



ELECTROLINE EQUIPMENT INC.

# Deploying House Amplifiers in Modern Cable Networks

- A white paper

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## Deploying House Amplifiers in Modern Cable Networks

### - Introduction

Cable networks were originally designed to provide adequate signal levels for at least two devices in a subscriber's home, such as for one main TV set and a secondary one. In the 80's subscribers began adopting more than two TV sets and a VCR in their homes, and by the 90's, cable modems and digital set-top boxes were added. This increase in multiple device usage and in the bandwidth that is required, has forced cable operators to provide even greater signal levels to maintain a satisfactory service to their subscribers.

Other more recent developments have further driven consumers to seek out solutions for optional in-home cable network performance:

- The use of increasingly larger screens makes the snowy, grainy visual texture more readily apparent to the viewer. The root cause is typically a weak signal.
- Flat Panel TV's, and HDTV (a digital signal) have increased consumer expectations for a high quality picture, on all channels.
- Larger homes necessitate longer cable runs within the household, with the resultant signal deterioration caused by *attenuation*. Plus, many new & renovated homes are now being wired for service delivery in every room.
- Finally, cable telephone service (VoIP) has risen dramatically in recent years, putting further stress on the signal integrity.

In summary, there are a significant number of factors that are affecting the in-home cable network, which highlights the needs to have high quality signal available to all the attached devices in the home.

### -The House Amplifier: A Practical and Cost-Effective Solution

Compared to upgrading the entire network, installing a house amplifier is the most practical and cost-effective solution for operators providing services to homes with several devices.

Originally, the first house amplifiers were designed to simply boost the signal level without considering its quality. In effect, cable operators did not perceive these amplifiers as a real solution and did not generally apply them for home signal distribution.

When house amplifiers began incorporating gallium arsenide (GaAs) technology in 1993, their specialized design was perceived as a significant improvement and they became widely deployed. The key feature of this type of amplifier is in the 3 dB noise figure, which helps preserve and enhance signal quality. Typically, they are useful to boost signal levels in homes equipped with multiple devices. They are also useful to enhance

signal quality when a TV set exhibits a high noise figure (approximately 10 dB) or when a set-top box or a VCR with high insertion loss is installed between an amplifier and a TV set.

**-Feature**

Ideally, house amplifiers should exhibit a low (3dB) noise figure, a very flat 15 dB gain between 54 MHz and 1 GHz, an insignificant distortion contribution at output levels of up to 25dBmV, and a good (18 dB) return loss in the operating band.

SCTE compliant "F" connectors guarantee a good fit between male and female connectors, and minimize common *path distortion* problems. Weatherproof connectors and housing are necessary for outdoor installation.

**-Amplifier Operating Conditions:**

**1. Installations Areas**

House amplifiers may be installed at the demarcations point between the cable network and the subscriber home wiring, either outdoors or indoors, in the basement, or behind a TV set.

**2. Powering**

House amplifiers are generally powered from a wall adapter to the power input (PWR) port. When the amplifier is installed in places where an AC outlet is not available, a power inserter can be used for remote powering through one of the RF output ports.

