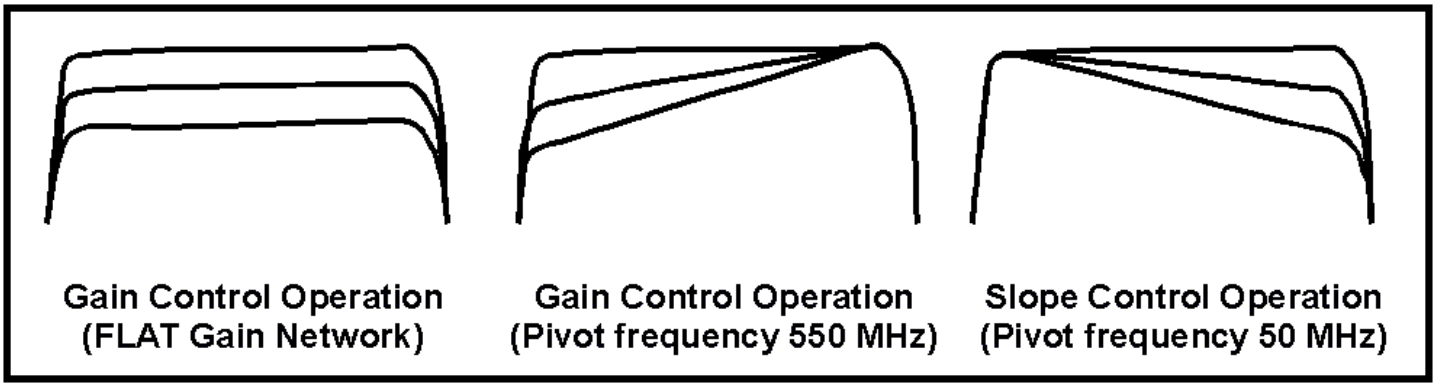
Generic CATV Amplifier AGC Setup

By Jerry K. Thorne

All CATV amplifiers with AGC/and or automatic SLOPE control have an operational sweet spot that will provide the optimum performance, not just in RF linearity, but in carrier-to-noise (C/N) and composite-triple-beat (CTB) levels. The most common problems with AGC amplifiers comes from not providing the correct input signal levels to operate at the "sweet spot" of the amplifier. This article will help the reader to identify that sweet spot.

If you have a good bench sweep setup, you can test your AGC amplifiers to be sure they have the correct maximum and minimum gain and slope ratings. Depending on the brand and type of amplifier under test, the factory specifications could list as much as 8 dB of total gain/slope range. How you utilize this range of gain and slope is what this article is about. Now that I have mentioned the words "gain" and "slope", I want to warn you that not all amplifier manufacturers mean the same thing when they put the GAIN and SLOPE labels adjacent to their controls. I will attempt to explain those labels with the diagram below.



Depending on whose amplifier you use, the marking of gain and slope controls may produce one of the response changes seen above. It is up to the technician to confirm which control produces the desired result. The example is for a 550 MHz trunk amplifier, but applies to other bandwidths also. The difference would be the pivot point tuned to 450 MHz, 750 MHz or 870 MHz. Do NOT think that GAIN always affects ALL channels or just the LOW frequency channels. Depending on the type of amplifier being used, GAIN could be the control for the high frequencies. Enough about that, let's move into what really counts here, proper year-round amplifier performance.

For those of you with underground cable systems, you probably wonder why I wrote this article. The reason you probably do not have AGC level control problems should be obvious. Buried cable remains at a relatively constant temperature and therefore, the loss of that cable does not vary with ambient air temperature. But, for aerial plant, the loss of the cable can vary by about 1 per cent for every 10 degrees Fahrenheit. Now I know that doesn't sound like much, but do the math. For a cable system with 20 amplifiers in cascade and each amplifier spaced at 25 dB of cable loss at 70 degrees F, if the temperature changes 40 degrees in one day, you could see the total loss of the cable change by 20 dB. Remember you have 20 spans of 25 dB each, or 500 dB of cable loss from the headend to the end of the cascade. Four percent of that is the 20 dB of AGC signal level control needed. For a system that has winter temperatures down to zero degrees F and as high as 100 degrees F, you now see that the total AGC action needed from winter to summer is 50 dB. If half of the amplifiers are AGC amplifiers, then each AGC amplifier will need a minimum of 5 dB range. Most CATV automatic amplifiers have from 6 to 8 dB gain control range.

