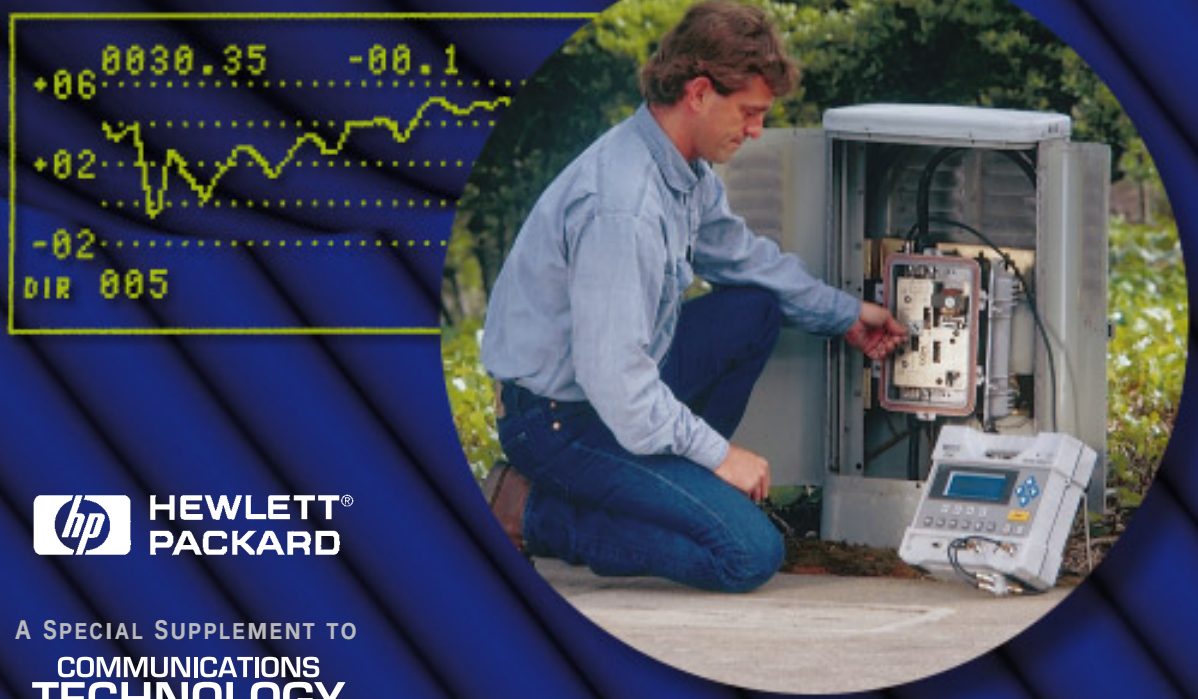
THE HP CALAN RELIABILITY SERIES

Are You Ready for Cable's Future?

PART 2: SWEEP AND INGRESS



HEWLETT® PACKARD

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INTERNATIONAL CABLE

Racing for Revenues on a Two-Way Street

SWEEP YOUR NETWORK AND STAY COMPETITIVE

A race for revenues is going on in the cable industry. Cross-competition among telecommunications providers has opened the door to high-speed data delivery and telephony opportunities over cable's two-way HFC networks.

There's a catch, however. Ingress in your system could turn your race for revenues into a long trip on a road to nowhere.

The fact is, cable operators must optimize their return paths before they can deliver these potentially lucrative new two-way services. Unfortunately, many operators are saddled with a plant that has difficulty carrying the bi-directional traffic of pay-per-view television—much less high-speed Internet access or life-line telephone service. The challenge, then, is to create a clean, robust and reliable system by locating, identifying and controlling the sources of ingress.

According to HP CaLan's Broadband Business Development Manager Syd Fluck, "Ingress can come from almost any source, from electrical equipment in the home to a ham radio transmitter. However, it tends to concentrate in the lower frequency bands and can be most detrimental in the 5 to 40 MHz band typically used for return path communication."

To minimize the potential for interference in your cable system, Fluck recommends a procedure known as "sweep balancing."

