Drop Tap and Home Run Designing

After thousands of consultations on the subject of MATV and SMATV there is one area that stands out as causing a major percentage of the confusion - and that's the hassles associated with the distribution of cable and off-the-air TV signals throughout large complexes ...whether it be a motel, hotel, hospital, nursing home, apartment house or just a good sized residence.

Some would say there are only two systems to be considered, DROP TAP or HOME RUN but In reality, there is a third system, that being a hybrid combination of these two systems.

From this starting point, we shall proceed to define the elementary principles that need to be understood to successfully design your own system. We'll start with the drop tap system since it is the most commonly used procedure in larger systems (motels, hotels, hospitals and the like). Also, it is the system that causes the most worry with newcomers to the area of master distribution.

All rf tv systems specify cables that are nominally 75 ohms impedance. The most popular flexible coax cables being RG-59U and RG-6U for the smaller systems with RG-11U sometimes being specified on longer runs or in bigger complexes...especially for the main trunk runs. It is absolutely imperative to not mix 75 ohm type cables with other impedances (i.e., 52 ohm). You can however, have a mix of 75 ohm type cables such as RG-6U and RG-11U or RG-59U...this is completely acceptable.

All things considered, most satellite dealers and cable companies use RG-6U almost exclusively. It's the best compromise for cost and performance.

Before starting, it is suggested you have a cable attenuation chart for the brand of cable you will be using as well as a loss chart for the drop taps of your choice.. Without this information you can use the generic charts shown in fig. 1 with reasonable accuracy.

Before any calculations can be made, it is necessary to know the headend output level. It may be anything from 20db to 60db. Typically we find that most commercial systems run about 50db and most home systems in the 20-30db range.

Once you know the type of cable and are familiar with the loss per hundred feet at the lowest and the highest channels you can proceed to calculate the first drop tap value. Since most tap manufacturers don't offer tap values greater than 30db, it is quite conceivable that the first TV will get a somewhat stronger than necessary signal...this is not considered a serious problem.

The term "tilt" is synonymous with cable distribution and refers to the fact that high frequency channels attenuate faster in the coaxial trunk line than the low frequency channels . It's very important to watch the amount of "tilt" in your system, otherwise it could completely destroy the performance of some or all of the channels. Therefore, assuming anything other than the smaller systems, it is important to calculate db levels at both ends of the range. A good rule-of-thumb: any time a trunk line is more than about 200 feet, tilt becomes a factor that should not be ignored.

Let's assume we are designing a mid-sized complex of 30 drops, all in a single line. We'll use RG-6U cable and the system will be a 550Mhz cable system with channel 78 being the highest channel. The output from the headend combiner is 40db. The first drop tap is right in the headend room. Obviously, a 30db tap will be ideal. Referring to the manufacturer's drop tap loss chart you will note that the average thru-loss is about 0.5db, thus the signal exiting the first drop tap is now about 39.5db.

Let's continue approximately 100 feet to our second drop. Again, referring to the cable chart, it is clear that the loss at ch. 2 is 1.5db and at ch. 78 it is 4.76db. That means we now have about 38db at ch. 2 and 35.22db at ch. 78. A 30db tap will still work at this point since our goal is to maintain a positive db level above zero. Already you can begin to see what "tilt" in a system can do.

To quickly illustrate the effects of cable tile lets assume the next tape be be 200 feet down the line. Once again, thru-loss on the tap is figured at 0.5db and cable losses calculated from the chart in fig. 1. The resulting values now are approximately 34.5db at ch. 2 and 30.16db at ch. 78. Tilt is now at 8.34db. The tap value will now need to be 20db in order to meet "good engineering practices" ...that is to say, keeping our levels above 0 db...even at the highest channel. With slightly over 8db of tilt now showing in our system we much correct immediately with tilt compensation or pay the serious concequences of a degradated signal beyond this point. We generally like to use an active compensation amp because we can offset the losses thus far and provide a good signal level for the balance of the run.

Using these principles, it is clear to see that designing a drop tap system is really quite easy, although the calculation can be a little time-consuming. In reality, however, time spent on paper with the calculator will result in a much shorter time on the job site.

