Detecting QAM Signal Leakage with the DSAM QAM Egress Option

Cellular providers use licensed on-air radio frequencies in the UHF band, and cable providers carry signals in this frequency range on their closed networks. Cellular provider services in this range, called LTE for Long Term Evolution, are widely deployed for use by smartphones for data transmission. Cable providers occasionally receive complaints from cellular providers of interference to LTE services caused by signals leaking from the cable network, and cable customers have experienced service-quality issues due to interference from LTE signal ingress.

Cable providers have established methods for monitoring leakage and for detection and measurement by field personnel. These methods have traditionally focused on the aeronautical band in order to meet the most stringent leakage test requirements put forth in government regulations. Cable industry tests have shown that leaks can be frequency specific, and that a leak in the UHF band can have much lower field strength in the aeronautical band. It is logical that monitoring for leakage in the UHF band will help to mitigate LTE service interference issues. Also, where there are leaks in the UHF band, there is the potential for interference with cable provided services.

Cable industry leakage test and monitoring equipment manufacturers are now providing systems that operate in the UHF band to enable detection and troubleshooting in this range. Most of this equipment is designed specifically for leakage testing, and only for that purpose.

Cable field personnel use the JDSU DSAM Digital Service Analysis Meter to perform preventive maintenance, to verify signal quality, and to troubleshoot network problems. The DSAM offers a QAM Egress option that lets a technician detect and locate QAM signal egress (leakage) from the cable network. Key features of this test mode are optimized preset spectrum settings, automated detection of QAM signals present in the air, and clear visual and audible confirmation of the presence of QAM egress.

QAM Egress Use Cases

Outside Plant

Leakage monitoring — this case is the continuous monitoring for leaks as a technician or designated person drives in a methodical pattern to detect leaks from the cable network. This method can be highly automated and use GPS to pinpoint leak locations on a map. These systems can also create and forward work orders to leakage or maintenance technicians for repair. Leakage monitoring is not the primary function of the DSAM QAM Egress mode, but it does find and fix leaks in response to work orders created by the monitoring system.

Find and fix — this case assumes the technician receives a work order or knows of a leak at a certain location. As leaks are frequency specific, ideally the monitoring system would be logging leaks in the UHF band in order for the DSAM QAM Egress mode to be successful in locating it for repair. The technician uses the directional antenna and the QAM Egress mode (tuned to a relatively clean on-air spectrum location) to scan the suspected location of the leak along the cable and associated components. When the DSAM detects a QAM signature on-air with the directional antenna, its channel identification bars turn red and it emits a beep with every scan that has a detectable QAM signature. The technician watches the display while moving the antenna in the direction of the detected signal, and when the QAM haystacks are peaked, the antenna is pointing in the direction of the strongest source.

Repair/service verification — in this proactive case, the technician verifies that any service work done is leak free. The technician passes the near-field probe over a device and/or connections and watches the DSAM QAM Egress display for red channel bars. If the DSAM detects a QAM signature, its channel bars turn red and it emits a beep with every scan that includes the detected QAM signature. The technician watches the display while moving the near-field probe over a device or connections, and the signal peak indicates the location of the highest received field strength (leak location).

Inside Plant

Leak scan — in this case, the technician has detected ingress either through the ingress scan test at the tap or ground block, or through QAM ingress analysis of channels at LTE frequencies in the home. The technician moves through the home with the directional antenna, scanning in all directions. When the DSAM detects a QAM signal, the channel identification bars turn red. The technician watches the display and the scan peaks when the directional antenna points in the direction of the leak. When in close proximity to the leak, the technician can change to the near-field antenna for close-in inspection. After fixing the leak, the technician passes the near-field probe over the repaired components to ensure no QAM signals remain.

Using QAM Egress Test Mode

A technician uses the DSAM QAM Egress test when responding to a known leak, which may have been discovered using the leakage monitoring system, or when investigating a suspected leak location. In either case, the technician connects a directional antenna to port 1 on the DSAM and enters the test mode. The technician accesses the QAM Egress test mode by pressing the Measure key, scrolling to QAM Egress on the Spectrum tab, and pressing Enter. When the mode starts, with no QAM signal detected, the display will scan and show the spectrum with blue vertical bars to indicate QAM channel bands in the currently active DSAM channel plan (see Figure 1).

