

# DQM and RDMS™ Troubleshooting

## What is the Data Quality Metric?

**The Data Quality Metric (DQM) is an accurate reflection of received signal quality.** Everybody knows that the output from a telemetry receiver is a stream of bits – 1's and 0's. On the surface, the results could not be any more definitive. What you may not have thought about is that, when a receiver processes an incoming signal, it is taking ambiguous analog waveforms and declaring definitive answers. Stated another way, receivers literally have inside information about how certain – or uncertain – they are of each bit of their output. This is the foundation of the DQM; and as it turns out, it is exceptionally powerful.

**DQM expresses an estimate of the bit error probability.** For each bit, the receiver can estimate the probability that it is the wrong bit – an error. This can then be averaged across a block of bits to get an average estimated bit error probability (BEP), which will range from 50% (the receiver has no idea if the bits are right or wrong) to  $10^{-12}$  (maybe one in a trillion bits is wrong) or even smaller. DQM simply encodes this BEP in a form directly and optimally usable by best source selectors.

**DQM can be observed on the receiver and can be recorded by the Status Logger.** Quasonix RDMS™ displays a streamlined version of DQM known simply as “Q,” which is the exponent of the BEP. For example, if you have an estimated BEP of  $10^{-5.3}$ , the Q will be 5.3. Since a BEP of  $10^{-10}$  is nearly perfect data, the maximum displayed value of Q is 10.

## What Makes DQM So Useful?

**DQM works all the time.** It works with any data, even encrypted, and any data modulation. This is because determining the certainty of any given bit is done without knowing what the bit is supposed to be. As a result, end-to-end mission performance can be evaluated using a recording of DQM from the Status Logger with no knowledge of the received data.

**DQM is a great diagnostic tool.** When DQM is high, you know that the received waveform very closely matches a valid transmitted waveform, period. Because this determination is made independent of the bit values (1's or 0's), however, it is still possible that the bits are not what you expect them to be. So, for example, if you know the signal is clean (Q = 10) but your decomm still won't sync, it's very likely that your baseband encoding at the transmit end doesn't match the decoding at the receiving end (randomizer,

differential encoding, etc.).

**DQM is calculated in real time.** As a result, it can be used in Best-Source and Best-Channel Selectors to determine, on a bit-by-bit basis, whether a transmitted bit was most likely a 0 or a 1.

## How Do We Know DQM is Accurate?

**DQM is calibrated and verified against a wide variety of signal impairments.** You may realize from the description above that DQM accuracy will depend substantially on the approach used to translate the receiver's “inside information” into a BEP. For this reason, DQM must be calibrated by the factory to match actual measured bit error rates (BERs) under a variety of channel conditions (noise, dropouts, adjacent-channel interference, multipath, and more). Quasonix has developed a standard set of calibration tests to verify that DQM is not only highly accurate but also interoperable among equipment vendors.

You can benefit greatly from DQM, whether via Best-Channel Selection or to speed up troubleshooting.