From this little example it's easy to see why shorter runs with less drop taps on any one leg are more desirable and easier to calculate. Longer runs almost always require a certain degree of tilt compensation and intermediate amplification.
In reality most of the large complexes use a splitter near the headend and/or part way down the trunk line to feed different wings, floors and hallways. Although they are basically drop tap systems, they are more like the hybrid combination of drop tap and home run systems mentioned earlier.

Here's some simple rules that will make drop tap designing easier and more successful;

1. Always calculate for lowest channel and highest channel losses
2. Know your cable per/hundred ft. losses
3. Know your drop tap characteristics, especially "thru-losses"
4. Be sure to maintain + db levels at both the low and high channel limits
5. Generally attempt to maintain levels between +2 and +10db (this will help in keeping stray leakage radiation to an absolute minimum and at the same time prevent excessive power from being unnecessarily sapped from the trunk line.)
6. ALWAYS terminate the last drop tap in a run...otherwise ghosting and other degradation problems can occur to the picture quality.)
9. Add tilt compensation (passive or a tilt-compensating amp) when levels get too low, or when tilt becomes intolerable.
10. Never use 6db drop taps until absolutely necessary. The thru-loses are too great.

In a nutshell that's the information you need to go out and start designing your own drop tap systems...at least the simpler ones. Let's now look at the HOME RUN approach.

Actually, the HOME RUN design is very easy and straightforward. It is the "design of choice" by most cable companies not only because of the ease of design but also because they have total control of each and every tenant within a multiple dwelling without having to enter their actual premises. Should someone not pay their bill or should want a change of service, it can be done from a central point within the building rather than having to enter their apartment.

When designing a home run system, less emphasis is needed towards the tilt problem that is so prevalent in the drop tap systems. Most homes are best serviced with a home run system. When you have 8 or fewer TV's in a dwelling, the distribution network is nothing more than a single 8-way splitter and a small amplifier. When it's more than 8 runs, such as some larger homes or in apartments, motels, etc., then the extensiveness of the split-out network is limited only by one's imagination. A few typical possibilities are shown in fig. 2. Note the systems go from simple to the elaborate.

When it comes to designing a home run split-out network, consider if you want all feeders to have the same db levels. If you have similar length runs you will probably be able to go this way. If, on the other hand, some runs are quite long then design an unbalanced network like that shown in fig. 2(a) or 2(c). Extra ports should be terminated for best performance although many service techs report satisfactory performance even when they leave them open. It's not as critical to terminate unused ports in a home run system as it is the thru-port of a drop tap system.   sufice it to say the reason is simply because of the port-to-port isolation provided by the home run splitters minimizes reflections caused by the missing terminator.

Let's now analyze our final system, a hybrid combination of the home run and the drop tap approaches. Refer to Fig. 3. This is a typical layout like what will be found in many motels. It consists of a 3-way split out network at the headend point to accommodate three distinct areas of the complex. In addition, the bottom leg has been further split to feed a small annex area. This split can be either a splitter (assuming the remaining runs in both directions are equal) or a drop-tap if the runs are unequal. For instance, it would be rather foolish to use a splitter if you only had 3 drops one way and 10 drops the other direction.