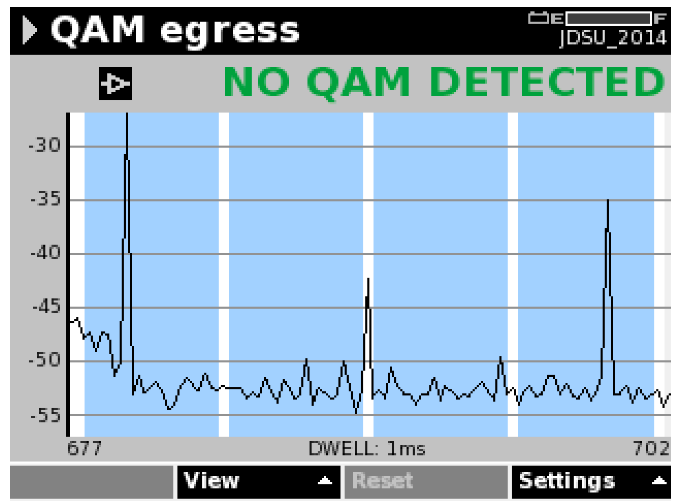

Figure 1. QAM Egress mode with no QAM signals detected

With the meter scanning the test frequency range, the technician slowly waves the antenna, pointing in the direction of possible leak locations. When the DSAM detects a QAM signal or signals, the channel band bars turn red as shown in Figure 2.

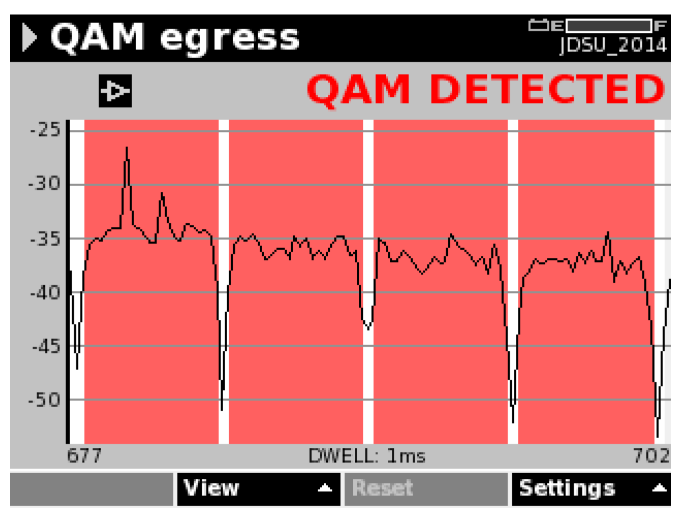

Figure 2. QAM Egress mode with QAM signals detected

As the antenna sweeps the direction of the leak, the detected signals will peak when the antenna points directly at the leak. The technician then moves closer and continues this process until the leak location is obvious. In some cases, it may be helpful to use the near-field probe antenna to identify further the exact source of the leak. The technician connects the near-field probe antenna and, with the meter in the egress detect mode, waves the probe over the cable or network component to find the point at which the signal peaks on the egress detect scan.

Another use case is for the technician to test the location of a repair or service to ensure that no inadvertent leak has been created. With the DSAM in the egress detect mode, the technician can pass the near-field probe over and around a serviced network component to ensure that no QAM signals are leaking.

Tuning Recommendation

The QAM Egress mode is scanning a 25 MHz portion of on-air spectrum to detect low-level QAM signal leakage from the cable network. It is a good practice to tune the mode to a relatively clean spectrum area. This enables detecting QAM signals with optimal sensitivity and a clear view of these signals at the lowest level possible. Because one of the primary motivators for testing in the UHF band is the potential interference with/from LTE signals, it may seem logical to test at LTE signal frequencies. This is not the best technique, because the LTE signals will overpower lower-level QAM signals. A better choice is to tune the center frequency so that it is out of the LTE band but is still relatively close. This applies to other on-air signals as well. A clean spectrum area is the best place to start with a QAM Egress test.

