WHITE PAPER

SignalOn® Series

D3.1/CCAP™ Compliant

1.2 GHz

Carrier-Class CATV Networks

Maintaining Signal Connectivity During Configuration Changes & Maintenance

SignalOn® Series

D3.1/CCAP™ Compliant

1.2 GHz

Carrier-Class CATV Networks Maintaining Signal Connectivity During Configuration Changes & Maintenance

Today's cable systems serve up more than just television. Because community antenna television (CATV) systems now incorporate high-speed data and telephony services, signal flow is critical for multiple systems operators (MSOs) and their customers. Signal levels and network configurations must evolve to meet the new service demands of transitioning headends. The impending challenge for MSOs is to effectively manage their networks amid change and maintain maximum uptime for subscribers.

Abstract

The efficient management of radio frequency (RF) signal splitting and combining has proven vital to the advancement of today's cable networks. CATV RF signal management has slowly evolved from a restrictive wall-mounted environment with limited access to cables and modules to a modular, rack-mounted hitless environment with built-in default attenuation values to ensure continuous signal transmission for subscribers. It has helped MSOs transition their networks to accommodate the new demands and requirements of high-speed data and telephony services.

Hitless technology allows operators to adjust signal levels to accommodate fluctuating take-rates easily without interrupting service. Hitless technology is the prevailing advancement driving continued success for MSOs in the telephony and high-speed data market.

Background

Early CATV systems consisted of television signals combined at the headend and delivered to subscribers via a coaxial cable network. Signals were transmitted from the headend to the subscriber and provided entertainment and information only—vital "lifeline" telephony or data services were not offered. The assurance of uninterrupted service was a distant priority. Repairs, replacements, and upgrades were performed at the convenience of the operator. System outages were common, and generally tolerated, if limited to short periods of time.

The inclusion of advanced services has forced MSOs to develop networks that can deliver uninterrupted service. CATV RF signal management breakthroughs have proven paramount in the evolution to nonintrusive networks.

Wall-Mounted Network

Initially CATV RF signal management consisted of fairly simple, low-tech modules serving as either splitters or combiners. These modules were usually attached to a plywood-covered wall using self-tapping screws in an arrangement similar to the network design diagram. This "wall-mounted" method (see Figure 1) was a widely used practice for splitting and combining signals in headend networks.

