BLONDER TONGUE LABORATORIES, INC.
One Jake Brown Road, P.O. Box 1000
Old Bridge, NJ 08857-1000 USA
Tel: (732) 679-4000
Fax: (732) 679-4353

DESIGNING THE DISTRIBUTION SYSTEM

DISTRIBUTION SYSTEM

Since the losses of the Distribution System, the specific frequencies to be received (i.e. which VHF and/or UHF channels) and the direction of the transmitters determine the requirements of the headend, the distribution system should be designed first. The first step in designing any MATV distribution system is to obtain building plans or a rough layout of the structure and mark the locations of the necessary TV outlets and a central location for the amplifier.

You must decide whether the distribution cables are to be run horizontally or vertically. Generally speaking, if the building is taller than it is wide and the floors are identical, the cables should run vertically. If the building is wider than it is tall or each floor is different, it is usually more economical to run the cables horizontally. Next, determine the number of distribution cable runs necessary to supply every outlet in the system. Avoid long runs wherever possible - two 400 ft. runs are usually better than one 800 ft. run. Cable runs should be as straight as possible - avoid zigzag runs and loops. Once the distribution cable runs have been determined, each tapoff and splitter location should be marked.

The longest cable run, or the one with the greatest number of splitters and tapoffs, should be used to calculate the distribution system losses. The object is to use the branch with the greatest loss (in dB), because if you can supply an adequate signal to the last outlet in that line, you can supply every other set location. When you are in doubt which branch has the highest loss, it is best to calculate the loss on several branches to find the one with the greatest loss.

In general, there are four types of loss that must be considered. They are Cable loss, Splitter loss, Insertion loss, and Isolation loss.

CABLE LOSS

A certain amount of signal will be lost as it travels through coaxial cable. This loss is dependent on two factors: the type of cable used and the frequency of the signal being carried (refer to the cable manufacturer's specifications for cable loss or refer to the typical cable loss chart enclosed).

Losses are greater at higher frequencies, therefore loss calculations should be made at the highest channel the system is expected to distribute. The Cable Attenuation Chart shows losses in dB per 100 feet of cable for the different types of cable listed. Note that the cable losses are specified at 68 degrees F and will change with temperature, however calculations utilize the published figures. A comparison of the loss between the lowest and highest frequency on the cable results in different attenuation values. This difference is referred to as cable tilt. Compensation for this characteristic is accomplished by using the slope control common in most amplifiers.

INSERTION/THRU-LOSS

When a 2-way splitter is inserted in the line, the signal level at the output ports will be reduced by approximately 3.5 dB (4.0 dB). This loss is referred to as thru-loss or insertion loss. For calculation purposes it is best to utilize 4.0 dB as the actual loss. If a 4-way splitter had been used than resulting loss would be 6.5 dB (7.0 dB).

The insertion loss of the splitting device is the same no matter which direction the signal is traveling. Occasionally splitters are also used as combining devices.

The signal sent to each branch of the system will be equal to the signal sent into the splitter minus the splitter loss. That is, an input of 30 dBmV into a 2-way splitter will deliver a signal of 30 dBmV minus 4.0 dB splitter loss, or 26.0 dBmV to each branch of the System.

All devices inserted into the distribution system create signal loss. When estimating total loss on a given run, loss of each component must be added together to find the total insertion loss for that run. For example: if there are 10 tapoffs on the line, and each tapoff has an insertion loss of 0.5 dB, the total insertion loss would be 4.5 dB. The insertion loss of the last tapoff is not considered since the signal is not passing through that device.

NOTE: For initial calculations the tapoff values and the insertion losses must be estimated because the output of the amplifier will influence the final selection of tapoff values.

ISOLATION LOSS

Each tapoff reduces (attenuates) the signal removed from the trunk line by a specified number of dB to provide a level at the outlet of 10 dBmV +/- 5 dB.

For example: if there is a +25 dBmV signal in the line, and a 20 dB isolation wall tapoff is inserted in the line, the signal available at the tapoff would be 5 dBmV. The 20 dB loss is called Isolation Loss or Tap Loss.

In computing the total distribution system losses, we figure the isolation loss of the last tapoff, insertion, cable and splitter loss. Since our system design requires that we provide a nominal of +10 dBmV (3200 microvolts) to each outlet, we use the lowest isolation value. For most MATV tapoffs this value is 12 dB.

