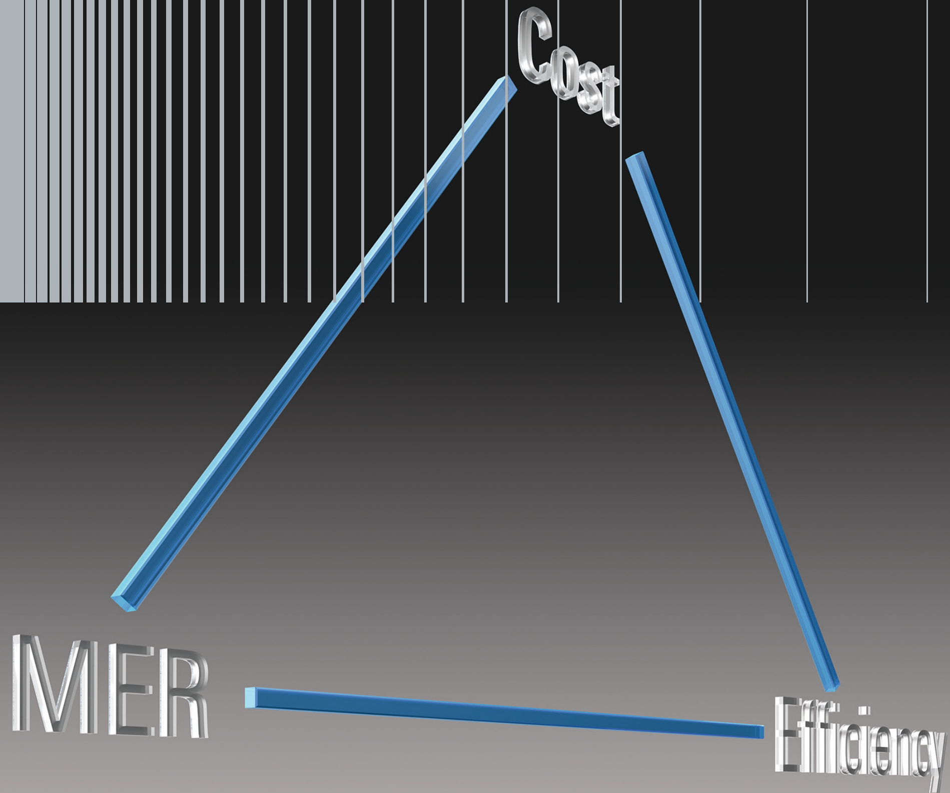
MER and coverage in broadcast network planning

ROHDE&SCHWARZ

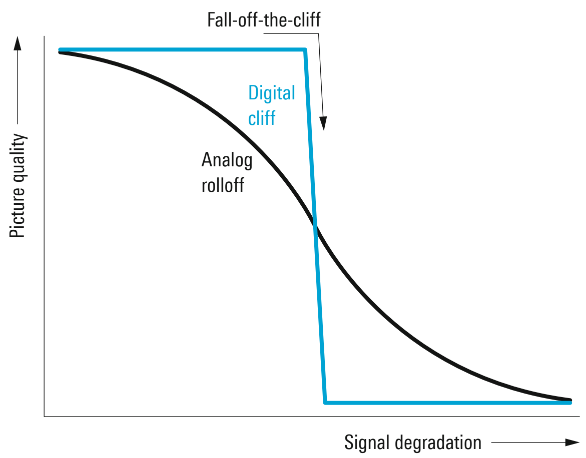


General

When planning DTV networks, it is vital to consider various key parameters. In COFDM broadcast networks, the MER value is a key parameter for the quality of DTV signals. At the DTV receiver input, this parameter (the receiver MER) determines whether or not the received signal can be decoded on the customer premises. The MER value at the transmitter output (the transmitter MER) influences the receiver MER. But what is the required minimum transmitter MER that ensures that the receiver MER is always sufficiently high in the RX range? To what extent is it possible to influence reception/coverage by boosting the transmitter MER? This brochure provides answers to these questions.

How high should the receiver MER be?

Cliff effect in DTV



Depending on the network concept and the intended receive situation, a minimum requirement can be defined for the receiver MER. Assuming a Gaussian transmission channel, the following requirements are globally accepted as a valid basis for network planning.