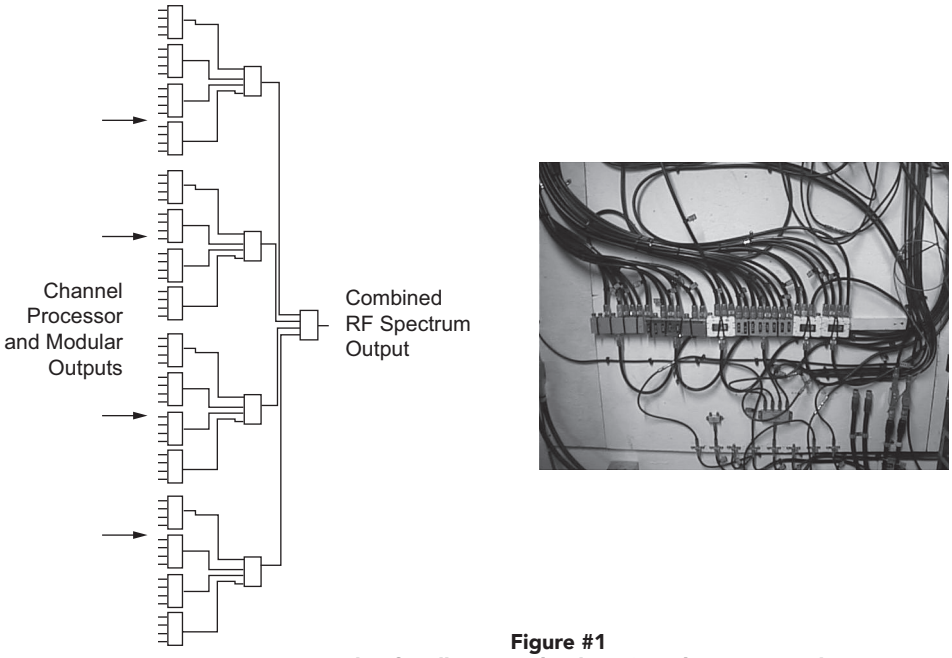

Figure #1
Example of Wall-mounted Splitter/Combiner Network

Individual programming channels processed by satellite receivers, RF channel modulators, or intermediate frequency (IF) channel processors fed the wall-mounted combiners with 6 MHz CATV RF channels. This culminated in a cable system with a RF spectrum consisting of 6 MHz channels occupying the electrical spectrum. The electrical "broadband" spectrum of these early systems operated in the frequency range between 54 MHz and 300 MHz.

Signal levels in a wall-mounted application were controlled using a couple of disparate methods. Usually, signal output levels were adjusted to full gain with in-line attenuators inserted into the coaxial path (see Figure 2). Signal levels could also be adjusted with the built-in controls at the RF modulator or IF processor.

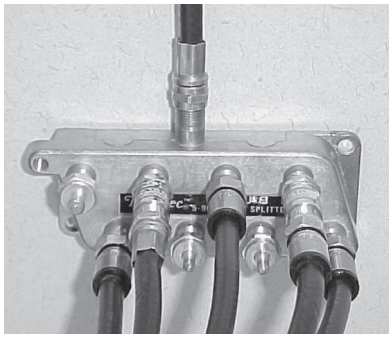

Figure #2
Wall-mounted Splitter/Combiner with In-line Attenuator Pads

Wall mounting enabled operators to install inexpensive, simple equipment to facilitate easy construction while enabling operators a view of the signal flow. The lack of flexibility, however, introduced a litany of disadvantages.

Restricted cable management made in-line attenuation difficult and time-consuming for technicians. Locating the corresponding cable; removing the connector by hand; and attenuating the signal level at a new value introduced a great deal of risk. Broken connectors, extensive cable disconnection, dropped pads, and the hassle of retermination made the wall-mounted method ineffective. Reconfiguration often left channels without service for minutes at a time. This dated solution proved inadequate for the burgeoning cable environment.

Rack-Mounted Networks

The infiltration of advanced services into networks quickly led to an influx of active electronics proliferating equipment racks. With even more electrical RF equipment mounted into racks, cabling concerns became paramount. Rack-mounted combining networks (see Figure 3) were designed to ease the sudden onslaught of cables. By maintaining all cabling within the rack lineup and allowing operators easy access to circuits, maintenance and rerouting procedures were greatly simplified—minimizing operational costs and ensuring system integrity. Despite its modest improvements over wall-mounted signal management, the rack-mounted network still had its share of drawbacks. Limited by its use of wall-mount type splitter/combiner modules, in-line attenuator pads, and space confinements within the rack, configurations and troubleshooting remained extremely difficult.

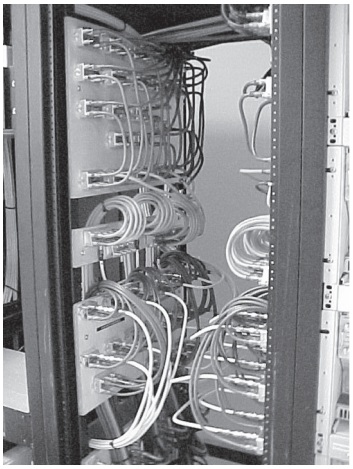

Figure #3
Rack-mounted Splitter/Combiner with In-line Attenuators

Modular Rack-Mounted Networks

As systems evolved, manufacturers of telecommunications equipment applied the same modular, rack-mounted, cable management techniques used in complex central office environments to revolutionize the cable industry. By the mid 1990s, rack mounting, modularity, rear cabling, and front access for attenuation had become the new standard for high-quality CATV RF signal management in advanced headends (see Figure 4).

