

# BTR

BROADBAND TECHNOLOGY REPORT™

## BEST PRACTICES

# Fiber Node Troubleshooting

Making an optical signal convert into RF signals carried over coaxial cable is the “special sauce” that defines the Hybrid Fiber Coax network. But as the node grows more complex, so do the attendant challenges as operators push the bandwidth envelope to 1GHz — and even farther beyond. While the basic role — conversion — is still the main role of an optical node, troubleshooting the node needs to look past just the flashing red LEDs indicating a problem. Fortunately, there are tangible steps to take to find the heart of the issue.

In this installment of Best Practices, Tom Gorman, Founder and President of opXL, LLC, takes you through some key troubleshooting tips to make the fiber node — the key to the HFC system — back online, quickly.



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Installment 6:  
Fiber Node  
Troubleshooting



With Senior Adviser  
Tom Gorman  
President  
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# Fiber Node Troubleshooting

**T**HE FIBER NODE defines the Hybrid Fiber Coax (HFC) network. Its function is to convert optical signals carried over fiber optic cable into radio frequencies (voltages) carried over coaxial cables.

The history of the fiber node dates to the late 1980s. Cable operators discovered that by installing these devices, they could reduce long cascades of amplifiers and, at the same time, improve signal quality and network availability. Early on, one node fed 2000 homes in the HFC architecture. Nowadays, however, with fiber deep configurations, one node serves as few as 125 homes. Additionally, today's nodes allow operators to push the bandwidth envelope out to 1 GHz and beyond. By expanding the top end, they can support hundreds of new video channels as well as residential and business services for both voice and high speed Internet.

Of course this means that nodes are more complex than ever, with multiple forward and reverse transmitters and receivers. But the bottom line is that they still perform the same role--the conversion of optical-to-electrical signals in the downstream and electrical-to-optical in the upstream.

When the node isn't performing as it should, quality of service suffers. Flashing, RED, or dark state of indicator LEDs inside the node are a sure first sign the device is not in a normal state. In this installment of Best Practices, Tom Gorman, industry veteran, former SCTE Chairman, and founder/president of opXL, LLC., suggests a number of troubleshooting tips designed to bring the node back in line.

(Please note: For the purposes of this paper, it is assumed that the fiber itself is in good condition.)

### Step One. Provide Proper Power.

If the DC power supply to the node is not operating properly, it could cause hum, intermittence, or other signal problems. This power supply converts 60 V or 90 V AC to 24 V DC. The technician should make sure the switch that initiates this change is set correctly and that the output registers at 24 V DC.



*Make sure the power supply is providing 24 V DC*

### Step Two. Verify Input Optical Power.

Nodes have many access points for checking signal levels, setting up parameters, and testing. DC optical power test points enable monitoring of the optical power level of the receivers without service impacting disruption.

- Checking Signal Levels
- Setting Up Parameters
- Testing

Level testing, is done with a voltmeter. The optimum optical input to a node is 0dBm or 1 milliwatt (mW), and conveniently, 1 V equals 1 mW.

*Start here when verifying optical input power*

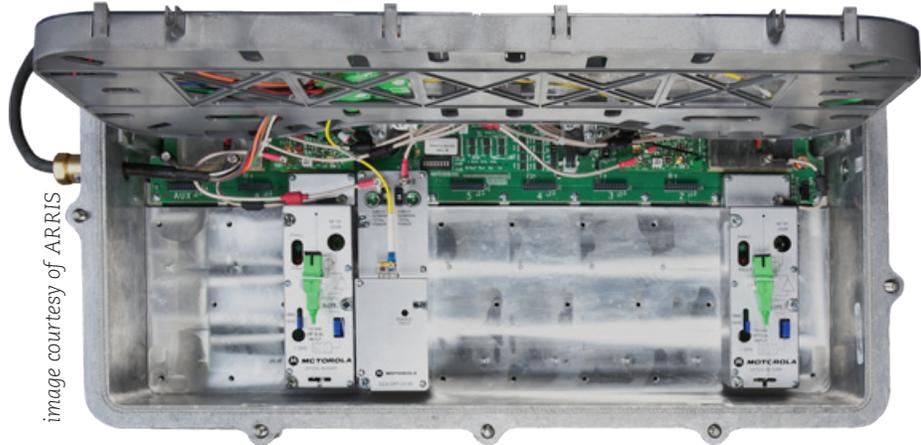
In modern nodes, a measurement of 2 V is enough to trigger a high optical power alarm. If this happens, the fix may be adding an optical attenuator. On the other hand, a measurement of 0.3 V (0.3 mW) or less will result in a low optical power alarm. This could be an indication there is a problem with the fiber or that a higher power laser is needed.

Neither is a certainty so ultimately, registering a high or low power level really means more troubleshooting. Changes in the headend, for example, may have caused the blip. The technician should correlate data to see if this is the case.

### Step Three. Ensure the Optical Receiver is Working Properly.

The optical receiver, within the node, demodulates signals from the optical fiber and feeds electrical RF levels to the amplifier stages. RF levels are supposed to be transmitted flat from the headend. The technician should access an RF test point with an RF meter to determine that they are still flat when they reach the node.

This is necessary so that the correct RF levels are available to feed the amplifier stages without creating additional noise or distortions. Always check the manufacturer's documentation for optical input power vs. expected RF output level, and recommended padding.



If the optical levels are correct, but the RF output level of the receiver is not within the proper range, the technician should check to make sure the proper

**IMPORTANT! Check to ensure the proper attenuator has been installed...**

attenuator has been installed. If this determined not to be the case, the optical receiver may be affecting the RF levels and might need to be replaced.

