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R&S® TLU9 GapFiller: not just another gap filler – a game changer

Ideally, operators of terrestrial TV transmitter networks would like to deliver proper coverage to their areas using only a few high-power transmitters. Unfortunately, topology considerations can often upset this simple approach. Repeaters are typically required in mountains and valleys. The new R&S® TLU9 GapFiller has completely redefined this class of transmitters.

Fjords and mountain valleys are where the problem is most obvious: Terrestrially broadcast TV signals from a distant transmitter do not make it all the way to the valley floor, leaving the population there without coverage unless additional steps are taken. Installing complete low-power transmitters at such locations with baseband signal feeding (via data network or satellite) is generally not an economically viable option – especially since the number of transmitters required can grow very quickly. Instead, the standard practice is to use repeaters that operate in relay mode: They receive the signal at an elevated position “over the air” – just like a normal TV receiver

– and rebroadcast the signal toward the valley floor. Depending on whether the same frequency or a different frequency is used, the following distinctions are made:

- Transposer: A transposer is a repeater that converts the received signal to a different frequency
- Retransmitter: Like a transposer but with signal regeneration; the received signal is demodulated and reconstructed
- Gap filler: A gap filler or on-channel repeater transmits on the same frequency on which it receives the signal (SFN application)

Today's gap fillers are vulnerable to external influences

Because the transmit frequency is the same as the receive frequency, gap fillers suffer from a problem that does not occur when transmitters with independent signal feeding are used: echoes, i.e. disruptive signal feedback to the input. The rugged topology of typical locations where gap fillers are used has many vertical reflecting surfaces, which exacerbates the problem. A compounding factor is the constricted nature of these locations, where everything happens in a relatively confined space. As a result, the distance from the transmitter to the reflecting objects and back is so short that the resulting echo signals are still of significant strength overlaying the actual source signal and disturbing it. Until now, there has been no all-embracing satisfactory solution to this problem. One issue is that echoes are not caused just by natural obstacles but also by moving objects such as vehicles. The Doppler echoes resulting from moving objects are very hard to counteract because of their sporadic and unpredictable nature. Moreover, any structural changes that occurred – for example if a road bridge or a wind farm was built (which invariably causes a change in the echo situation) – meant that the maintenance team had to analyze the new situation and reconfigure the echo cancellation mechanism on site. Unfortunately, the new configuration could also become obsolete at any instant, e.g. at the start of rush hour or when the wind turbines began to turn faster. A poor Doppler echo performance or a generally high noise contribution by signal processing could have consequences ranging from signal degradation to transmission failure. In such cases, the operator was forced to choose between two evils: Either use strict echo cancellation to ensure continuous transmission while accepting permanently poor signal quality, or opt for high quality and live with occasional broadcast interruptions.

Since the vulnerability of gap fillers to external influences made it difficult to predict how they would behave when installed at specific transmitter sites, operators found it impossible to make reliable network planning. For instance, a gap filler from supplier A might never work properly at a certain location despite repeated efforts, while the model from supplier B would not have these problems. At other locations, however, this situation might be reversed. This complicated