If you have not already read my article: **Set your amplifier to the "Sweet Spot",** now is a good time to read it by clicking **HERE.** Once you understand the principles of the amplifier "sweet spot" you will find this section on AGC and SLOPE setup will be quite logical. Since all AGC/SLOPE amplifiers have a definite gain and slope control operating **RANGE,** it is up to the technician to be sure the amplifier has **input and output levels that remain WITHIN that RANGE!** How to set up the amplifier in that range is discussed on the **next page.**

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From the "Sweet Spot" article, the first thing to remember is that all amplifiers have an input noise figure that is reasonably flat to 1 or 2 dB different in the higher bandwidth amplifiers. This is shown in the hybrid

noise figure specifications by comparing the noise figure at 50 MHz with the noise figure at 550 MHz, 750 MHz, or 870 MHz. With this information in mind, it should become obvious that choosing an input equalizer for any amplifier is all about presenting relatively FLAT RF input signals to the first gain stage of the amplifier. If the EQ value cannot be chosen to provide a perfectly flat input response, then choose an EQ that will provide about 1 dB more attenuation at 50 MHz compared to the upper frequency limit of the system. This will provide signal levels that follow the noise figure curve of the input amplifier as described above.

What did that accomplish? For one thing, the right equalizer will insure a uniform carrier-to-noise ratio for all channels in the cable system. The choice of the correct pad value at the input of the amplifier will then assure that the input signals are within the range for the AGC to maintain a constant output level when the ambient temperature changes with the day/night and seasonal variations. Are you working at a system that has **winter pads and summer pads?** If you are, this article is for you!

By the way, for those of you who learned on a Jerrold SJ system as I did, you will have the input EQ and pad on the connector chassis or "mother board". The point here is that SJ systems have the luxury of removing the active trunk amplifier briefly to see that the EQ and PAD are indeed providing a FLAT input to the trunk module at the optimum RF input level. For the SJ systems, the correct input level was +9 to +10 dBmV on ALL channels. When the noise figure of the input gain block inside the trunk module is taken into consideration, that 10 dBmV of signal is about 3 to 4 dB above the noise figure of the input gain block. At that level, the C/N degradation from each amplifier is acceptable. To drive the amplifier harder will improve the C/N of the system, but will reduce the AGC/Slope control range due to the gain reduction that must be made on the gain and slope controls to provide the desired output levels.

Now, what output levels are we going to use? That depends on whether or not your system has push-pull, power-doubled, our feedforward trunk modules. We discussed all three types of amplifiers in the "Sweet Spot" article. Each type has an optimum output level by design. For Jerrold SJ push-pull trunk modules, output levels of 32 dBmV flat or 30 dBmV at channel 2 and 32 dBmV at channel 61 (450 MHz) were common. The power-doubled SJ modules would usually be setup at 30/34 or 30/35 levels. Why the output slope? To improve the composite triple beat specification of course. The modules also had more gain because they were designed to allow drop-in bandwidth upgrades from 300 MHz at 22 dB spacing to 450 MHz with 25 dB spacing, which is approximately the same distance in FEET of a given coaxial cable.

Ok, here we go for the meat of this topic. If you have that 25 dB trunk spacing we mentioned earlier, then there is a good chance that your module is going to put out +35 dBmV at the highest frequency and expects to see 10 dBmV input levels. If your system is in the middle latitudes of the USA, those hot and cold winter temperatures of ZERO in February and 100 degrees F in August could be a reality for your system. Now, ask yourself this question, if these are the maximum and minimum temperature extremes for the cable system, what is the nominal temperature? Do not think that it is in the middle of these two extremes. What you are asking is this: What temperature range exists for the greater part of the year? It could very well be 60 to 70 degrees Fahrenheit.

Way back on page 1 of this article I mentioned that AGC amplifiers could have as much as 8 dB of gain range, although 6 dB would work in our later example. But for sake of the next argument, we will use the 8 dB range.

It's springtime and a young cable man's thoughts turn to sweep and balance season. For some of you, the boss could have scheduled sweep and balance for the fall, but that's OK too. The reason is simple, for the three months of spring, the temperatures are likely to be similar to the three months of fall. Hey, that means that we could be having SIX months of cool temperatures and three months of hot or cold temperatures. Now you see why the "nominal temperature is not half way between the hottest and coldest days. And that is why the AGC setup which works best is NOT half way between maximum and minimum gain settings, but is more than likely 3 dB below maximum gain. For that amplifier above with 8 dB gain range, that leaves 3 dB of reserve gain for the hot days of summer and 5 dB of reserve ATTENUATION for the cold days of winter. With this setup, the idea of winter pads and summer pads is not an issue. When the system is setup correctly, pads and EQs will NEVER be changed after the initial construction and balance of the system. The final setup of your amplifier is on **page 3.**