Most readers are familiar with the concept of sweep, but it is

Why Control Ingress?

As cable operators, you have a certain amount of control over your network. For example, you can train your technicians to be careful about putting taps in securely. Once coax has entered a house, however, you lose almost all control over how it is used. Customers can improperly terminate connections when adding a new TV set. Then, without realizing the effect they're having on the cable, they might run a popcorn popper or a power drill or some other device in the home, sending RF noise up the coax…

THE DAMAGING EFFECTS OF INGRESS

Ingress is RF noise in the cable system. It raises the noise floor, reducing the carrier-to-noise ratio over all affected parts of the system. In the forward path, ingress is more discrete. You typically see it on one or two channels. In the return path, the impact of ingress can be catastrophic. Excessive ingress can completely take out a telephone circuit running over the plant. Imagine the disastrous consequences if that circuit happened to be an emergency call for help.

Ingress will also adversely affect cable data services in a way that may not be readily apparent to the end user. Owing to the robustness of data services such as the Internet, any data impaired by ingress can be identified and retransmitted by the modems. The lost data would slow down the Internet connection. To the end user (or a technician, for that matter) this may appear to be the result of traffic on the Internet. Rather than getting a message that the communications channel is too noisy, the customer is left frustrated, waiting. That's not the best way to market cable's high-speed online access capabilities; it only fuels the public's misperception of cable's poor network reliability.

Most data communications schemes use some form of error correction so that if a little data is lost due to noise, it can be reconstructed. This is particularly important for digital signals, which try to squeeze as much information onto the carrier signal as possible. 64-QAM, currently proposed for carrying digital communications, has a much lower threshold for noise interference. A burst of RF noise can completely disrupt the signal, especially if it exceeds the duration of the forward error correction. It would take some time to re-establish the connection, and the consumer would see his or her TV black out.

LEARNING ABOUT DIGITAL

The simple truth is, these phenomena are as new to many cable technicians and engineers as they are to consumers. Adding digital

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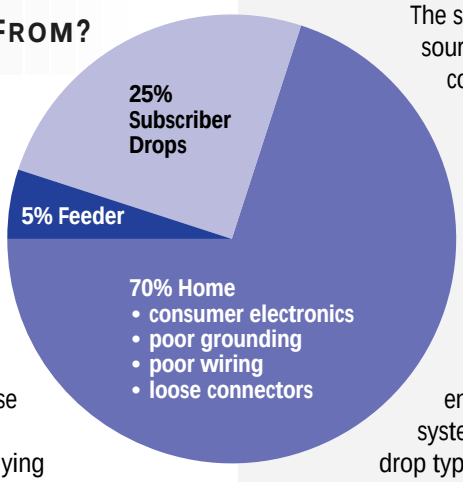
important to note that in optimizing a network for two-way communications, sweep is required for both the forward and the return path. Regularly sweeping your system can help locate the sources of potential problems, and allows you to take preemptive measures to correct them. Sweep balancing also puts amplifier gains and operating levels at optimum points to minimize the impact of interference.

Sweep your system, identify ingress and take proactive steps to minimize its effects. It's a small price to pay for greater two-way network reliability. Last year, revenues of local telephone companies outpaced cable by five times. If cable operators could capture one-fifth of this market alone, they could double their revenues! Add high speed data delivery to the two-way equation and you can see the cable industry is poised for great income potential—but only if your network is ready.

What about you? Are you poised to win the race for revenues, or on a road to nowhere? ■

Where Does Ingress Come From?



Sources of Ingress

What's the greatest source of ingress in your cable system? According to HP's Syd Fluck, it's the home. Some 70% of the induced noise on the average coaxial network comes from home-based sources—typically sources such as poorly shielded consumer electronics, loose connectors, faulty grounds and wiring problems in the home. The frequency of this noise is typically under 20 MHz and is generally worst between 5 and 15 MHz. Operators ought to avoid this range when deploying lifeline services such as telephony.

The second greatest source of ingress comes from the drop connecting the tap to the house, which generates about 25% of the problems in the average system. RF interference entering the cable system through the drop typically can be traced to installations utilizing poorly shielded cable or low quality connections.