### **Step Four. Find and Fix Pinched or Kinked Fiber.**

If the fiber in the node isn't properly dressed and stored, kinking might occur when the housing is closed. It also is possible that someone previously opened the node and allowed a fiber to catch in the housing. A resultant micro bend can create anywhere from a few dB of loss to a complete outage.



*And easy troubleshooting step is finding and fixing kinked or pinched fiber*

### **Step Five. Check with the Headend.**

Problems in the headend could cause out-of-spec optical levels. It is here that the forward optical transmitters reside. They must be set up correctly in order to deliver a quality signal to the node. If operating properly, they transmit all signals at the same RF level. This is so the entire spectrum arrives at the node with a flat signal response. Determining what this RF level should be requires that a

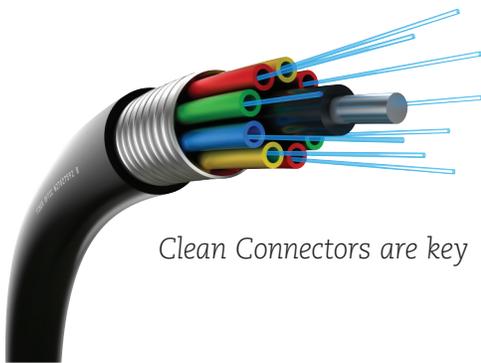
balance be struck. If it is too high, the laser transmitter will overdrive. Alternately, if it is too low, carrier-to-noise ratio will suffer.

To determine if signals are set up correctly, a spectrum analyzer is used at the headend test point. Together with a headend engineer, the technician can work to ensure only signals in pristine condition are sent to the node. It's also a good idea to check MER at the headend and compare at the node.



*Be sure to coordinate with your headend in case of out-of-spec optical levels*

### **Step Six. Remember: Clean Connectors Mean Clean Signals.**



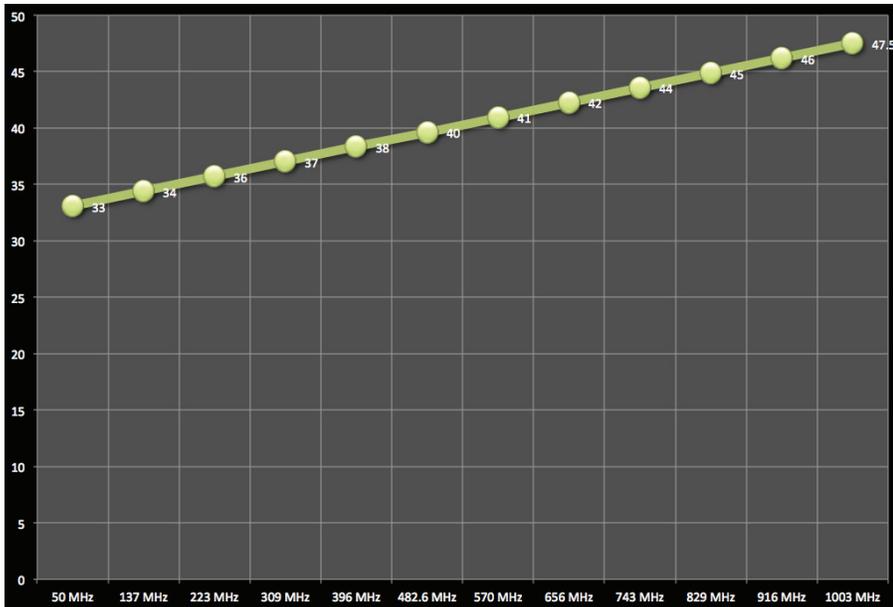
*Clean Connectors are key*

There are a number of locations along the fiber feeding the node that require mechanical connectors: the output port of the laser transmitter, the patch panel in the headend, the input port to the optical receiver and the output of the return transmitter in the node itself. The connector interfaces can become contaminated due to mating and unmating, testing, dust, moisture and vibrations. This results in poor performance. Since the center core of a strand of

fiber is only about 9 microns in diameter, even microscopic particles can reduce the connector's performance. A technician checks for contamination using a fiber scope, but only after the fiber is disconnected. It cannot be live while the test is occurring. If particles are discovered, the fiber should be cleaned using a company-approved cleaning kit. (If a fiber scope is not available and there is an optical problem, the technician should clean the fiber and recheck)

### **Step Seven. Establish the Slope.**

The slope is the frequency response of all signals amplified for transmission through the coax. Because attenuation causes higher frequencies to exhibit greater loss than lower frequencies, the slope must be set with the higher frequencies at a higher RF level than lower frequencies.



For 860 MHz networks, a typical slope is 12dB, for example, while a node operating at 1GHz, might have a slope of 14.5 dB. In this latter instance, the highest frequency is set at an RF level that is 14.5 dB higher than the lowest frequency. Ultimately, if both the slope and gain are set correctly, the node should provide a good signal to customers.

*The slope must be set with the higher frequencies at a higher RF level than lower frequencies*

### Step Eight. Verify the Upstream.

While in the downstream the node converts optical signals to electrical signals, in the upstream network, the opposite occurs. The electrical RF signals are converted to optical signals for transmission back to the headend. The signals carried here are from modems and telephony traffic, telemetry and set-top box communications. The technician should make sure RF transmit levels are correct and that the laser output is within spec.

Following these steps will help to ensure all light and RF levels are correct. As a result, the node will operate optimally and customers will receive the quality of service they expect.



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