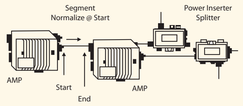
"Find & Fix" Guide Using DSAM

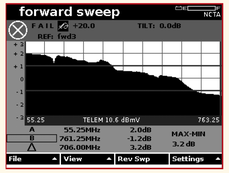
Sweep and Balancing: Still the Best Find & Fix Tool

- Analog or digital, the cable plant is one seamless HFC network. Defective network components that cause analog signals to fail also can impair digital signals. The best way to find these faults is to use normalized sweep.

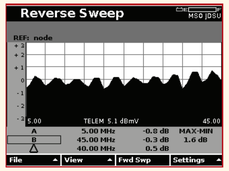
Key Sweep tips:

- Divide or segment the plant between actives by using normalization. Test each segment to plant specs. Normalization requires taking a sweep reference at the 'start side' of each segment.
- Sweep provides a non-invasive, in-service measurement for analog and digital signals. Sweep is compatible with all digital TV (DTV) and cable modem formats—use sweep and spectrum tools with QAM measurements to diagnose digital faults.



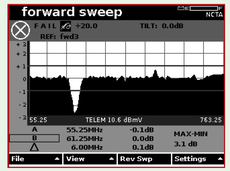


Bad Sweep Trace. Cause: amp is over-driven, or the tilt is bad. Too much amp gain can cause CTB/CSO-intermodulation. In the reverse path case, increased gain can cause the reverse optical node to clip. Setting gain too low can deteriorate C/N and MER.

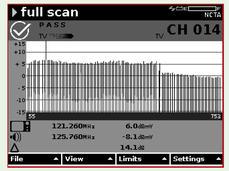


Finding Tap and Connector Problems

- Bad taps or connectors can cause a suck-out (notch) in frequency response. Suck-outs cause in-channel and/or adjacent channel impairments.
- Tip: Sweep (upper display) is the best tool for finding these faults. Sweep is used up to 1000 MHz. Full Scan mode (lower display) is fast, but may not show the real problem. Full Scan modes are limited to the channel plan.
- Tip: SDA meters also allow viewing of the in-channel spectrum.
- Causes:
  - Humidity problems
  - Bad connector mountings/housings
  - Small RF leaks to ground



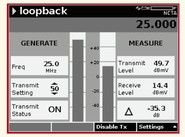
Bad Forward Sweep Trace with suck-out



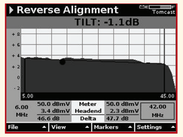
On Full Scan, suck-out is less visible

Optical Node Test and Reverse Measurements

- In cascade maintenance, the Reverse Path driver-amp laser must be aligned first. With a Loopback mode, the generated test signal is measured back through the driver-amp.
- After aligning the driver-amp, perform the reverse sweep and alignment for accurate balancing of the return path. The reverse alignment of the DSAM display shows the absolute reverse levels in dBmV/dBuV.
- Tip: Displaying the absolute levels lets you see the signal behavior of the cable modem signals during this setup and test.



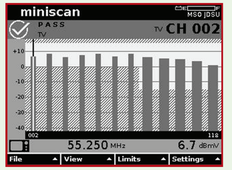
Local Sweep Loopback Mode

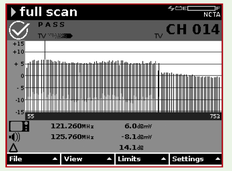


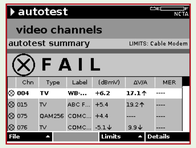
Reverse Alignment Sweep Trace

Level Problems

- Verifying proper power levels should be the first step to finding and fixing service issues. Using the Full Scan, Mini Scan, Level, and Autotest modes in comparison with the proper limit set makes finding level issues easy.
- Full Scan provides a fast, convenient method for viewing the entire frequency spectrum and providing a quick visual indicator of problems including roll-off, suck-outs, and standing waves.
- Mini Scan and Tilt quickly identify performance of critical channels and identify the presence of tilt problems.
- Autotest can provide a complete battery of tests on all of the channels and can identify issues such as poor MER, BER, C/N, Hum, and adjacent channel issues as well as DOCSIS upstream level issues.

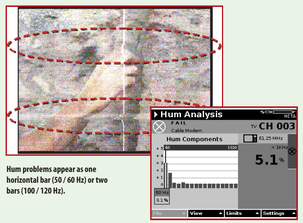






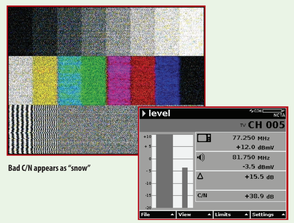
Hum and Carrier-to-Noise Problems

- Causes of Hum problems:
  - Bad power supplies in amplifiers
  - Earth loops on coax cables
  - Bad ground blocks
  - Bad connection to ground
  - Earth loops in headend, interfering with the TV modulators



Hum problems appear as one horizontal bar (50 / 60 Hz) or two bars (100 / 120 Hz).