OK, Jerrold SJ fans, you have your pad and EQ selected on that 70-degree day for that magic +10 dBmV input to the trunk module. For systems further north, the nominal temperature may be a day which ranges from 40 to 50 degrees Fahrenheit. The next thing to do is **set both switches to manual** and check the maximum settings and the minimum settings for both gain and slope controls to verify that the +3 dB and -5 dB range is available. If it is there, then you need only set the manual controls to the correct output levels, then set each of the auto controls, **ONE at a time**, to the same levels and you're finished, right? Not quite. Let's test the amplifier AGC action.

Just one more test for the SJ guys. Take a push-on fitting out of your pocket, screw a terminator on it. Don't do anything with it yet. With all this talk about input and output levels, push-on fittings, etc. - - we never mentioned the Jerrold SPD-30 test probe, did we? You have been using it on the trunk input and output test points, and on the test point on the feeder maker, too? What, you use the push-on fitting directly to your meter? No wonder you have AGC problems, all your readings were 3 dB OFF! Oh, but for those of you who did know to use the SPD-30 probe and measure 0 dBmV and +4 dBmV to set your trunk output level, then all is forgiven.

What that was all about is painfully obvious to those of you who have made that mistake. If you double-terminate a 75-ohm transmission line, you reduce the measured signal level by 3 dB. And that is what we are going to do with that push-on fitting and the 75-ohm terminator. If you have a trunk amplifier like the Jerrold SJ, Pathmaker, Magnavox, etc. that requires an RF test probe, then you have direct access to the input and output transmission lines (minus AC power) and can do the next test. On the Jerrold SCD-2W chassis, or on a Pathmaker 750 diplex filter, the INPUT test point can be double-terminated with the push-on fitting and terminator, effectively reducing the RF input to the amplifier by 3 dB. If the AGC/Slope is working correctly, it should hold the same output level within 1/2 dB or so. Now take the push-on fitting and put it away. Did the RF output levels remain constant after removing the terminator? IF yes, then you're finished now.

Oh, for those of you who have Magnavox, S-A, or other trunk modules that do not have the ability to break into the RF path after the pad and EQ and before the trunk module, there is some truth here for you, too. If you have that bench sweep handy, sit down there with a zero EQ and a zero dB pad in the input of the trunk module you want to test. If you don't have a bench sweep, use the flat headend test point used to set up all the signals and feed that to the amplifier to be tested.

With the input at 10 dBmV flat and outputs of 30/35, be sure that your amplifier gain is set to 20 dB of gain at 55.25 MHz and 25 dB gain at 550 MHz (or wherever you're headed). Do this in manual gain and then check for the 3 dB reserve gain and 5 dB reserve attenuation described above for those hot and cold days. Reset the manual settings for 20 dB and 25 dB and leave it there. When the module gets to the field, the tech should NOT change the manual settings at all. Make sure the input EQ and pad are installed to produce the desired output levels of 30/35 (or whatever for feedforward, push-pull, etc.). When that is done, you have again made things right for the C/N performance and AGC dynamic range that will work year round. Turn on the AGC and slope controls one end at a time if you have dual pilots, and adjust the AUTO controls to the correct output levels and walk away, after you close the housing of course.

If you have a system spacing that is different, 22 dB for older systems, 25dB and 30 dB gain for a system amplifier, D/A, or mini-bridger, use a bit of common sense about setting the levels to apply to your specific situation. The main thing is to be sure the input stage has received a FLAT RF input from the pad and EQ chosen. After that, be sure that you have enough reserve gain and reserve attenuation to handle the temperature changes for your area.

There you have it, the secrets are out now, your signal levels should be great year round. You have now been introduced to the sweet spot for automatic trunk modules. With any amplifier, the goal is to have input levels that are a reasonable level above the noise figure of the input gain stage, and output levels that are within the AGC gain range. If the system has the right choice of output technology for the cascade required, then the composite-triple-beat performance will be there at the end of the line.

To know you have the right technology for the job, system distortion calculations can be performed using a

popular spread sheet program that has been around since the introduction of fiber optic lasers and nodes became popular around 1990. An example of that type of spread sheet can be seen on the QRF web site at **www.qrf.com/syscalcs.htm** to see what I mean about choosing the correct input and output levels on trunks, bridgers and line extenders to meet the desired goals of C/N and CTB at the end of the line.