- DTV networks for stationary outdoor reception (e.g. DVB-T with 64QAM and code rate 2/3) with high data throughput and low-level signal robustness:
  receiver MER approx. > 18 dB
- DTV networks for stationary indoor reception (e.g. DVB-T with 16QAM and code rate 2/3) with average data throughput and medium-level signal robustness:
  receiver MER approx. > 12 dB
- DAB+ networks for mobile and stationary indoor reception:
  receiver MER approx. > 8 dB

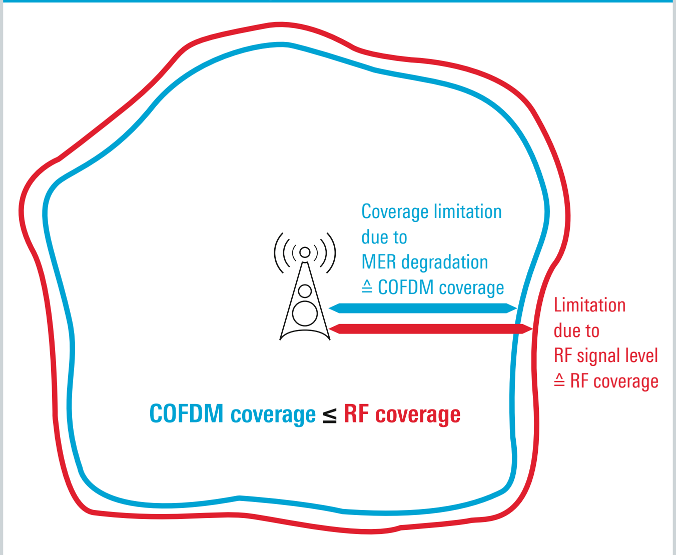
If these minimum MER values are not reached, a cliff or brickwall effect can occur. In such cases, it is suddenly no longer possible to receive the TV or audio broadcasting signal after minimal degradation in signal quality.

MER impact on coverage

What is the required minimum transmitter MER? Transmitter coverage is defined by the transmission loss down to the noise level (= RF coverage). Moreover, MER degradation affects digital COFDM signals. Consequently, COFDM coverage ends where minimum receiver MER requirements are just being met. Since RF coverage is the dominant physical characteristic, increasing the transmitter MER allows the COFDM coverage to be extended only up to the RF coverage limit.

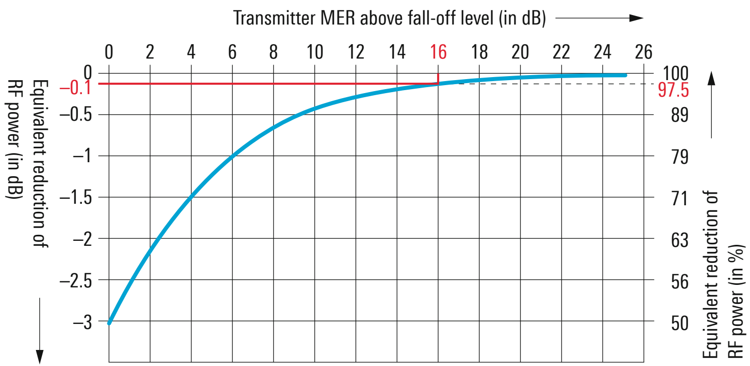
If the transmitter MER is increased beyond the minimum requirement for the receiver MER, this boost has continuously less impact as the MER level rises. As a result, the trace depicting the MER influence approaches a threshold value. From a certain level onward, any further increase in the transmitter MER only marginally impacts the receiver MER.

Limitation of coverage



If, for example, the transmitter provides a signal with an MER of 16 dB above the fall-off level, this has an influence of about –0.1 dB on the receiver MER. With regard to RF coverage, this influence corresponds to a reduction in transmit power to approx. 97.5%. If the signal at the transmitter has an MER of 20 dB above the fall-off level, the influence on the receiver MER is –0.04 dB, which corresponds to a reduction in transmit power to 99%. Increasing the transmitter MER by 4 dB improves the receiving conditions by only 0.06 dB. Compared to an equivalent reduction of the transmit power, there is a difference of only 1.5 percentage points.

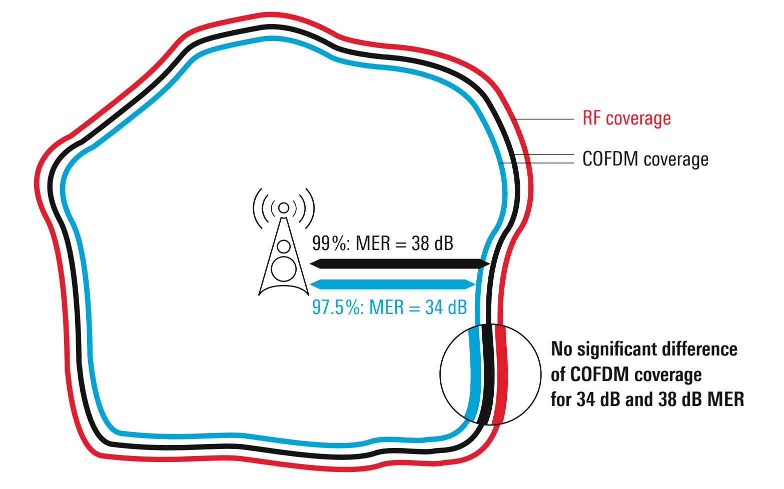
Impact of transmitter MER on COFDM coverage