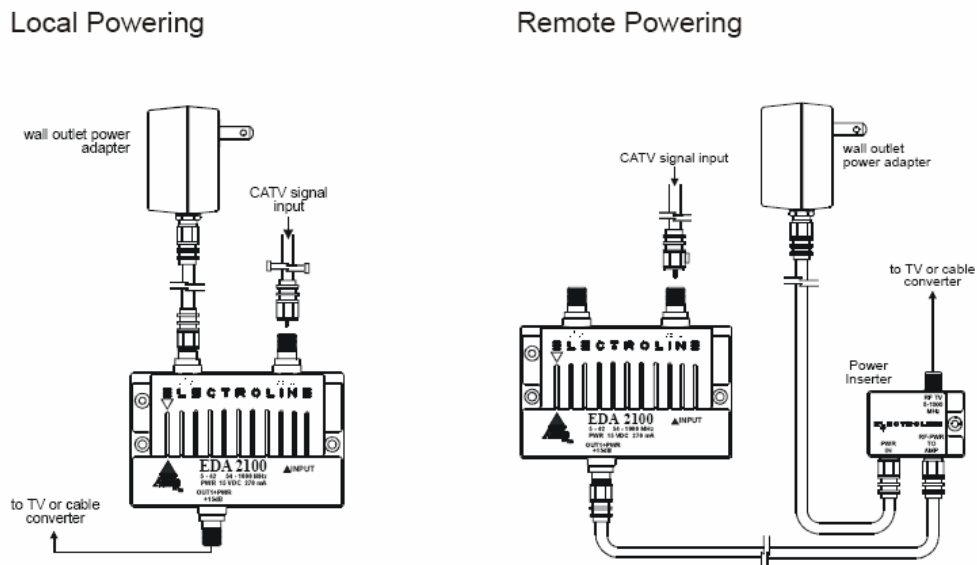


Image 1: A house amplifier with remote and local powering

The power inserter module must be well designed to prevent ingress or egress. This can be accomplished by having two compartments in the power inserter module for better isolation between the RF and power sections.

### 3. Led Power Status

Drop amplifiers should include an LED power supply indicator, which shows the amplifier's status of operation during a service call at a subscriber's home. An accidental disconnection of the wall adapter that is powering the amplifier may cause a failure in the cable service. If the amplifier is easily accessible to the subscriber, service calls may be avoided by asking the subscriber to check on the LED. Simple corrective measures can be taken to remedy the situation.

### 4. Different Levels in Downstream and Upstream Signals

Modern amplifiers must be able to transmit signal both *downstream* (the signal coming into the home) and *upstream* (the signal leaving the home from a cable modem or digital set-top box). This is commonly referred to as a *Bi-directional* capability.

The amplifier usually operates at the input with downstream signals between 0 and 10 dBmV and upstream signals as high as 55 dBmV (5 to 42 MHz). The upstream and downstream signal level differences, which are not found in distribution amplifiers, stem from the fact that house amplifier return path signals are much stronger than those in the downstream path. The ratio between the desired and undesired signals can easily reach 100 dB when assuming upstream signal levels of 50 dBmV and distortions in the downstream path below -50 dBmV. Only an amplifier carefully designed to meet very specific quality standards will be able to meet such performance criteria.

In addition, the internal splitter must be made using modern *Ferrite bead* technology, in order to ensure proper signal load dispersion and avoid saturation, which hampers upstream performance.

### 5. Electrical Discharges, RFI and Other Types of Protection

A house amplifier must also be resistant to electrical discharges and it must meet IEEE 6KV surge requirements for all ports including the power port.

A good protection circuitry includes non-shorting to ground in order to prevent damage when power is accidentally applied to any of the ports. The design should be good enough so that the energy released due to surges is not dissipated in the splitter circuits to avoid residual magnetization and increased distortion. The return filter should also retain its characteristics after experiencing a surge event. In addition to the 6KV surge protection, the input and output of the GaAs electronic component must be protected from fast voltage transients emanating from the TV set and elsewhere.

House amplifiers must have an RFI shielding factor of 100 dB to ensure that there will be no ingress from over-the-air signals and no egress from the amplifier. A tongue-and-groove approach to the cover closure is a good technique to achieve this high degree of shielding.

The power source entry point is most vulnerable and it must be well filtered to avoid ingress through this connector. The most effective method of meeting this electrical requirement is to include an internal compartment in the amplifier housing to isolate the power supply circuitry. An amplifier that has not been designed with a power-to-RF input isolation may pick up ingress from the wall adapter and inject it into the network.

Over-current protection is also a desirable feature. A PTC (Positive Temperature Coefficient) device inside the wall adapter will protect it from a short circuit emanating from the power cable side. Once the short-circuit is removed and the wall adapter has cooled down, it may be used again to power the amplifier. The PTC device prevents the wall adapter or the amplifier from being irreversibly damaged. Replacement units are thus not required each time a short-circuit occurs.