The feeder is less susceptible to ingress because of the high quality materials used in its construction; it accounts for just 5% of ingress. However, the feeder also can suffer from another problem: common path distortion. This condition is caused when dissimilar metals—for example, oxidized connectors—come in contact with each other. Over time, diodes can form at that point of contact, rectifying the signal and mixing it with the return path signal. The problem can be made worse by the return path amplifiers. (Conversely, common path distortion is not generally a problem on the drop or in the house.) ■

services to your network can complicate the life of technicians who lack experience with digital technology.

Cable TV technicians are used to looking for problems such as gradual fading. The cable industry has had 48 years of experience in analyzing analog video signals for problems such as noise, distortion and ingress. On the other hand, when a customer calls in to say, "My modem is responding slowly," a technician may not undertand the reasons why.

There are many reasons for slow data delivery over a cable network. Often, the problem can be as simple as misalignment of amplifiers. This can be adjusted by sweeping the system and aligning each amplifier to its proper gain. Sometimes technicians do not understand the need to put exactly the same input level into each amplifier; that simple error alone can cause every amplifier thereafter to be misaligned.

Tom Staniec, director of network engineering for Time Warner's Excalibur Group, underscored the importance of using the return amplifier input as the technician's reference point. "If you use the output, you would have varying levels at each return amplifier input, which means you could never properly balance the network. If, on the other hand, input to the return amplifier is your point of reference, you can do the alignment while going forward from the node out to the end of the system, which saves an incredible amount of time, trouble and energy."

Proper alignment, coupled with good maintenance and a knowledge of the sources of ingress and how they are corrected, means higher network reliability. When a cable operator's technical staff learns that correcting ingress problems is an important part of overall system reliability, it will help reduce some of the fear of implementing two-way cable plants. ■

Identifying and Eliminating Ingress

The first step in eliminating ingress involves locating the source of the problem. One approach is to disconnect the return path coming into an amplifier, and then perform a return path sweep on that section. If ingress is still present in the network, then you know that it is coming from somewhere further up the network; if not, you'll know to check the other direction.

There are other approaches, of course:

- **Blinkers.** Blinkers attenuate the signal on the return path by 6-10 dB for a short period of time. With blinkers, you can locate the source of the problem by noting whether or not the ingress level drops.
- **Leakage detection equipment.** You can use leakage detection equipment to look for signal leakage from your cable system. However, signal levels in the drop are so low that leakage gear typically doesn't find a problem there.

A more efficient alternative to finding ingress is to use a sweep receiver. Even this approach has its problems: For some technicians, it means dealing with awkward pieces of extra gear that make the whole field testing process unnecessarily complicated (see the accompanying sidebar).

Fortunately, there is a device that makes this important procedure easier to manage. HP CaLan's new Sweep/Ingress Analyzer is not only ideal for forward and return path sweeping, but also is specifically designed for ingress trouble-shooting. It comes equipped with built-in ingress detection capability for quick analysis of ingress at any point in the system, and displays adjustment results to field technicians in real time.

HP CaLan's Sweep/Ingress Analyzer: The 3010R field unit (right) and 3010H headend unit (top)

When purchasing sweep gear, keep in mind that many such devices on the market will not work if the ingress is too severe. Consequently, the technician in the field may not know whether the problem is coming from the system or the test gear. The HP CaLan Sweep/Ingress Analyzer can detect ingress, and automatically informs the technician if a sweep measurement cannot be made due to excessive ingress.

CORRECTING THE PROBLEM

Because most ingress comes from the home, it is the best place to start eliminating it. A good first step is to install high pass filters at the tap of each home not subscribing to return path service. These filters guard the return path by blocking any interference from leaving the home via the cable system.

Eliminating homes from your network that do not use return path service obviously is a good way to reduce or eliminate return path problems. For example, you know that 70% of your problem is going to come out of the home. Say you also know that only 10% of your customers are using data modems or two-way services. By eliminating the other 90% of the homes from the return path, you've knocked that 70% down to only 7%. This lowers the chances of a return path problem. What's more, people using return path services typically have higher quality wiring in their homes, which will also reduce the impact of ingress in your system.

