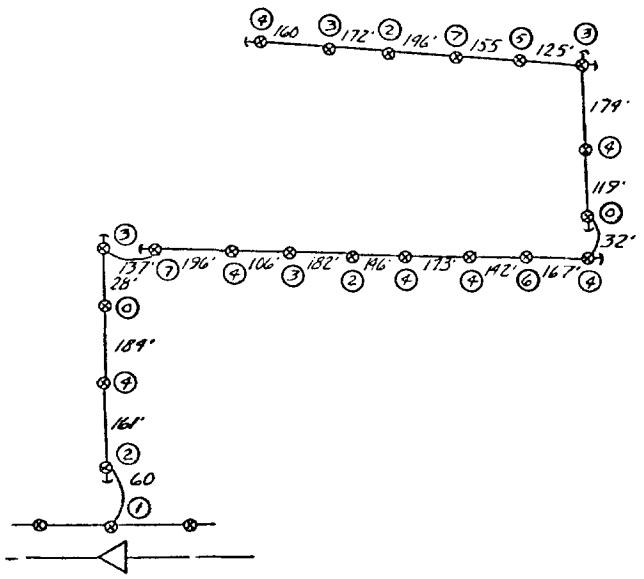
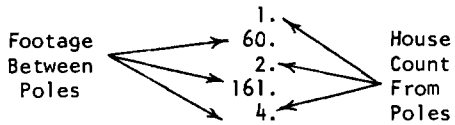


FIGURE 2



1.
60.
2.
161.
4.
184.
28.
3.
137.
7.
196.
4.
106.
3.
182.
2.
146.
4.
173.
4.
142.
6.
167.
4.
32.
119.
4.
174.
3.
125.
5.
155.
7.
146.
2.
172.
3.
160.
4.

It will read the first number entered. It will determine if it requires a tap or it it is a footage. If it is decided that a tap is needed, it will then determine the type required to feed the homes from that pole. This is a fairly simple process. You can pick a number such as 12, and anything that is 12 or below, will be considered as drops. Anything 13 or above will be considered as a footage. If you get into a high density area, you can raise this number higher and still not interfere with your footages. You will very seldom have a footage less than 20.

When it is determined that the first bit of raw data is the house count from a pole, the calculator will decide what type of tap configuration will satisfy the requirements. Will it take a 2 output, 4 output, an 8 output or some combination of these? After this decision is reached, the machine will then determine what value tap is needed.

It will first try the highest tap available with the required number of spigots. If this will not provide the minimum output, the next lower tap value will be tried and so on until it finds the appropriate tap output level. After this is done, it will subtract the pre-programed insertion loss of that tap from the signal level, and proceed to the next piece of information entered with the raw data. It then again will go through the process of determining if a tap is required or if it is a footage.

This time, let's assume it is a footage. All the machine does is simply multiply the footage by the attenuation per foot of cable and subtract this from the signal level. Also, during this entire time, there are many checks on the signal level. The machine has been programed with minimum line extender inputs, and it is constantly checking the signal level for this input. If it finds that the input of the line extender will be too low, then it backs itself up, basically just reversing the process that it has done before, until it reaches a point where the line extender input is above the minimum level. It will then total the footage to that amplifier, give the line extender input, raise the signal level to the pre-programmed line extender output, and start on the next bit of raw data, again determining if it is a tap or a footage. It will repeat this entire process until it reaches the end of the line. (See Figure 3)

Throughout this procedure, each tap used is sorted in a memory. When it is determined that the feeder line method is the way it is to be built, the calculator then takes the taps used from the memory and records them on a cassette tape. At the end of the job, this information is read off the cassette tape and bill of materials can be made from this. The machine will automatically read its tapes, tally up all taps used, and count them at the rate of hundreds per minute. (See Figure 4)

FIGURE 3

Attenuation Per Foot of Cable-----.0163	C
Bridger Output----------41.5000	A
Tap Value & No. of Outputs---------27.2	D
Footage----------60.	F
27.2	D
161.	F
24.4	D
184.	F
28.	F
20.4	D
137.	F
17.8	D
196.	F
11.4	D
106.	F
Footage To Line Extender----------872.	F
20.486	I
Line Extender Input & Output----43.0000	A
30.4	D
182.	F
27.2	D
146.	F
24.4	D
173.	F
20.4	D
142.	F
17.2	D
17.4	D
167.	F
14.4	D
32.	F
119.	F
11.4	D
961.	F
20.035	I
43.0000	A
174.	F
27.4	D
125.	F
24.2	D
24.4	D
155.	F
21.8	D
146.	F
17.2	D
172.	F
14.4	D
160.	F
11.4	D
Footage From L.E. to Termination---932.	F
Termination Level----------20.30840	E

FIGURE 4

Cable Size----------.412	C
Amount In Feet----147159.	F
Amount In Miles-----27.87	M
.500	C
123456.	F
23.38	M
Tap Value & Outputs--30.2	D
Quantity----------175.	A
27.2	D
210.	A
24.2	D
265.	A
20.2	D
295.	A
17.2	D
317.	A
14.2	D
245.	A
11.2	D
210.	A
7.2	D
141.	A

Programming is really not as complicated as some people believe. What it requires is a high degree of logic and common sense. The machine will do exactly what you tell it to do, no more, no less, and I do mean exactly . GIGO, or G.I.G.O. is an expression that is widely known in computer programming. It's short for "garbage in, garbage out." This applies both to the program and to the data inputed to it. To be effective, the program must be well thought out and well planned. However, with a good program, the machine can do almost anything you want it to do.

Computers make decisions by comparing data to each other. For instance, if X is greater than Y, then proceed to step 25. If X is equal to Y, then proceed to step 30. If X is less than Y, then proceed to step 50. Is X positive? Is X equal to 0, or is X unequal to 0? Each of these logic decisions would be followed by a command to perform a certain function if the preceeding condition was met. Generally, these commands would be to go to a sub-routine.

A sub-routine is basically just a program within a program. It will be a series of steps in one program run which may be run through several thousand times. For instance, selecting the tap value is basically a sub-routing of my main program.

So, although the machine is capable of 4,000 steps, in order to accomplish just one feeder line it may actually run through more than 10,000 steps or calculations by repeating some sub-routines several hundred times.

There are many other programable calculators on the market in addition to the Wang. In fact, there are approximately half-a-dozen manufactures that make machines with basically the same capabilities. There are machines available in all price ranges with all memory sizes. Again, the Wang as I use it costs $5,500. You can get machines ranging from 100 steps to 10,000 steps, and costing from $1,000 to $10,000. The optimum price range is probably somewhere between $4,000 to $7,000.

Another often used machine is the Hewlett-Packard 9820. The price of the comparable model to Warner Cable's Wang would be approximately $7,000. The Hewlett-Packard does have certain advantages over the Wang. For example, it features a non-impact thermal printer, which is much quieter and which, instead of a printing action uses a heat sensitive paper. In addition, it also has better alpha capabilities and can label answers completely. This feature becomes very useful when printouts are used by people who are familiar with the program.

Regardless of the machine chosen, anyone who is involved in large amounts of system design should be aware that a programable calculator is not a luxury but rather a necessity, and the more design work being done, the more of a necessity such equipment becomes.