Specific example

As mentioned above, for DVB-T with 64QAM and code rate 2/3 with high data throughput and a low-level signal robustness (for stationary outdoor reception), the MER requirements at the receiver are 18 dB. For the two scenarios examined, this results in MER requirements at the transmitter of 34 dB and 38 dB. The figure below provides a simplified explanation of the correlation: Both for 34 dB and 38 dB MER at the transmitter, the COFDM coverage is very close to the theoretically achievable RF coverage limit of 100 %. Increasing the MER from 34 dB to

Example: limitation of coverage due to different MER values

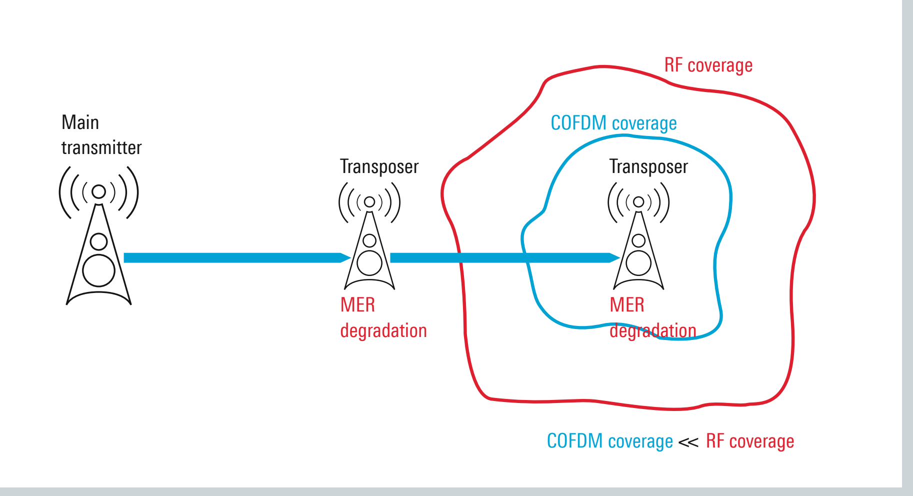


38 dB results in a difference of just 1.5 percentage points referenced to the equivalent reduction of the relevant transmit power. In this example, increasing the MER would barely expand the covered area at all.

However, there are also scenarios in which high MER values at the transmitter would make sense with regard to coverage. When transposer chains are used in a network, the signal is subjected to a certain level of MER degradation for each station that forwards the signal.

Depending on the extent of that degradation, coverage at the last station in the chain can be significantly impacted. Increasing the MER at the main transmitter above 34 dB in such a scenario can raise the coverage of the subsequent transposer chain in specific cases.

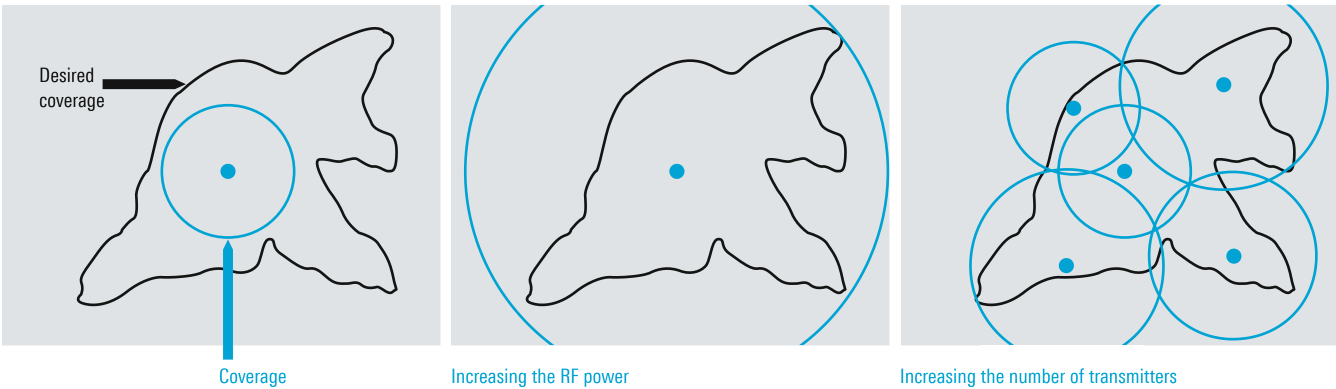
MER degradation for transposed signals



Factors influencing coverage

In most cases, the transmitter MER has no significant influence on coverage. Network coverage is primarily determined by the RF coverage of the individual transmitter sites. RF coverage, in turn, depends on the output power and number of transmitters in a specific region. When transmitter coverage is to be increased beyond the existing RF coverage, the primary approach of doing this is to increase the transmit power. Increasing the MER, on the other hand, does not influence the signal level and consequently cannot increase the RF coverage.