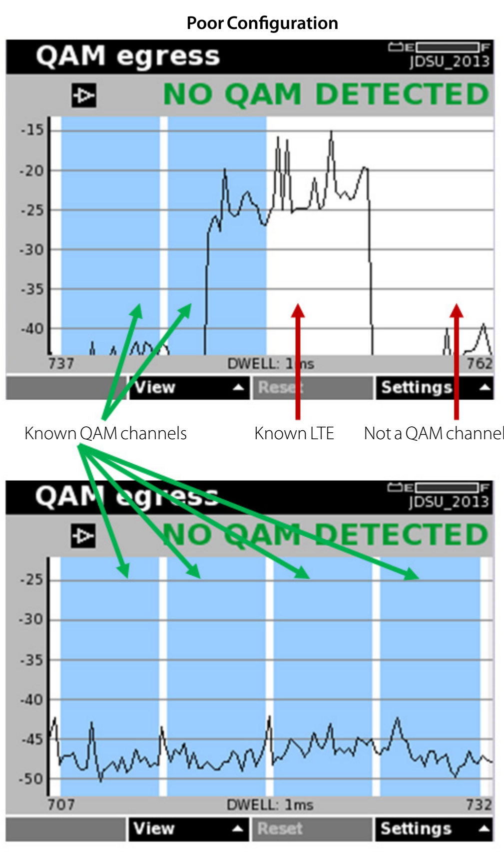

Figure 3. Choosing a test frequency

Figure 4. DSAM Digital Service Analysis Meter

Figure 5. Directional antenna

Figure 6. Near-field probe antenna

Measurement Units

This option empowers any technician to find and fix QAM leaks. A leakage monitoring system may have identified a leak or the technician may be proactively searching for potential leaks while on a job. In all cases, the instrument must be able to detect and locate QAMs leaking out. For this application, measurement readings in dBmV are adequate since the detection of any QAM indicates the presence of a leak. Since this functionality is primarily for tracking down the source of egressing QAM signals rather than for legal reporting purposes, the field strength conversion to µV/m or dBµV/m is less crucial.

Converting from dBmV to µV/m or dBµV/m requires considering a number of variables, including antenna impedance, antenna gain (which varies over frequency), effective area, and the received voltage at the antenna terminals. Converting becomes more complex as the instrument tunable frequency range increases. Typically, leakage meters that read in µV/m or dBµV/m are hard-tuned to a very specific set of frequencies (proprietary tagged signals injected in the headend) and are using a specifically designed frequency-tuned antenna. The DSAM QAM Egress mode is tunable from 100 MHz to 900 MHz, and uses a broadband antenna to detect QAM signal leakage through a wide frequency range. Combined with algorithmic QAM signature detection, this means that the DSAM can measure multiple adjacent QAMs simultaneously without the need to inject anything at the headend. The QAM Egress mode on the DSAM also allows the use of third-party antennas. Key factors affecting µV/m or dBµV/m measurement units for this test include the flexible antenna choices, the DSAM's agile tuning, and the antenna gain changes over frequency that cause the field strength reading in µV/m or dBµV/m to also change over frequency for specific dBmV level readings. This variable combination makes converting to µV/m or dBµV/m from dBmV impractical.

Now, operators can expand their capacity to mitigate interfering egress and ingress with valuable features only the DSAM can provide like lower-cost, frequency tunable detection, and antenna flexibility—and it requires no additional headend signal-injection equipment.

QAM Ingress Troubleshooting

The DSAM QAM Egress option enables any technician with a DSAM and the proper antennas to locate and troubleshoot QAM signal egress. It is not intended for government-regulated leakage monitoring or CLI, but rather as a complementary tool to mitigate cable signal interference with licensed off-air services such as LTE. Conversely, any instance of signal egress is also an opportunity for signal ingress that can interfere with cable-provided services.

The DSAM locates and troubleshoots this ingress, especially using the QAM Ingress option that displays the channel spectrum with the QAM haystack removed as shown in Figure 7. The combination of these two features gives the technician a powerful toolset for managing signal egress/ingress in the UHF band.

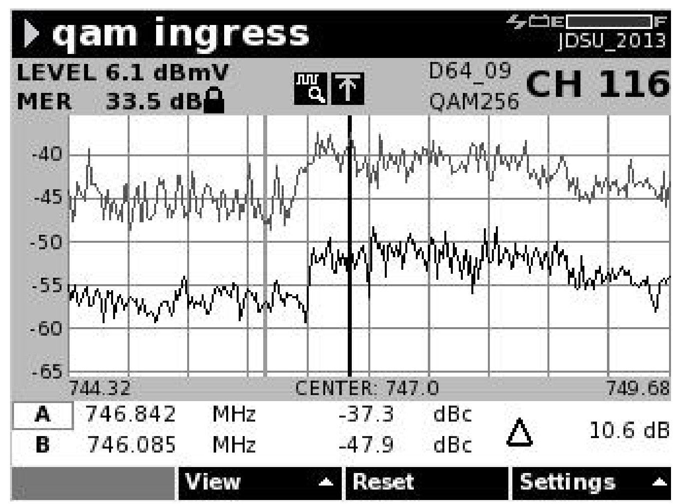

Figure 7. An LTE carrier interfering with a cable video QAM in the DSAM's QAM Ingress mode

For more information about the DSAM, QAM Egress, and other features, please visit http://www.jdsu.com/go/dsam.

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