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Technology

The Real Truth About Feed Forward Amps

By Steven K Richey, CEO, 4Cable TV Inc.
And Andrew F Staniak CTO, 4Cable TV Inc.

In the early 1980's the industry started to see the first Feedforward amplifiers hit the market. The concept had been around for at least 20 years prior to them but no one had commercialized the product.

The basic concept of Feedforward is to sample the incoming signal prior to amplification and then after a delay line to equalize any time differentials combining the original sample and the amplified signal 180° out of phase and have the original sample and the amplified signal cancel each other out leaving only the distortion products. These distortion products were then amplified and mixed 180° out of phase, with the amplified signal, which had also passed through a delay line to equalize any time differentials.

This technique allowed the designer to cancel out the distortion products and achieve extremely low distortion numbers. In the 1980s with long cascades of 40-60 amplifiers these low distortion numbers were essential to maintaining a good system.

The first feed forward amplifiers were discrete amplifiers but in the mid 1980's both Motorola and TRW came out with feed forward blocks which made the production of these amplifiers much easier.

In today's world, especially in the smaller systems there is an increasing demand for 550 MHz feed forward modules as operators try to extend bandwidths without respacing by utilizing the higher outputs with lower distortions offered by the Feedforward amplifiers. Because of the increased demand and the scarcity of the original modules these amplifiers are becoming harder and harder to find and the price has climbed accordingly.

Most operators believe that in order to achieve the distortion numbers they need at the end of their system they need the -85 db CTB numbers that a typical Feed Forward amp has at a 40/34 dB output.

The first thing that the operator needs to be aware of is that the real distortion values of the Feedforward amplifiers has degraded over time and are probably 5-15 dB worse that the original spec. Remember that the Feedforward amplifier works by combining signal 180° out of phase and at precise levels in order to achieve cancellation and as the amplifiers and components age the exact gains of the amps change and in a Feedforward amplifiers even a small change in gain can result in a large change in distortions. We have recorded the average distortions in 550 MHz Feedforward amplifier modules in Figure 1.

Figure 1

Amp Number	Original Spec	Measured
Feedforward #1 40/34 dBmV	CTB -85 CSO -81	CTB -69 CSO -70
Feedforward #2 40/34 dBmV	CTB -85 CSO -81	CTB -72 CSO -71
Feedforward #3 40/34 dBmV	CTB -85 iiCSO -81	CTB -68 CSO -69
Feedforward #4 40/34 dBmV	CTB -85 CSO -81	CTB -78 CSO -79

When you look at the real numbers and you add in the higher current costs of the Feedforward amplifier the actual advantage disappears

A much better solution is to use a regular amplifier and have the output hybrid changed to a GaAs, Gallium Arsenide power doubler hybrid. You will need to find a qualified upgrade house to do the modification as without proper care and careful construction practices it is possible for the modified amplifier to oscillate. In a properly modified amplifier it is possible to achieve very close to the original specs of the Feedforward amplifier with less current drain and much improved distortions.

We have recorded the average distortions in a 550 MHz GaAs upgraded amplifier modules in Figure 2.

Figure 2

Amp Number	Original Spec Feedforward	Measured
GaAs #1 40/34 dBmV	CTB -85 CSO -81	CTB -84 CSO -80
GaAs #2 40/34 dBmV	CTB -85 CSO -81	CTB -83 CSO -79
GaAs #3 40/34 dBmV	CTB -85 CSO -81	CTB -85 CSO -81
GaAs #4 40/34 dBmV	CTB -85 CSO -81	CTB -84 CSO -82

With the scarcity of Feedforward modules on the market it may be possible to upgrade to GaAs at close to the same price as a Feedforward module and the current usage on your system will be less.

In the infancy of GaAs hybrids, there were some extensive problems with the GaAs devices failing when subjected to a high RF level. Unfortunately there are still many who remember these problems and do not want to have anything to do with GaAs devices. The GaAs manufactures solved this problem a number of years ago and today GaAs devices are every bit as robust as their Silicon counterparts.

An added benefit of using GaAs is that your bandwidth can be upgraded at the same time. In many cases the difference between a GaAs upgrade for distortions and adding the additional bandwidth is less than $50.00. Even if you do not need the bandwidth at this time if might be cheap insurance for the future. In most cases a 550MHz amplifier can be upgraded to 650 MHz giving the system operator an additional 100MHz to be used in the future. Now that the headend price of a digital channel has dropped to around $2,500 per program (e-mail me for more information), you may be needing that 100 MHz sooner than you think!

Feedforward technology was a great boon to the industry when introduced 20 years ago, but in the 21st century, it is a haunting siren who promises much and delivers little. ❑

Next month we will look at Return Loss and revisit this basic and important parameter, which seems to have become lost in today's world!

About The Authors

Steven K. Richey, President and CEO of 4Cable TV, has over 42 years of varied CATV experience, including being in charge of repairs at a major manufac-

turer (Ameco) and the former Chief Engineer at CADCO. Prior to founding 4Cable TV, he was VP New Product Development at dB-tronics. He was the owner/operator of 8 CATV systems in Texas and Oklahoma, and has published over 20 technical articles. Steve can be reached at steve.richey@4cable.tv.

Andrew F. Staniak, is the Vice President and CTO of 4Cable TV Prior to co- founding that firm he was the CTO of dB-tronics and did the research and qualifications on over 100 amplifier

bandwidth upgrades. Andrew has more that 40 years of varied CATV experience, including directing the ANTEC Design Validation Laboratory where he valuated the best GaAs hybrids for the new generation of fiber nodes and RF amplifiers. He spent 6 years as technical supervisor at the New York State Cable Commission. He has performed engineering management for many thousands of miles of CATV system construction. You can contact Andrew at andrew.staniak@4cable.tv.