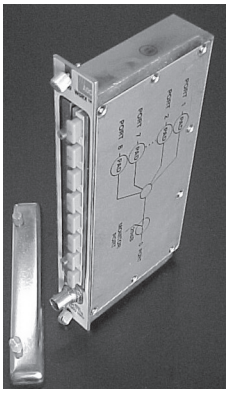

Figure #4
Applications of Modular Rack-mounted Splitting/Combining

All cabling was contained within the rack lineup, improving cable management functionality. Subsequently, circuit access and routing was performed more easily and quickly than ever before.

It minimized remounting and reduced the need for tools during maintenance. Front access to the attenuation pads further reduced circuit downtime during changes on traffic-carrying circuits from minutes to seconds. Connectors no longer had to be removed for signal level adjustment. The attenuation pads reduced the risk of broken equipment, while maintaining a more consistent attenuation value. Although this modularity provided drastic improvement, MSOs knew that any service interruption during signal level changes would not be tolerated and a new solution was necessary.

The Next Evolutionary Stage: Carrier Class

Advanced cable services now rival the traditional service offerings of the telecommunications industry.

In addition to television program delivery, CATV offers high-speed data and voice (telephony, dial tone) service. These advanced networks require highly-reliable and always-available network service.

However, as with any new service, networks must accommodate change. People join and leave the service provider; the network grows due to new residential construction; or an "upgraded" network must be upgraded once again to add subscriber bandwidth capacity. Network systems rarely stay in one configuration for any significant length of time.

One steadfast technology—used for decades in telecommunications—has been incorporated into today's cable networks to revolutionize the communications industry. Hitless technology ensures that service remains uninterrupted during maintenance or access operations. High-speed digital circuits (T-1/E-1 and T-3/E-3) have access points within the path of the circuit that can be used for testing, cross-connection, and interconnection. Circuit termination panels provide access jacks that are installed into the path of a high-speed digital circuit. These jacks accept patch cords that connect circuits and network elements to perform switching functions. Patch cords also enable test equipment to be hooked up directly to the circuit for monitoring purposes. When a patch plug attached to the end of the patch cord is inserted into the jack, signal flow is maintained until the patch plug breaks the flow and routes the signal to the intended destination.

Every maintenance task performed on an advanced communications network has the potential for service interruption. Many business operations rely on CATV high-speed data connections for their daily functions. Residential subscribers also use cable for the bulk of their communication, including emergencies. Service availability is critical.

Reconfiguration with Minimal Signal Interruption

Not all CATV maintenance is performed at the headend. Some maintenance resides at the outside distribution plant (OSP). Fiber and coaxial cable must be installed to connect new signal paths from the subscriber to the headend and to balance the CATV spectrum before subscribers are connected and service established. Upgrades to OSP systems involve maintenance on existing, service-carrying networks, but the proper technology can minimize downtime and maintain signal transmission.

Reconfiguration of existing low-bandwidth nodes and amplifiers with new broadband models introduces a brief service outage during the replacement process. This "node splitting" involves adding new nodes to deliver services to a given set of homes passed, reducing the number of homes serviced on each node. Node splitting establishes new fiber connections from the headend to the OSP by installing nodes in strategic OSP locations within the distribution area, rerouting the coaxial feeder cable to the new nodes, and balancing the spectrum.

To properly coordinate with the OSP network, headend systems must also undergo changes. New fiber distribution frames are added, along with new laser transmitters and return path receivers. The reconfiguration of the electrical RF splitting/combining networks, in both forward and return directions, is critical during this transition. Splitters and combiners must be added, removed, or changed. With a variety of configurations (1x8, 1x4, and 1x2) to choose from, operators should have little difficulty finding one to accommodate network requirements. Attenuation pads and equalizers should be mounted on the front of modules to allow easy access in rack-mounted environments (see Figure 5). Broadband spectrum signal levels change with every modification, requiring re-balancing during the system re-engineering project.