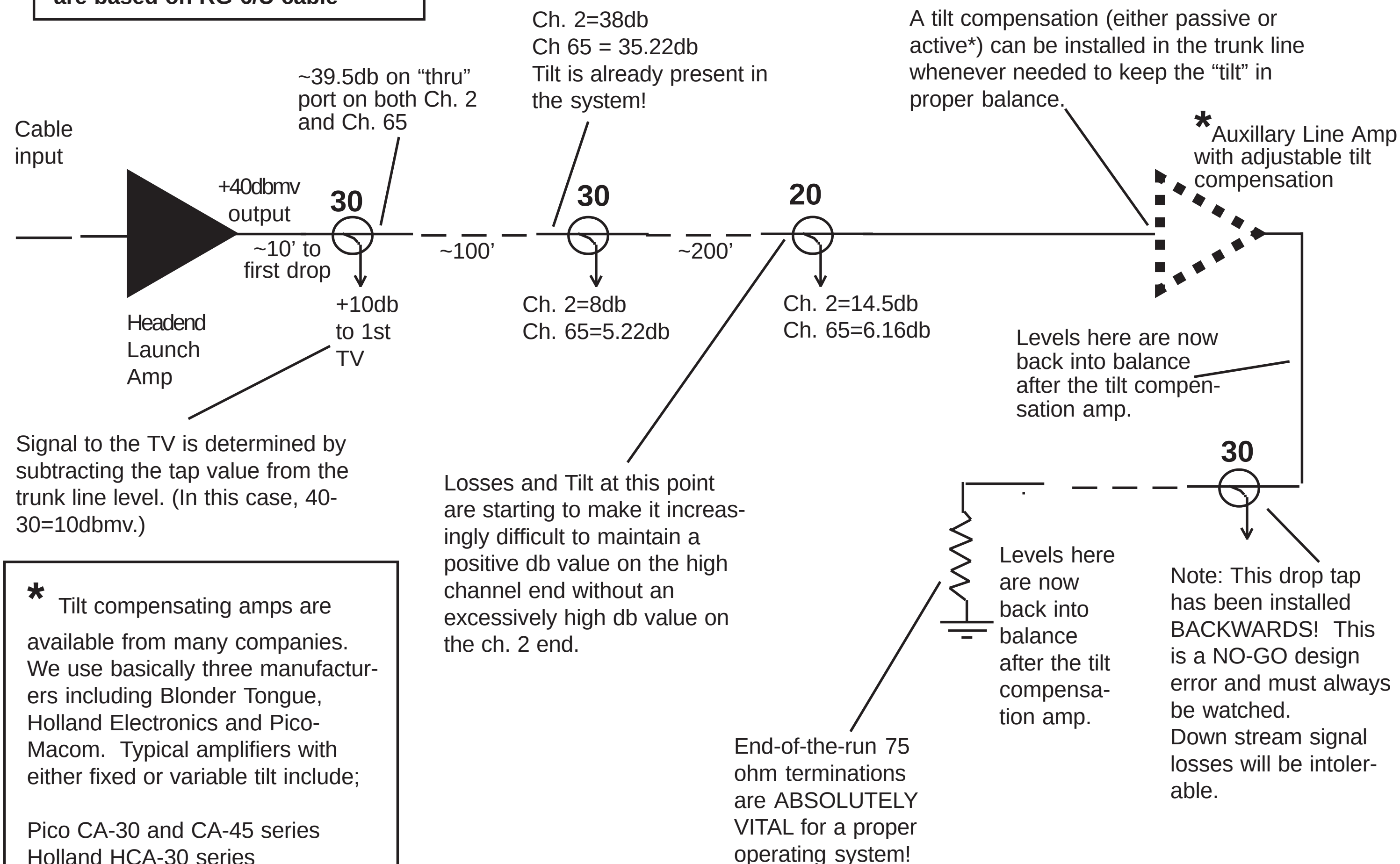
When using drop taps to divide the signal for sub-legs in a trunk line be sure to calculate your needs so that you don't "drain" any more of the signal from the main line than necessary.

A rather graphic way to recap our discussion of signal distribution systems, that involve drop taps, can be equated somewhat to one or more garden hoses than are looped around a number of flower beds...each flower bed getting it's necessary portion of water provided by a small hole "tapped" into the side of the hose. As we progress throughout the garden tapping off water at each flower bed we will need to keep making the "tap hole" slightly larger because of the reduced water pressure at that point. Obviously, if we put too large of holes at the beginning we won't have enough water to equally distribute to all points because we will exhaust the water pressure before we've gotten to the end. Also, when we do get to the end it will be imperative that we 'terminate" or plug the hose or our "system performance" will be virtually worthless except for the large mud hole at the end of the run!

Although the water hose scenario can't completely cover all the obstacles of an RF cable distribution system, it certainly can give the beginning tech a pictorial idea of some of the problems to be confronted with during the building of a system.

A more in depth study of the subject can best be gotten through any number of readily available cable television books that can be purchased at most local full-line electronic wholesale houses. We would be the first to strongly recommend any installer, wanting to better equip himself, to pursue one or more of these works. The wealth of information to be gained will be invaluable on that next "big" job.

