Channel State Information (CSI): The key to making better DTT measurements

Common practice dictates that in order to measure the quality of a received Digital Terrestrial Television (DTT) signal we have to look at one or more of the following parameters: Bit-Error Rate (BER), Channel BER (CBER), Carrier-to-Noise Ratio (CNR) and Modulation Error Ratio (MER). The Channel State Information (CSI) feature available in the **PROMAX PROLINK** series of DTT measurement equipment is a very valuable tool providing additional insight into the quality of reception in a typical domestic or professional DTT installation.

BER, CBER, CNR and MER in a nutshell

Using the BER alone is an ill-advised “hit-or-miss” strategy because of the 'cliff-edge effect' characteristic of any digital TV system. A BER reading below the reference QEF value of 2×10^{-4} might wrongly lead us to conclude that the receiving conditions are satisfactory.

However, the BER provides a very narrow signal measurement range. Even for vanishingly small BER readings, a small drop in the level of received DTT signal can push the DTT receiver over the digital cliff edge beyond the point of system failure. The Channel BER (CBER) is closely related to the BER providing a wider signal measurement range. Depending on the type(s) of unknown disturbance(s) affecting our DTT installation (noise, co-channel or adjacent PAL, co-channel DTT, etc.), the CBER corresponding to the reference QEF BER of 2×10^{-4} varies between 4 and 7 in 100 [1]. Unfortunately, the CBER is not a reliable indicator of how far the digital cliff edge is.

DTT installers need a tool with a wide measurement range that solves the shortcomings of the BER and CBER. This measurement tool should provide some estimate of the noise margin of the DTT installation. That is, how far are the current reception conditions from those yielding the received signal unusable? A first candidate comes to mind: Carrier-to-Noise Ratio (CNR) or, alternatively, its sibling the Modulation Error Ratio (MER).

The CNR is defined as the ratio of the average RF power of the DTT signal to the power of the noise present in the UHF channel. Similarly, the MER is defined as the ratio of the average power of the DTT signal to the average power of the constellation errors.

In situations where there is no multipath propagation so that the channel frequency response remains reasonably flat, CNR and MER are in principle the same thing. In practice, the accuracy of the measured CNR is limited by the noise floor of the measurement equipment and by the presence of other disturbances on adjacent UHF channels. Likewise, the MER estimate is degraded by both the receiver's noise floor and other issues resulting from its practical implementation.

PROMAX **PROLINK 4** ***Premium***

CSI is here to help

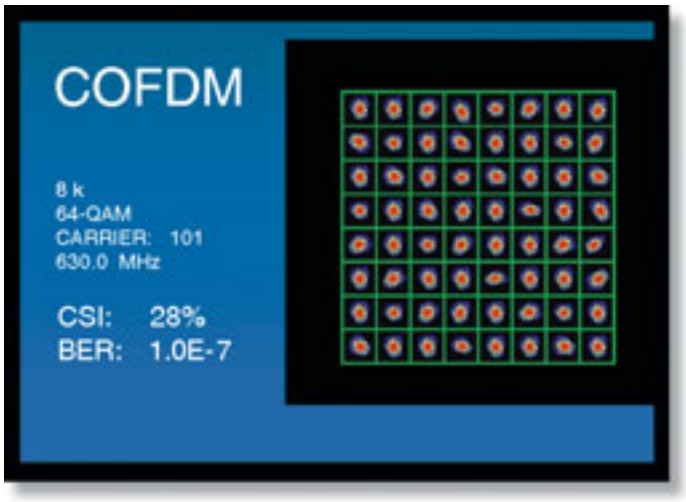
Some flavour of CSI is used internally by all commercial DTT receivers to achieve the recommended target system performance. The CSI counts the effect of both the noise present in the channel and the shape of the transmission channel itself.

In other words, the CSI gives a measure of the reliability of the received DTT signal. The percentage CSI as displayed by the PROMAX PROLINK 2, 3 and 4 is an average of the CSI across the UHF channel occupied by the DTT signal. The higher the percentage CSI, the less reliable DTT reception is.

As explained in **[1]**, the CSI can be used as a means to measure the noise margin in a DTT installation. Let us call CSI_{QEF} the percentage CSI measured at the point where the **PROLINK** displays the reference QEF BER. The noise margin in dB is then approximately given by

$$NM\ (dB) = \frac{CSI_{QEF} - CSI}{2.6}$$

This empirical approximation represents a good estimate for NM below 8 dB. The CSI alone, on the other hand, has a wider measurement range, providing meaningful results for NM of up to 15 dB.



PROMAX **PROLINK 4** ***Premium*** constellation display showing the percentage CSI reading

Conclusion

The Channel State Information (CSI) feature available in the PROMAX **PROLINK-2** ***Premium***, **PROLINK-3** ***Premium*** and **PROLINK-4** ***Premium*** can be readily used to estimate the noise margin of a DTT installation. The CSI reading is reliable even in cases where the accuracy of the CNR and MER values are affected by the lack of a suitable clean frequency bandwidth in which to measure the power of the channel noise.

The CSI's wide variation range and gradual response to a change in received signal power (approximately 1 dB per 2.6% CSI change for typical impairments within 8 dB of the QEF point) allows the installer to easily tweak the DTT installation so as to optimise the quality of reception.

[1] J. Lago-Fernández, "Using Channel State Information (CSI) to Characterise DVB-T Reception", IBC, Amsterdam, 12-17 September 2002.

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