## 6. Manufacturing Considerations

In addition to being carefully designed for high performance and protection, house amplifiers must also be manufactured in a strict, well-controlled environment. Applying ISO-9000 procedures is a minimum requirement to obtain optimum and consistent product quality. There are several key factors to consider in the manufacturing of a reliable house amplifier:

1. Because GaAs components are extremely sensitive to ESD (Electrostatic Discharges) and to overheating during soldering, precise control processes must be applied; otherwise the finished product may suddenly fail at a later time. For instance, automated assemblies utilizing surface mount technology protect the electronic component's life against ESD.
2. Components must be soldered with the same automated process in order to eliminate inconsistent manual solder heat. ESD avoidance practices (following the EIA-625 standard) minimize human contact of material, such as using ESD protective gear and equipment to avoid direct contact with components.
3. Testing of individual components prior to their insertion to a finished product will improve overall quality.
4. A 100% testing policy before shipment.

### -Drop Amplifier Applications for Various Needs:

#### 1. Typical Installations

House amplifiers are usually available in 1-, 4-, and 8-port versions: The 1- and 4-port models are very common and are used in the most installations. The 8-port version has become more popular with the increase in the number of outlets in homes and in full-house wiring applications where each room is equipped for video, data, and telephone services.

#### 2. Return Path Amplification

High value multitaps, long cable drops, and multiple outlet splitters in the home can weaken the subscriber's return signal reaching the two-way network amplifier.

This feature, commonly referred to as *Active Return*, actually amplifies the upstream signal and restores it to the original strength that was generated by the modem and/or set-top box.

This ensures optimal modem performance. In addition, if the modem is directly connected to the amplifier (as opposed to being split off), then the other devices (TV's) will also benefit from the stronger net signal delivered in this configuration.

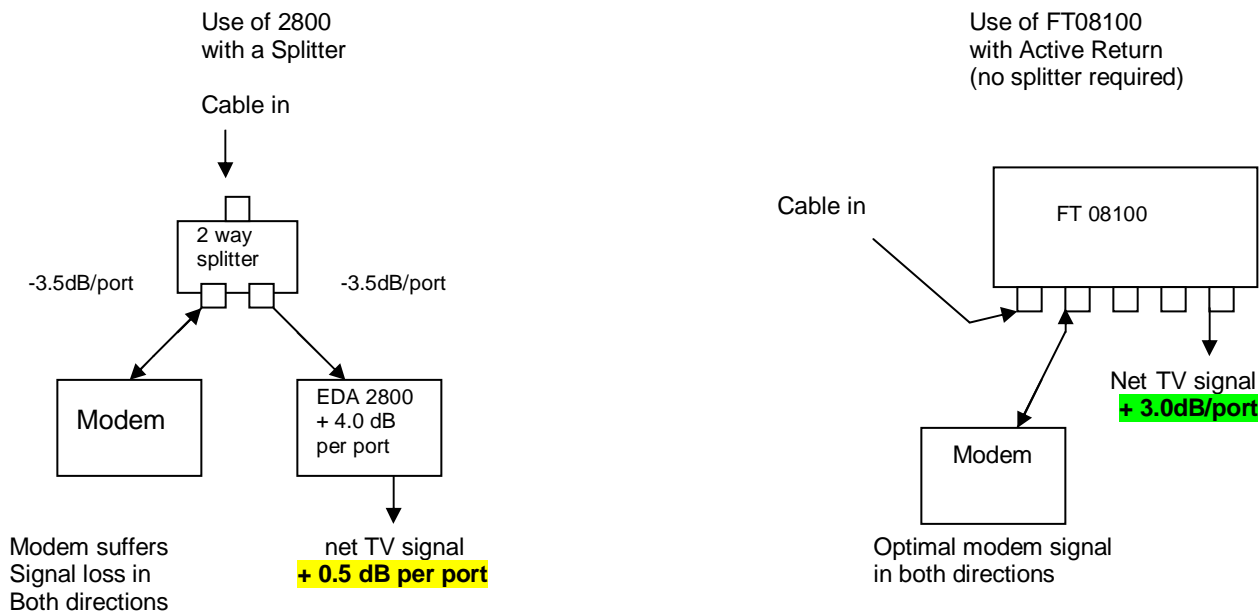


Image 2: Maximizing signal gain with a modem connection

For a subscriber connected to a 36 dB tap with a four-way splitter (7 dB) in the home, the attenuation of the subscriber's return signal is more than 43 dB. This loss results in a very low signal level at the distribution amplifier, making it non-optimal at the headend. The solution to this problem resides in the amplification of the return path signal in the subscriber's home. An amplifier with 10dB gain will generally suffice to counter losses in high value multitaps.