Wall Tap Isolation Values with Insertion Losses

23 dB isolation - .3 dB insertion loss
17 dB isolation - .5 dB insertion loss
12 dB isolation - .7 dB insertion loss

SELECTING TAPOFF VALUES

In selecting tapoff values, the object is to use taps that will deliver a minimum of 1,800 microvolts per channel (+5 dBmV) to each set in the system, and provide enough isolation at each set to prevent interference.

More than 1,800 microvolts at the set will not harm reception, but no set should receive less than 1,800 microvolts per channel. In strong signal areas where there is possibility of direct signal pickup, it may be necessary to feed more than this to each receiver.

Many professional application engineers design their systems to provide a 10 dBmV signal level at each tap. For the sake of discussion and computations here, we will use a +10 dBmV signal level for each tap.

The higher the isolation value of the tap, the lower its insertion loss - so higher value taps mean lower total insertion loss. The insertion loss of a single tap is small compared to its isolation value - but the insertion loss of every tap on the line must be added together to get the total insertion loss for the line. On the other hand, as stated earlier, the isolation loss is determined by only one tap (the last tapoff on the line).

When you are using line drop taps, you must consider the cable loss between the output of the tap and the TV set. When you are using wall taps, the distance between the tap output and the set is usually so short that cable loss between the tap and the set can be disregarded.

SAMPLE CALCULATIONS

Here is a sample VHF distribution system with losses calculated step by step. We'll go through them one at a time in order to determine the requirements of the head end, and the isolation values at each tapoff.

For purposes of illustration, we have selected a system with two equal branches, each having identical isolation values. In a system with unequal branches, we would figure the head end requirements based on the branch with the largest losses.

Our first step is to determine the total system losses, i.e. the combination of loss incurred through cable, splitter, insertion, and isolation.

CABLE LOSS

Let us assume in this instance that we will be using a coaxial cable with loss approximately 4.0 dB per 100 feet, at channel 13. See Figure 1 on page 6.

50 ft.	cable leading to the first tapoff
30 ft.	cable to the second tapoff
30 ft.	cable to the third tapoff
40 ft.	cable to the fourth tapoff
40 ft.	cable to the fifth tapoff
190'	cable through the entire branch of the system

190' cable at 4.0 dB attenuation per 100 feet gives us 4.0 dB x 1.9 or a total of 7.6 dB cable loss.

INSERTION LOSS

We have 5 tapoffs in our branch. Note that these are wall tapoffs. Since the losses must be estimated, we will use the median isolation value...17 dB with attendant insertion loss of .5 dB per tapoff. 4 tapoffs x .5 dB = 2.0 dB.

ISOLATION

Since 12 dB is the lowest tap value we can have at the last tapoff, we will use a tap with an isolation value of 12 dB for this last tapoff.

Our System's losses tally as follows:

Cable Loss	7.6 dB
Splitter Loss	4.0 dB
Insertion Loss	2.0 dB
Isolation Loss	12.0 dB
Signal Req'd.	10.0 dBmV
Signal Level Required	35.6 dB

Therefore, the headend must supply at least 35.6 dBmV signal to overcome the system's losses, and deliver a minimum of 10 dBmV to the last TV receiver on the line.

> NOTE: It is generally good practice to allow an additional 3 dB in selecting an amplifier for the system, however we do not include the extra 3 dB in calculating the isolation values.

Now that we have determined the requirements of the headend, we can determine the isolation values of each tapoff, bearing in mind that each set on the line must receive at least 3,200 microvolts or +10 dBmV input signal.

A rule of thumb in selecting isolation values is to use the highest value possible in order to keep insertion losses to the minimum.

We will proceed through the system step by step, from the distribution amplifier to the final tapoff.

DISTRIBUTION AMPLIFIER

Since the system's losses are 35.6 dB, we will base our calculations on the assumption that we will use an amplifier with a signal output level of +37 dBmV which will provide enough signal to overcome the system losses.

The amplifier sends +37 dBmV of signal to the 2-way splitter, which incurs a 4.0 dB loss.

37.0 dBmV
- 4.0 dB
33.0 dBmV being sent to each branch of the distribution system.

NOTE: In instances where it is necessary to locate the amplifier at a distance from the splitter, the cable loss from the amplifier to the splitter will have to be calculated.

FIRST TAPOFF

The splitter sends 33.0 dBmV of signal to the system. This signal must pass through 50 feet of cable to reach for first tapoff. 50' cable at 4.0 dB signal loss per 100 feet equals 2.0 dB cable loss.

33.0 dBmV	Input Signal
- 2.0 dB	Cable Loss
31.0 dBmV	Input to First Tapoff

Now, using an isolation value at the first tapoff of 17 dB, we deduct the isolation from the input signal to determine the signal being fed to the set.