REGULARLY SWEEPING YOUR SYSTEM AND CONTROLLING INGRESS CAN OPTIMIZE YOUR NETWORK'S TWO-WAY PERFORMANCE.

The drop to the home is the second area that should be addressed when dealing with ingress. This can be done by installing quality connectors and using waterproof seals on them. In addition, when installing the drop, make sure that most of the tension is on the support messenger, as opposed to the cable connector. This ensures that connections remain intact.

If a number of houses in a cable network are contributing ingress to the system, the sum of all of this RF noise combines in a phenomenon called "noise funneling." This affects any signal going to the headend. If the signal is robust enough, it can pass through the noise without problems. However, with some of the more sophisticated modulation schemes in which more information is put onto the carrier (such as 64-QPSK), the signal is far more susceptible to noise.

If you haven't yet allocated new two-way services to your available bandwidth, careful planning can help minimize the effects of ingress. Ingress problems are most likely to develop in lower frequencies, such as the 5 to 10 MHz range. Therefore, lifeline telephone service, for example, ought to be located in a higher frequency range typically clear of ingress, such as the 20 to 40 MHz range.

On the other hand, if you've already made your allocations, regularly sweeping your system and controlling ingress can optimize your network's two-way performance, regardless of where your services are located. ■

The Tricky Part of the Sweep

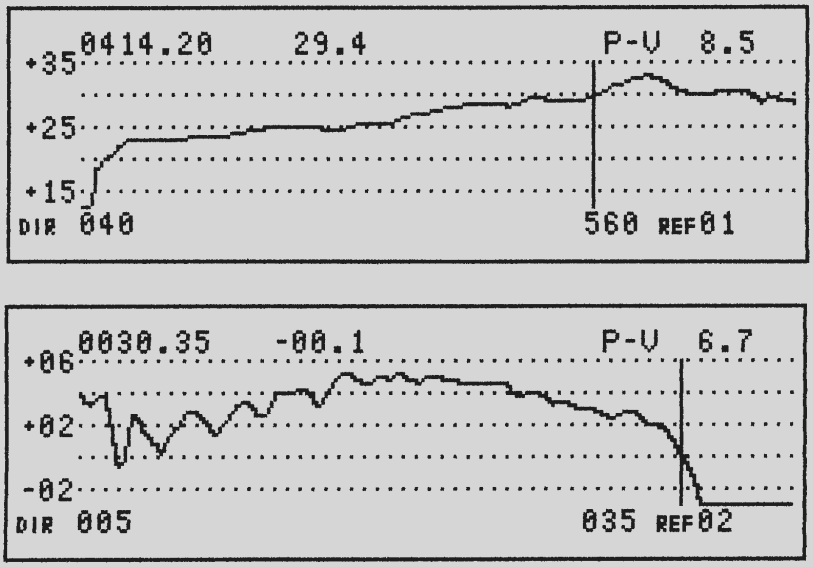
There's no disputing that ingress is the primary culprit affecting the reliability of your cable network's return path for two-way communications services. To be ready for cable's future, you have to minimize ingress in your system. That means adjustments based on field measurements. Unfortunately, that has not always been as easy as it sounds.

Even now, when cable technicians perform a return path sweep, they have to come up with inventive ways to see the effect of their adjustments from the field. One way is to use a spectrum analyzer in the headend that looks at the signals and ingress entering the system. This analyzer is monitored by connecting it to the input of a spare video channel. The technician then watches the results on a portable television set.

While this approach enables the technician to see the impact of his adjustments in real-time, it has distinct disadvantages. It requires a dedicated channel (which is not always available, or can adversely affect network capacity), and the technician must carry a cumbersome TV in the field.