NOTE: Calculation shown below are based on RG-6/U cable



* Tilt compensating amps are available from many companies. We use basically three manufacturers including Blonder Tongue, Holland Electronics and Pico-Macom. Typical amplifiers with either fixed or variable tilt include;

Pico CA-30 and CA-45 series
Holland HCA-30 series
BT BIDA and RMDA series

Typical Drop Tap Thru-Loss Chart

Drop Tap Value	Single Tap Thru-loss	Dual Tap Thru-loss	Quad Tap Thru-loss
6	2.55	NA	NA
9	1.35	2.2	*
12	0.6	1.0	2.9
16	0.6	1.2	1.25
20	0.55	0.5	1.0
24	0.6	0.5	0.5
27	0.65	0.5	NA
30	0.75	0.5	0.5

* Lowest value in a quad is 8db, terminating. No thru port.

NA = not available in this tap value
Thru losses can vary slightly with frequency and are shown above as mean averages. When specific manufacturers data is available always use it. If unavailable the above chart should provide adequate approximations for most calculation purposes.

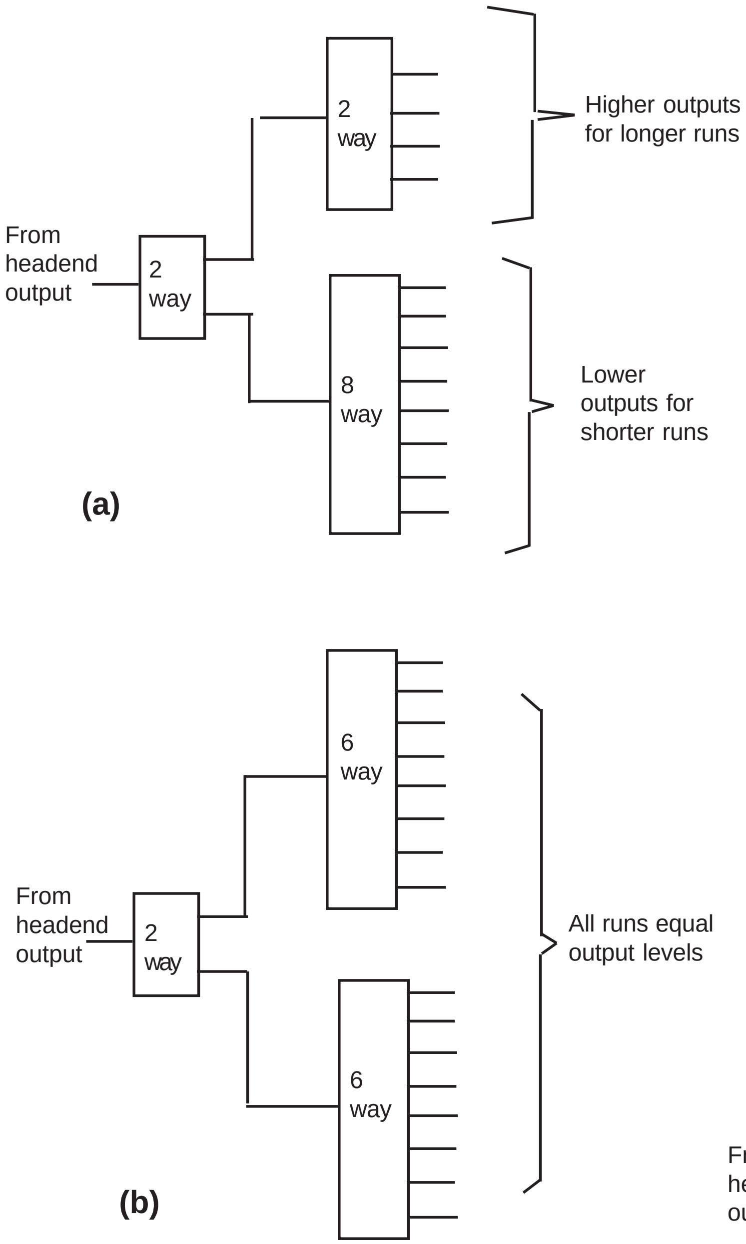
Cable DB Attenuation Chart

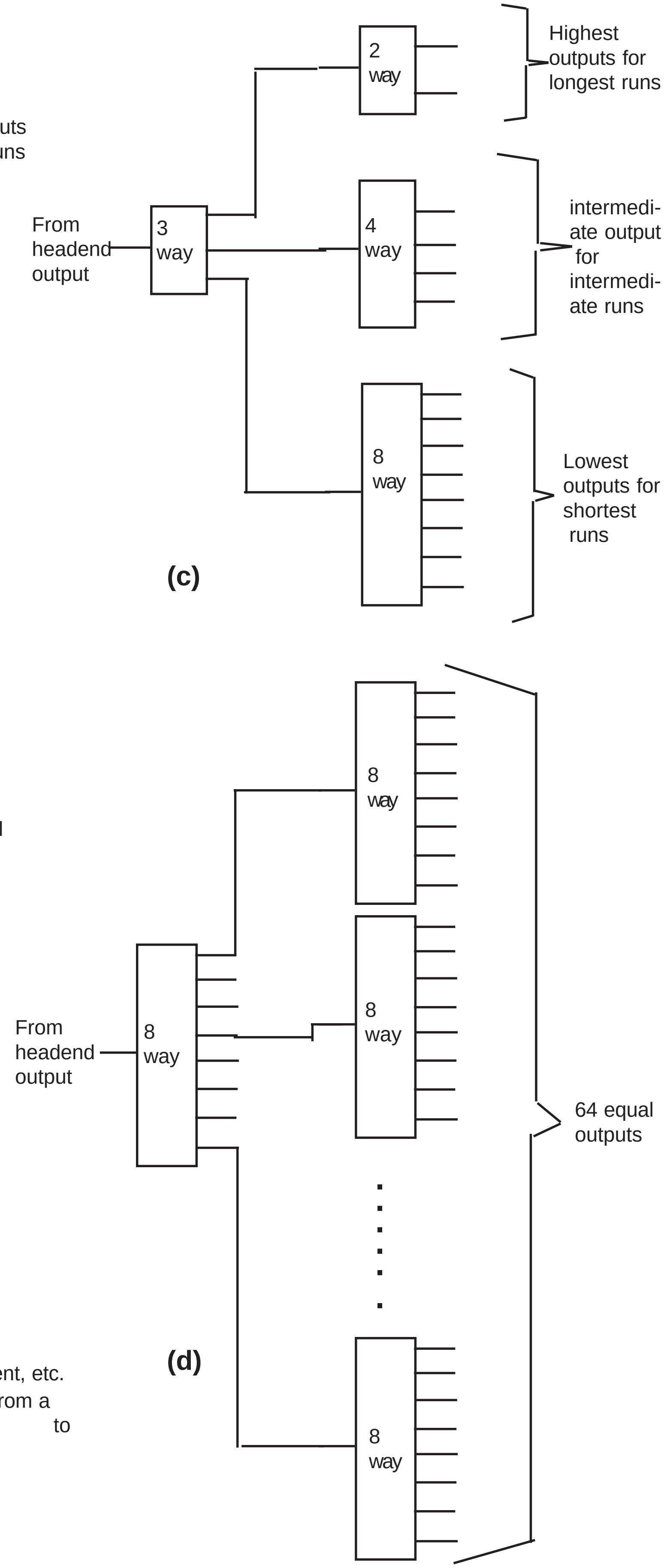
Frequency	RG-59/U	RG-6/U
Ch. 2	1.88	1.50
Ch. 13	3.59	2.87
Ch. 65	5.30	4.28
Ch. 78	5.90	4.76

This is a general chart for the two most commonly used cables used in cable TV distribution. The db values shown are per hundred feet. Specific cable manufacturers ratings may deviate slightly from these figures and should be used, if available.

NOTE: Above chart shows the affects of high frequency attenuation. As the frequency increases, so does the per-hundred-feet attenuation. This is known as "TILT" or "SLOPE" in cable television terminology.

Fig. 1 Typical 550 Mhz Cable System Showing Drop Tap Calculations





(a) Best suited when some runs are much longer than others

(b) Best suited when all runs are about the same length.

(c) Extensions of basic layouts of (a) and (b).

(d) Equal outputs for a 64-run system like a motel, hotel, apartment, etc. This type system can be expanded by driving this circuit from a 2-way, 3-way or 4-way and mirroring this circuit to expand it out to 128, 192 or even 256 drops. Note however, that line amps would probably be needed on the larger systems. Although this system is shown as a balanced, equal output system, it could be built using different combinations of spitters for short, medium and long runs.