With three signals operating at 60 dBmV each in the return path, the distortion level in a return path amplifier should be -60 dBc in this path. Under the same operating conditions, downstream path distortions are less than -50 dBmV which is low enough not to interfere with television signals.

The use of return path amplifiers is limited to the few subscribers experiencing a significant loss in the upstream path. In certain cases, gain is only required in the return path. An amplifier offering gain in both directions is only required in very specific situations. Upstream amplification can increase ingress produced by home devices and by the subscriber wiring, therefore, return path amplification must be used with caution.

**3. Multiple-Output Amplifiers Offering Unity Gain or Active Lossless Splitters**

4- or 8-port amplifiers offering unity gain are useful in a network where the signal level has been optimally calculated to a specific value for various applications in the subscriber home. By using a multi-port unity gain amplifier, the signal reaching each terminal is equal to the signal that enters the subscriber's premises. Since this signal level is known, there is no need for calculations or adjustments to the signal levels at the time of installation. Thus, subsequent equipment installations are simpler and faster such as for cable modems and interactive set-top boxes.

**4. Cable Telephony Applications (VoIP)**

The house amplifier, which is normally powered from an outlet in the subscriber's home, may cause a problem when telephony is offered through the cable network. During power failures, the house amplifier is no longer powered and telephone service may be interrupted. In order to protect the telephone service, it is important to connect the telephone equipment before the house amplifier.

This requires the installation of a 7 or 8 dB directional coupler with the through-port connected to the telephone equipment side and the high loss tap on the house amplifier side. Thus, when a power failure occurs, the telephone equipment will continue working. The amplifier's very low noise figure allows signals as low as -5 dBmV to be applied to the amplifier without significantly degrading the carrier-to-noise ratio.

In the installation of a VoIP modem, either a directional coupler, or a 'Digital ready' 2-way splitter can be used.

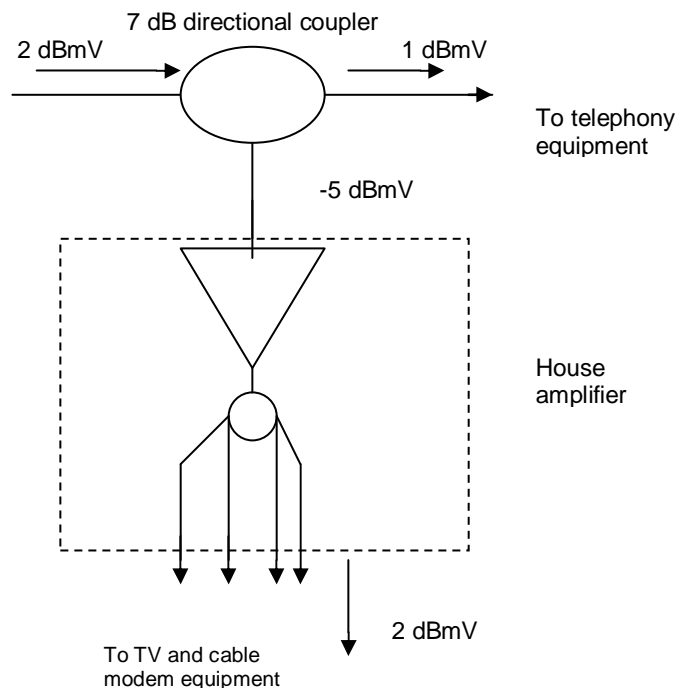


Image 3: A house amplifier by-pass configuration used to route signals during power outages.



**-Conclusion: Meeting the Requirements of Cable Operators and Subscribers**

With house amplifiers offering such great flexibility, cable operators are no longer required to modify their cable network design when subscribers add or change the equipment in their homes.

House amplifiers are now an integral part of cable networks and play a key role home signal distribution.

To find out more about the advantage of deploying house amplifiers in modem cable networks, you may contact:

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