- Causes of C/N problems:
  - TV-carrier levels too low
  - Insufficient amplifier gain
  - Raised noise floor
- Tools to find and fix C/N problems:
  - Use Sweep-mode to find gain/loss problems
  - Use Full Scan, Mini Scan, and/or Level mode to find individual level problems
  - Use Spectrum view to see elevated noise impairments



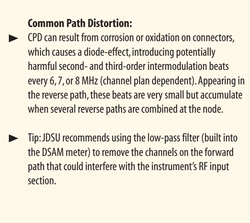
Bad C/N appears as "snow"

New Problems on the Reverse Path

- To quickly find and fix ingress problems, the JDSU Fieldview Interoperation tool is vital. It can perform two ingress spectrum measurements simultaneously, one at the headend or hub-site, and one in the field. Both spectrum traces are then compared in real time on the SDA meter display.

Advantages of JDSU Interoperation:

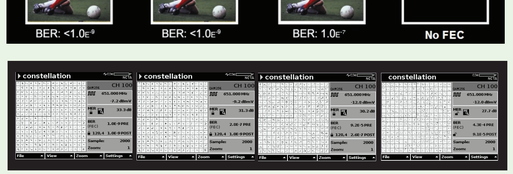
- Avoid self-inflicted errors
- Easily and quickly find faults by seeing in which direction to diagnose to/from the headend
- Isolate the cause of Common Path Distortion (CPD), which is a mechanical problem that requires real-time feedback to measure spectra in the hub-site
- Quickly commission and confirm repaired faults. One person can determine if the repair efforts resolved the problem



Common Path Distortion:

- CPD can result from corrosion or oxidation on connectors, which causes a diode-effect, introducing potentially harmful second- and third-order intermodulation beats every 6, 7, or 8 MHz (channel plan dependent). Appearing in the reverse path, these beats are very small but accumulate when several reverse paths are combined at the node.
- Tip: JDSU recommends using the low-pass filter (built into the DSAM meter) to remove the channels on the forward path that could interfere with the instrument's RF input section.

C/N vs. BER vs. MER



Analog signals degrade linearly with signal impairments.

Digital video channels stay clear until FEC can no longer compensate for signal impairments.

As MER degrades below its modulation threshold, the receiving device can no longer properly distinguish the data contents of the signal, which causes the channel to breakdown.

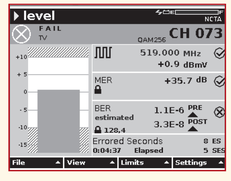
Digital Quality Testing

Modulation Error Ratio

- The modulation error ratio (MER) is a measure of the signal-to-noise ratio (SNR) in a digitally modulated signal and can show consistent issues, such as a raised noise floor or a constant ingress spike. If MER is low, check the signal level to see whether it has dropped too low and make sure there is not increased noise problem.

Bit Error Rate

- Bit error rate (BER) can occur from noise on the system, ingress, or service capacity issues and can show quick or intermittent issues. BER occurs when a binary 1 is mistaken for a binary 0 and vice versa.



Level Mode shows MER, Pre/Post FEC BER, and digital average power level of that QAM carrier

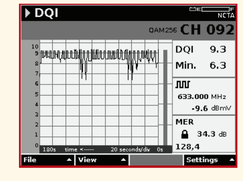
Digital Quality Index

- Digital Quality Index (DQI) is a simple indicator of the overall quality of a QAM digital stream. DQI is a statistical measure of the signal impairments that can cause uncorrected bit errors, resulting in video tiling and data packet loss, but it also detects impairments that have not yet caused any errors, including pre-BER errors.

DQI:

- Responds faster than BER on intermittent impairments
- Responds more sensitively to impairments that are too small or quick to cause bit errors or degradation of MER
- Easily interpreting results makes it easier for technicians with less training or experience to use and is less confusing than BER measurements

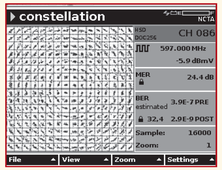
- TIP: Watch for momentary drops in quality to detect sporadic ingress.



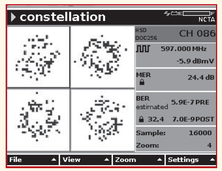
DQI makes troubleshooting intermittent QAM issues easier by simplifying results while at the same time increasing the sample rate of the QAM symbols.

Constellation Displays: Headend or Field Fault?