## How is DQM Used by Other Equipment?

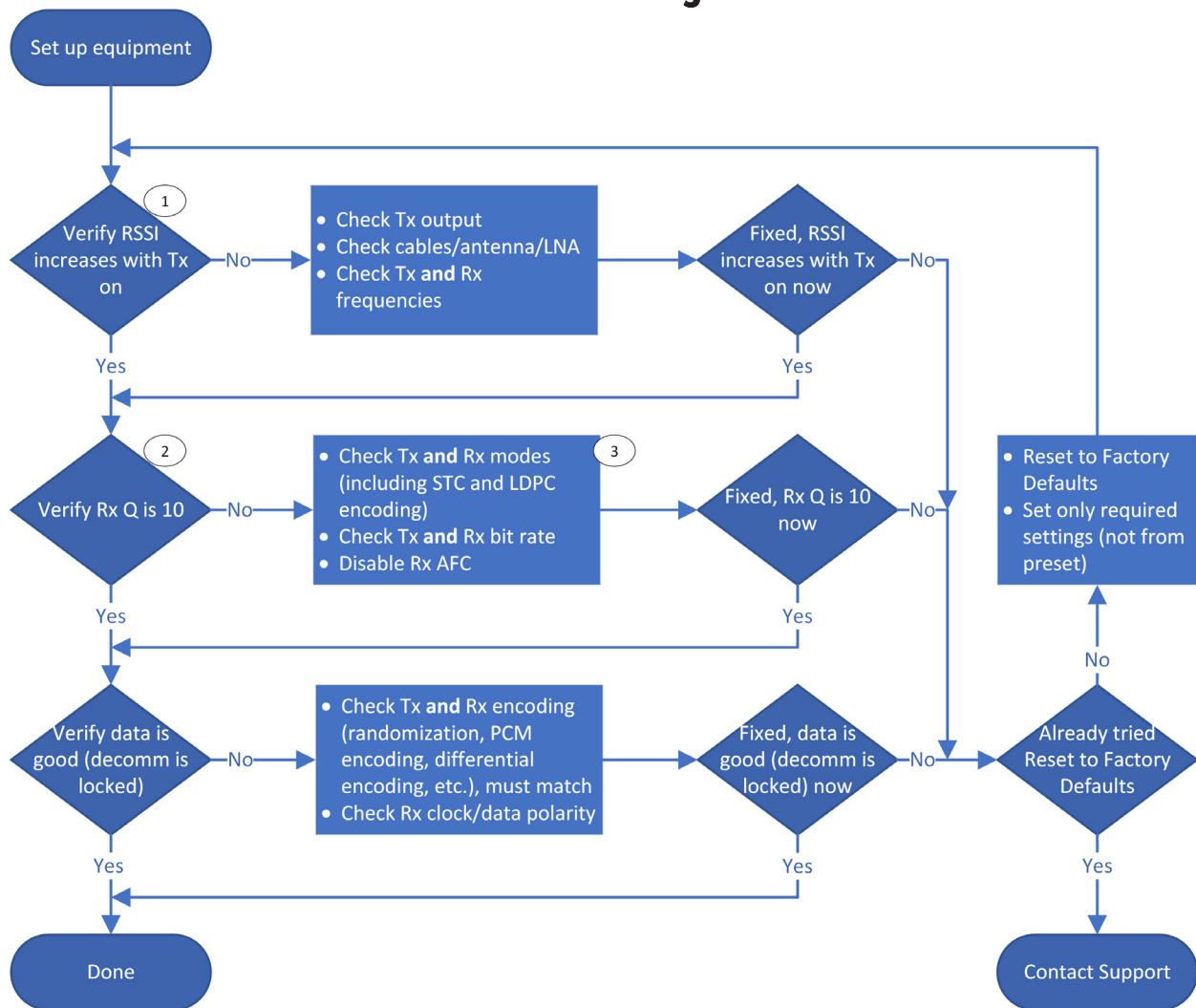
**DQM is bundled with received data blocks using a process called Data Quality Encapsulation (DQE).** For DQM to be used in Best-Source Selectors, it needs to be available downstream along with the data it represents. DQE adds a 48-bit header with every N bits of payload data ( $128 \leq N \leq 16,536$ ). The header includes a 16-bit sync pattern, two 8-bit reserved words, and the 16-bit DQM.

The programmability of the payload data block size allows you to strike a balance between more-frequent DQM updates (to allow tracking of more rapidly varying channels), or less-frequent updates (making more efficient use of the range infrastructure bandwidth). Note that since DQM is inserted during demodulation, it has no effect whatsoever on the over-the-air bandwidth.

## Summary

**DQM is all that.** DQM is a fast, efficient, and accurate measure of whether bits are received correctly or with errors. Quasonix has harnessed the power of DQM in many ways, including the Best Channel Selector (BCS) built into our RDMS™, with very impressive results. You, too, can benefit greatly from DQM, whether via BCS or to improve and speed up troubleshooting of your telemetry gear. See reverse for more information.

# Basic Troubleshooting Flowchart



**1** This flowchart assumes the transmitted signal is strong and clean enough that received data should be perfect or nearly so. In this case, there should be a substantial increase in the received signal strength indication (RSSI) when the transmitter is turned on versus when it is off. With a weaker transmit signal, the increase in RSSI may be small but should still be evident.

**2** Q is shown in the RDMS™ front-panel display and in the browser. More details on reverse.

**3** Adverse initial link conditions may make troubleshooting more challenging. For example, multipath is generally worst when the test article is nearby, especially in a hangar or on the tarmac. For these cases, it may be necessary to try some additional settings changes if Q is not 10:

- Disable Rx AFC
- Enable Rx Adaptive Equalizer
- Set Rx Modulation Index Scaling Mode to OFF (PCMF only)

As noted in the flowchart, Q will be low if the bit rate is set incorrectly, and the effective rate can be affected by encoding such as LDPC. If LDPC is in use, care should be taken to ensure all the LDPC settings (code rate, block size, and randomization) are set the same in the transmitter and the receiver. Though it is not explicitly noted in the flowchart, PCM encodings such as bi-phase also change the bit rate and must be set properly in the receiver to achieve a Q of 10.

This Basic Troubleshooting guide is intended to facilitate problem resolution for the most common issues setting up a telemetry link. However, every mission is different, and some scenarios are complex. The RDMS™ datasheet ([quasonix.com/files/rdms-rackmount-receiver-datasheet-gen3.pdf](https://quasonix.com/files/rdms-rackmount-receiver-datasheet-gen3.pdf)) and user manual (installed in the unit itself, accessible via the receiver's web server) provide additional detailed information to augment the flowchart.

Quasonix learns as much from our customers as they do from us. Please feel free to contact us at [support@quasonix.com](mailto:support@quasonix.com) with issues you find using this documentation, or with suggestions or tricks you have found to effectively troubleshoot your system.