Fig. 2 Home-Run Split-Out Networks for Residential and Commercial Applications

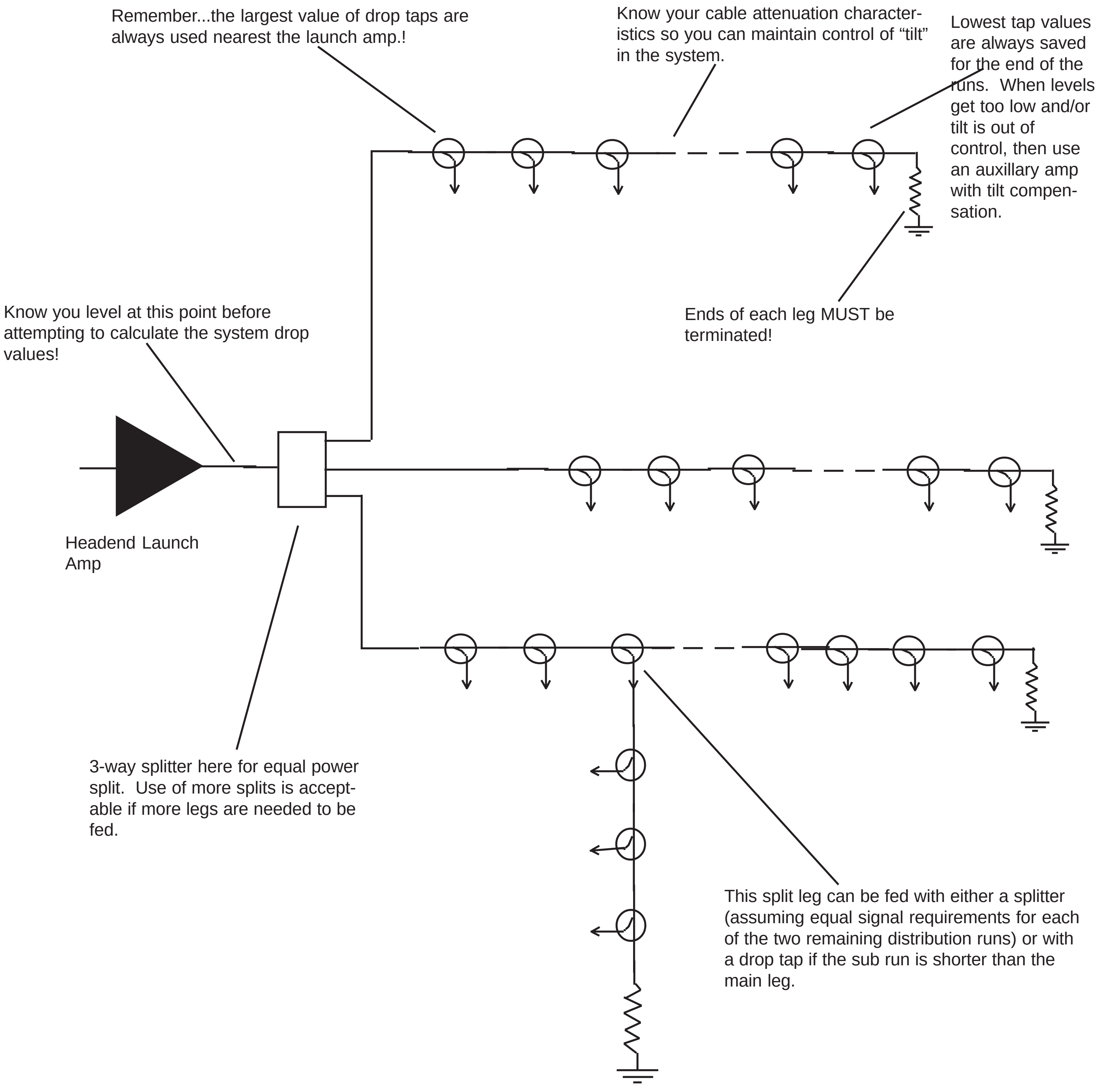


Fig. 3 Hybrid Drop Tap System Showing Multiple Legs and Also a Split Leg.