A more efficient approach is to use HP CaLan's new Sweep/Ingress Analyzer. This solution consists of a portable field unit (3010R) and a rackmount headend unit (3010H). Combining the functions of a signal level meter, sweep transmitter and receiver in a single box, the 3010R can sweep a signal between 5 MHz and 1 GHz. The signal travels to the headend where it is analyzed by the 3010H. In turn, the analyzer generates a data stream to represent the sweep response, and sends it to the 3010R, where it is visually displayed for the technician. This data stream only takes up a narrow 100 kHz data channel, as opposed to the 6 MHz required to send down a video channel.

Using the HP CaLan Sweep/Ingress Analyzer makes the important task of identifying and controlling ingress much easier. ■



HP CaLan's Sweep/Ingress Analyzer provides displays of your forward (top) and return path.

Summary: Sweeping Your System

As previously noted, one of the best ways to look for problem areas in the network is to sweep a reference signal through a range of frequencies to determine how the signal looks throughout the network. Sweeping can help you find problems that may affect data carriers in fringe areas, and can help set the operating levels properly in each amplifier.

In most networks, sweeping traditionally has been done downstream—a forward sweep. A sweep transmitter sits in the headend and generates a standard signal, which technicians can analyze from various points in the field.

In a forward path sweep, the signal is sent in and around the visual carriers (the frequencies of interest). To prevent interference with the video, place your sweep points at the edge of each channel. The signal level at the first amplifier output then becomes the standard level for the rest of the amplifiers in your cascade. Then, sweep down the cascade to determine the signal level at the output of each successive amplifier. If you discover that any amplifier is out of range, simply adjust it to your established standard.

A HIGHER RELIABILITY SYSTEM, MADE POSSIBLE BY SWEEPING THE SYSTEM AND CONTROLLING INGRESS, CAN END UP REDUCING RESOURCE DEMANDS OVERALL.

SWEEPING THE RETURN

Just as forward sweep can help optimize downstream network performance, return path sweeping can help identify problems coming from the other direction. A reverse sweep is typically done in the 5 to 40 MHz range, which is a much smaller band than used for the forward sweep. In addition, the carriers on the return path are intermittent, or missing altogether; you need to be aware of where the carriers are and set your sweep up to avoid them.

On the return sweep, you adjust each return amplifier to provide a fixed input level to the next one, all the way up to the headend. The optimal levels required depend on the fiber transmitter going to the headend, but most are in the range of +20 dBmV input.

HP CaLan's Syd Fluck advises running the proper signal level through the network, and setting up and balancing all the amplifiers to accommodate this level, to maintain system quality. If, after the system is properly aligned in this way, your communication becomes unreliable, ingress is most likely your problem.

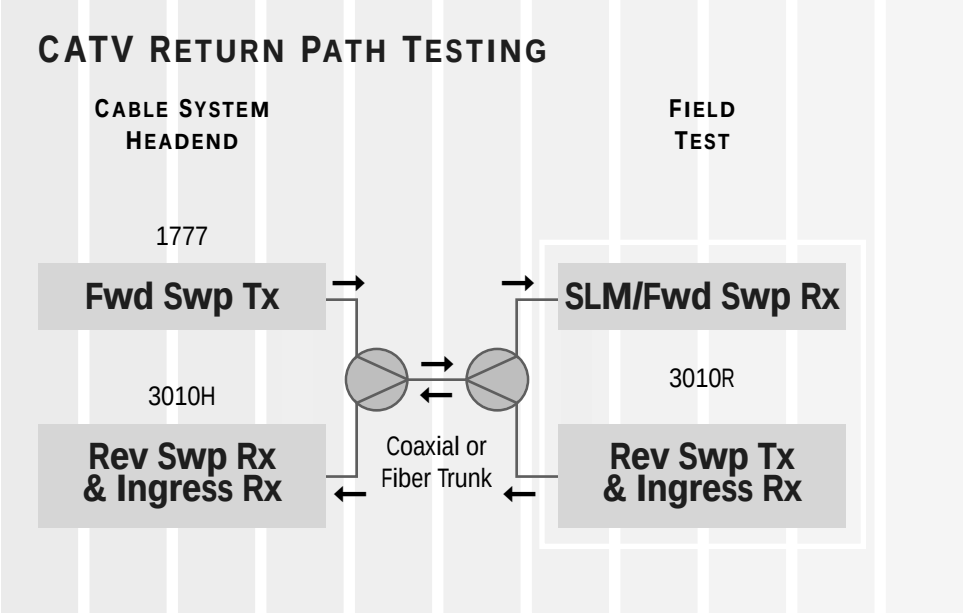
Most of the people conducting return sweeps use either a two- or four-carrier generator in the field that sends a signal to a monitor in the headend. Using multiple carriers in this way enables you to see both the ingress and the carriers at the same time. However, this approach has no frequency resolution, so poor frequency response in the system may not be detectable with a four-carrier generator.