Extending the coverage

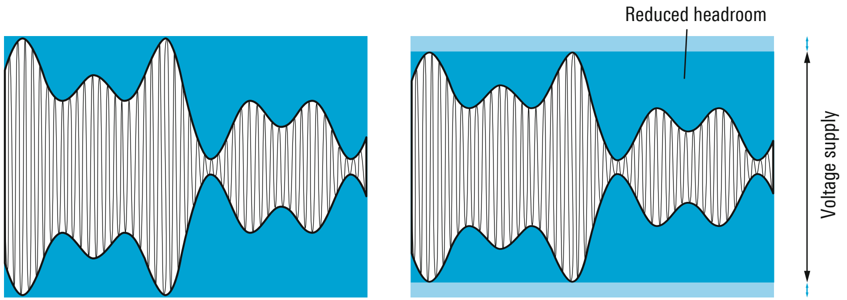


MER and energy consumption

The higher the transmitter MER, the higher the signal's shoulder attenuation needs to be. Normally, this can be achieved by employing a high amplifier supply voltage which increases the headroom, boosts energy consumption and reduces energy efficiency. A greater headroom boosts signal quality, but is largely unused energy.

In order to reduce energy consumption, it makes sense to reduce the headroom to the greatest possible extent without compromising on the signal-quality requirements. Surpassing the signal-quality requirements, on the other hand, automatically leads to a reduction in energy efficiency. The lower the transmitter MER, the better the available headroom can be used to increase the transmitter's energy efficiency. This means that – irrespective of the RF coverage – there is a direct correlation between the MER level and the transmitter's energy consumption, and consequently between the transmitter MER and operating costs.

Correlation between signal quality and efficiency



High voltage supply – low efficiency

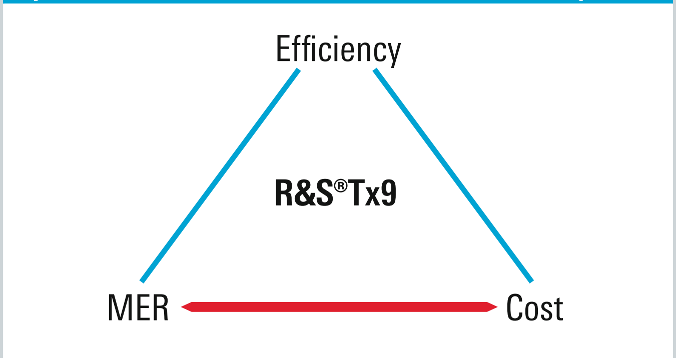
Adjusted voltage supply – higher efficiency

Best energy efficiency: R&S®Tx9 transmitters

For transmitter network operators, rising energy costs are increasingly shifting the focus of total cost of ownership (TCO) calculations to the energy efficiency of transmitters. It is important to achieve an optimal balance of cost aspects, MER and efficiency.

The ninth generation of Rohde & Schwarz transmitters has ideally adapted to all customer requirements. These transmitters make it possible to define the transmitter MER individually. Thanks to this capability, the market-leading Doherty implementation from Rohde & Schwarz, together with the outstanding adaptive digital equalization (ADE), is able to consistently achieve the optimal level of energy efficiency for the defined transmitter MER value. As a result, it is possible to realize transmitter MERs of 38 dB or higher. Market-leading energy efficiency values of up to 38 % for COFDM standards are achieved at a transmitter MER of 33 dB in the UHF band.

Optimum balance of MER, cost and efficiency



Summary

In most cases, increasing the MER above 34 dB has no significant influence on the transmitter coverage. When the COFDM coverage is already close to the theoretically maximally achievable RF coverage, additional increases in the transmitter MER will hardly affect the transmitter's DTV coverage. A further boost in network coverage can only be achieved by additional transmitter sites or by increasing the transmitter output power.

Nevertheless, raising the transmitter MER always has significant influence on the energy consumption of the corresponding transmitters. Consequently, maintaining an excessively high transmitter MER means that there are untapped reserves for optimizing a transmitter's energy efficiency. For this reason, every broadcast network operator needs to carefully consider if the MER value at the transmitter output has to exceed the minimum level required at the receiver input by more than 16 dB. Moreover, the higher operating costs that such an approach involves also need to be taken into account.

For all transmitter MER requirements, the R&S®Tx9 transmitters offer the best energy efficiency on the market. This is made possible by the market-leading Doherty implementation from Rohde & Schwarz in combination with an outstanding adaptive digital equalization (ADE), which ensures that the optimal efficiency level is always achieved for a defined MER target value.

Efficiency to the Power of Five®
by Rohde & Schwarz

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