- Constellation is an ideal tool to find QAM modulator problems. Distinguishable shapes/patterns of the constellation reveal modulator issues in the headend versus faults such as ingress, CTB, CSO, and other interferences in the field.
- Tip: Constellation displays show noise or ingress, typically only when interference is very severe. However, micro-reflection faults are invisible. Use the SDA Stealth Ingress and EQ modes to diagnose and find ingress, noise, and micro-reflection problems.
- Typical errors originating from the headend:
  - Phase Noise: The constellation appears to rotate at the extremes while the middle dots remain centered in the decision boundaries. Such phase noise is caused by headend converters.
  - Coherent Interference: Pixels appear donut-shaped with the dots clustered surrounding the middle boundary area but none in the middle of the cluster. Usually caused by ingress and CSO/CTB harmonics.
  - Gain Compression: The outer dots on the constellation are pulled into the center while the middle dots remain centered in the decision boundaries. Gain Compression is caused by bad filters, IF equalizers, converters, and amplifiers.
  - IQ Imbalance: The constellation is taller than it is wide, which is a difference between the gain of the I and Q channels. IQ imbalance is caused by baseband amplifiers, filters, or the digital modulator.
  - Carrier Leakage.



Constellation with phase noise

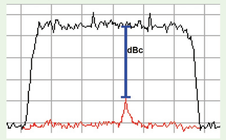


Constellation with coherent interference

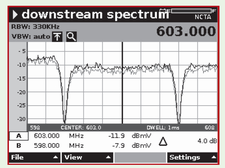
Ingress under the Carrier

- The QAM Ingress test allows the user to view what is going on under a live QAM channel. Technicians can see anomalies causing digital video impairments (MER or BER) that are invisible with a spectrum analyzer.

Measuring the power under the carrier (dBc) shows the powerful effects of the impairment within the QAM.



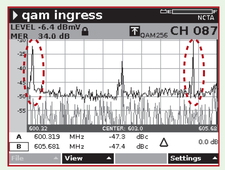
Black is QAM Channel
Red is Noise below QAM
Blue is difference between QAM carrier and ingress under the carrier (dBc)



Looking at the QAM Haystack does not reveal impairments hiding below.

QAM ingress shows anomalies under digital haystack, such as:

- Off-air carrier leakage
- Raised noise spikes
- Misplaced sweep points
- Composite interference, such as:
  - *CSO and CTB*
  - *Other harmonic events*

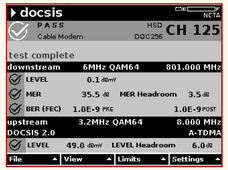


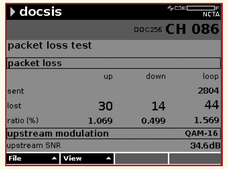
Shown are two misplaced sweep points causing the QAM channel to incur slight BER problems degrading the quality of the channel.

In-Service DOCSIS® Troubleshooting

- Running a DOCSIS test helps ensure subscriber high-speed data (HSD) services are running properly. Acceptable downstream and upstream levels are important as are good downstream MER and BER. Marginal connections to the network are unacceptable. The slightest change in network configuration can potentially disconnect subscribers from their HSD services.

Perform DOCSIS IP tests to check for packet loss and throughput at the subscriber's home. Many times excessive ingress causes high packet loss as well as low throughput speeds. Other issues can also cause HSD issues, such as frequency response, group delay, and standing waves on the network.





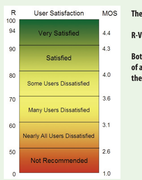
In-Service VoIP Troubleshooting

- Voice over Internet Protocol (VoIP) is very similar to HSD testing but requires a different set of IP tests.

Physical testing of the QAM carrier(s) should show digital level, MER, and BER within corporate specifications in order to operate effectively.

The IP tests performed on VoIP typically include delay, packet loss, and jitter. Where bad jitter and delay are usually associated with network congestion and routing problems, packet loss can usually be attributed to ingress in either the forward path, or more commonly the return path.

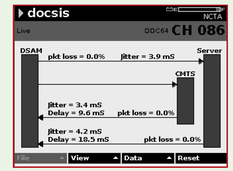
The quality of a call can be summarized using either the Mean Opinion Score (MOS) or R-Value. Both of these measurements consider the amount of delay, packet loss, and jitter on a call. The higher the delay, packet loss, and jitter the lower the quality of the call.



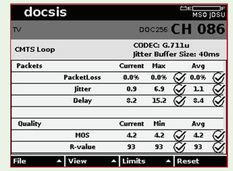
The MOS scale ranges from 1 to 5, with 5 being the best.

R-Value scale ranges from 0 to 100, with 100 being the best.

Both MOS and R-Value scale ranges measure the overall performance of a VoIP telephone call. This chart gives an approximate score to the subscriber's opinion of call quality.



VoIPCheck™ will identify and help segment call quality issues between the EMTA and the CMTS.



VoIPCheck™ verifies VoIP service over the DOCSIS communication connection

To learn more, visit www.jdsu.com/HFC

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