Turning on a return path in a cable system is a much bigger management problem than just installing return amplifiers. There are many places for problems to manifest themselves in the return path. Some companies have discovered that they deploy three or four times as many resources in the field to maintain the return path as they do for the forward path. A higher reliability system, made possible by sweeping the system and controlling ingress, can end up reducing resource demands overall. ■

HP CaLan's Sweep/Ingress Analyzer at work in the field

Winning the Race

The race for two-way cable service revenues is much like any other competition: Proper conditioning is essential. An Olympic athlete must prepare to deliver his or her best performance before stepping onto the track. Likewise, you need to prepare your network for the rigorous demands of advanced telecommunications services—in this case, by minimizing the harmful effects of ingress. The HP CaLan Sweep/Ingress Analyzer is an essential tool to help you win the race.



Specifically designed to optimize cable plant's two-way communications capabilities, the HP CaLan Sweep/Ingress Analyzer adds return path testing and ingress detection capabilities to its current line of fast, accurate and dependable sweep gear.The new Sweep/Ingress Analyzer makes the job of forward and return path sweep testing easy for cable technicians everywhere.

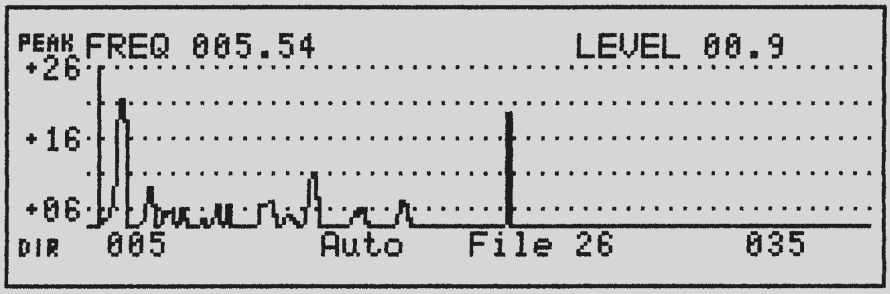
To conduct forward sweep, the HP CaLan 3010R receives sweep pulses from the HP CaLan 1777 sweep transmitter located at the headend. For return sweep, the HP CaLan 3010R injects a series of sweep pulses into the return amplifier, which are received by the HP CaLan 3010H, also located at the headend. The 3010H then sends its received sweep data on a forward data pilot to the 3010R in the field, which visually displays the result of the sweep (see the diagram above).

When ingress corrupts return path communication, the 3010H instantly senses the problem and transmits a "picture" of the ingress through the forward path. This image will be displayed on the 3010R in the field so the technician can begin troubleshooting immediately. (Other return path sweep testers available today simply stop working.)

The Sweep/Ingress Analyzer was designed with digital services in mind. It is compatible with cable modems, telephony, interactive TV, digital music services and Internet communications. The sweep pulses are only five microseconds in duration, compared to the several millisecond long pulses generated by most sweep transmitters. These narrow, fast pulses allow placement extremely close to the frequency location of any carriers, including data, without disruption.

And, like all other HP CaLan test equipment, the Sweep/Ingress Analyzer's instrumentation standards are directly traceable to the National Institute of Standards and Technology.

Don't run your race for revenues on a road to nowhere. Optimize your network for two-way communications by identifying and eliminating ingress. Use HP CaLan's Sweep/Ingress Analyzer, and get ready to win the race. ■



The HP CaLan 3010R displays a "picture" of ingress to your field technician.