31.0 dBmV	Input Signal
-17.0 dB	Isolation Value
14.0 dBmV	Signal being fed to the set. This provides us with more than the required 10 dBmV signal input to the set.

To figure the input signal to the second tapoff, we have 31.0 dBmV input to the first tapoff, minus .5 dB insertion loss of that tapoff.

31.0 dBmV	Input to the First Tapoff
- 0 .5 dB	Insertion Loss
30.5 dBmV	Signal Level at the Output of First Tapoff

The signal must now pass through 30 feet of cable to reach the second tapoff. 30' of cable at 4.0 cable per 100 feet equals 1.2 dB cable loss.

30.5 dBmV	Output from First Tapoff
- 1.2 dB	Cable loss
29.3 dBmV	Input to Second Tapoff

SECOND TAPOFF

We now have 29.3 dBmV of signal being fed to the input of the second tapoff. This requires us to use a tapoff isolation value of 17 dB, with an insertion loss of .5 dB. To determine the signal being fed to the set at the second tapoff, we have +29.3 dBmV going into the tapoff, minus the 17 dB isolation value.

+29.3 dBmV	Input Signal
-17.0 dB	Isolation Value
+12.3 dBmV	Being fed to the set

To determine the input signal to the third tapoff, we have +29.3 dBmV going into the second tapoff, minus .5 dB insertion loss.

+29.3 dBmV	Input to Second Tapoff
-0.5 dB	Insertion Loss
+28.8 dBmV	Output from Second Tapoff

We now have +28.8 dBmV of signal which must pass through 30’ of cable before entering tapoff number 3. 30’ of cable at 4.0 dB loss per 100 feet equals 1.2 dB cable loss.

+28.8 dBmV	Output from Second Tapoff
-1.2 dB	Cable Loss
+27.6 dBmV	Input to third Tapoff

THIRD TAPOFF

We now have +27.6 dBmV of signal at the input of the third tapoff, allowing us to use a 17 dB isolation value with a .5 dB insertion loss. To determine the signal being fed to the set at the third tapoff:

+27.6 dBmV	Input Signal
-17.0 dB	Isolation Value
+10.6 dBmV	Being fed to the set

To determine the signal level at the input to the fourth tapoff, we have +27.6 dBmV input to the third tapoff with a .5 dB insertion loss.

+27.6 dBmV	Input to Third Tapoff
-0.5 dB	Insertion Loss
+27.1 dBmV	Output from Third Tapoff

The signal now passes through 40 feet of cable. 40 feet of cable at 4.0 dB cable loss per 100 feet equals 1.6 dB cable loss.

+27.1 dBmV	Output from Third Tapoff
-1.6 dB	Cable Loss
+25.5 dBmV	Input to Fourth Tapoff

FOURTH TAPOFF

We have +25.5 dBmV input signal coming to tapoff number 4, which requires our using 12 dB isolation value at the tapoff, again with a .7 dB insertion loss. To determine the signal to the set:

+25.5 dBmV	Input Signal
-12.0 dB	Isolation Value
+13.5 dBmV	Fed to Fourth Set

To determine the signal being fed to the input of the fifth tapoff, we have +25.5 dBmV input to the fourth tapoff, less the .7 dB insertion loss.

+25.5 dBmV	Input to Fourth Tapoff
-0.7 dB	Insertion Loss
+24.8 dBmV	Output from Fourth Tapoff

We have 24.8 dBmV coming out of the fourth tapoff and passing through 40 feet of cable to reach the fifth tapoff. At 4.0 dB loss per 100 feet gives us 1.6 dB cable loss.

+24.8 dBmV	Output from Fourth Tapoff
-1.6 dB	Cable Loss
+23.2 dBmV	Input to Fifth Tapoff

FIFTH TAPOFF

We now have +23.2 dBmV of signal fed to the fifth tapoff, requiring the use of 12 dB isolation. To determine the signal being fed to the set:

+23.2 dBmV	Input to Fifth Tapoff
-12.0 dB	Isolation Value
+11.2 dBmV	Being fed to the Set

Since this is the last tapoff in the line, we must terminate the output of the tapoff. In planning your systems, always remember to include a terminator at the end of each branch line to maintain impedance match.

Since the other branch of the system has the same number of tapoffs and the same cable lengths, it is a mirror image of the branch we have just calculated. Therefore, the same isolation values can be applied. Our system calculations are now complete.