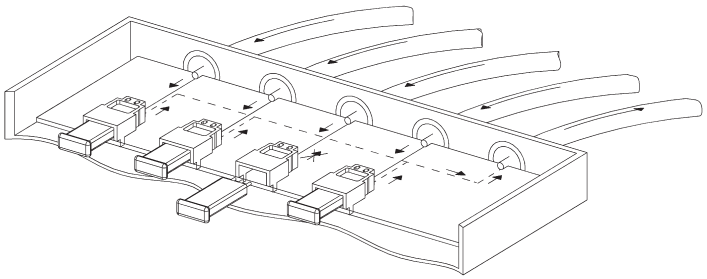

Figure #5
Sketch of Modular Combiner with Front-mounted Attenuation Pads

Maintaining proper CATV RF signal levels is crucial in the outside plant. By adjusting the output level at the node or amplifier, operators can control RF signal levels. Signal attenuation and equalization is applied using plug-in attenuators and equalizers located within the node or amplifier.

Integral attenuator pads and equalizers break the signal flow once the pad is removed from the socket. Hitless technology can minimize signal loss during attenuation and equalization (see Figure 6) by incorporating a default value built into the circuit board of the combiner. This allows a steady signal to reach its destination downstream.

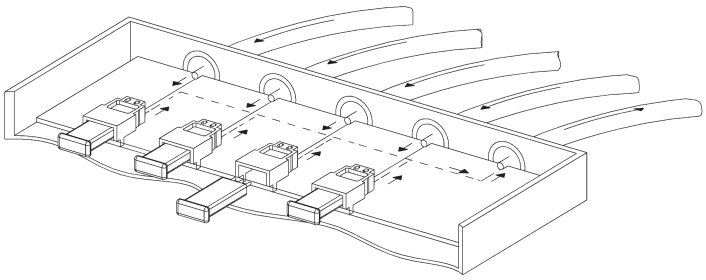

Figure #6
Sketch of Modular Combiner with Front-mounted Attenuation Pads and *Hitless* Attenuation Connection

Ensuring High Availability

Today's high-speed data and telephony subscribers demand always-on service without exception. While the telecommunications industry has long targeted 99.999% (five nines) service availability, CATV has traditionally been more 'relaxed' in its commitment to always-on availability. That attitude has changed. MSOs have become dedicated to reducing service downtime. They are incorporating new system maintenance and re-engineering practices that minimize service interruptions.

As new hitless technologies enter the cable marketplace, MSOs can now promise service continuity during periods of maintenance, upgrades, and general system re-engineering. Any device incorporating plug-in type attenuators such as splitters, combiners, nodes, and amplifiers will benefit from hitless technology. Grooming the CATV RF spectrum via plug-in attenuators and equalizers has revolutionized the cable industry. Signal levels can now be accurately maintained—resulting in uninterrupted service and satisfied subscribers.

Method	Average Service Disruption	Procedure	Risk
Wall-Mounted Network with In-Line Attenuation Pads	1-2 minutes	1. Identify appropriate cable. 2. Remove connector. 3. Remove attenuation pad. 4. Install new pad value. 5. Reassemble connector. 6. Test. 7. Repeat, if necessary.	• Technicians may damage or cross-thread connectors, requiring retermination of the cable assembly and significantly extended service disruption. • Technicians may drop or misplace the attenuation pad, resulting in extended service disruption.
Rack-Mounted Network with Front-Access Attenuation Pads	10-30 seconds	1. Identify appropriate cable. 2. Remove pad. 3. Insert new pad value. 4. Test. 5. Repeat, if necessary.	• Technicians may drop or misplace the attenuation pad, resulting in extended service disruption.
Rack-Mounted Network with Hitless Attenuation Pad Connection	None	1. Identify appropriate cable. 2. Remove pad. 3. Insert new pad value. 4. Test. 5. Repeat, if necessary	• None

This page left intentionally blank.

ISO
9001:15
REGISTERED

Rev. 01/20 (ANW0853)

ATX Networks
Tel: 289.204.7800 | Toll-Free: 866.YOUR.ATX (866.968.7289) | support@atx.com