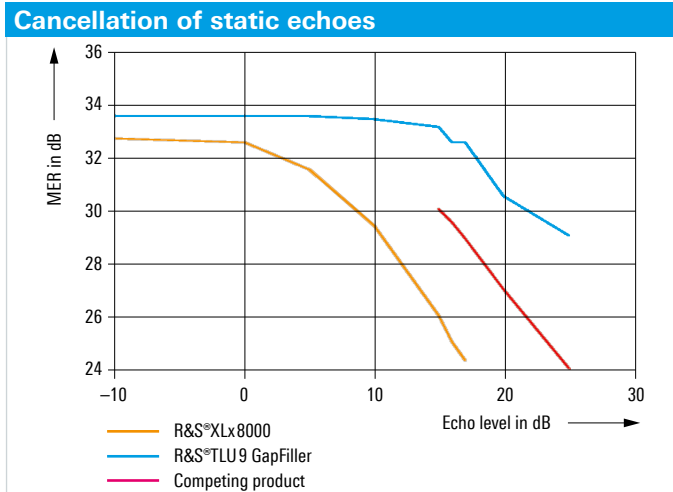


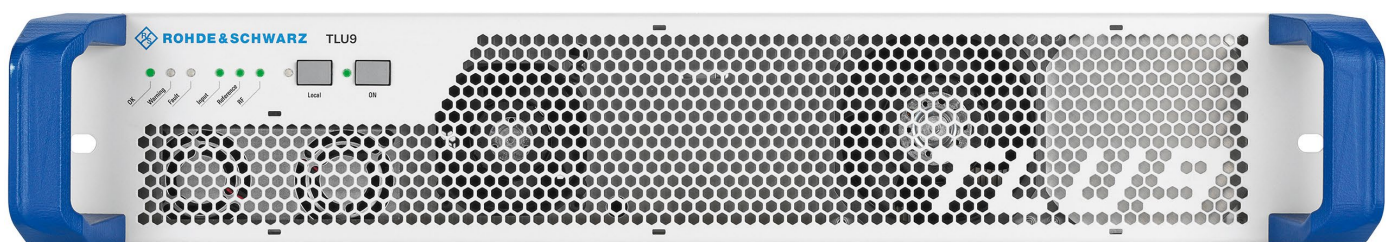
Fig. 2: Static echoes: The R&S®TLU9 GapFiller provides MER values well above any alternative product.

process of trial and error led to high installation and maintenance costs, offsetting the cost savings generated by the straightforward rebroadcasting concept. Considering the extreme reliability and long-term stability of large transmitters, broadcast network operators have a hard time accepting the apparent discrepancy. While Rohde&Schwarz has sold thousands of gap fillers from its long-established R&S®XLx8000 family, which enjoys a good reputation among network operators, the R&S®TLU9 GapFiller (Fig. 1) has now demonstrated that significant improvement is still possible.

First-time implementation: continuous optimization to changing echoes

The main driver is a technological advance in which a brand-new adaptive self-optimizing function supplements the existing manual and static configuration of the echo cancellation mechanism. The new R&S®smartEC feature analyzes the current echo situation and automatically finds the best echo cancellation setting – anytime and continuously. This ensures maximum signal quality at all times for the given situation. If no significant echoes occur, echo cancellation is unnecessary and the gap filler can operate with focus on maximal signal

Fig. 1: The R&S®TLU9 GapFiller sets new standards for echo cancellation and signal quality.



Cancellation of Doppler echoes

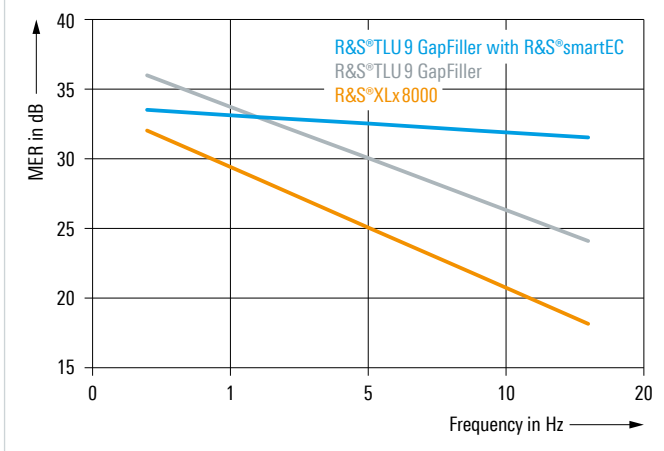


Fig. 3: Doppler echoes: The R&S®TLU9 GapFiller generally provides improved performance compared with the predecessor, the R&S®XLx8000. With R&S®smartEC, it provides optimal echo cancellation with excellent signal quality, anytime and continuously.

quality. On the other hand, coverage interruptions are avoided because the R&S®TLU9 GapFiller can take immediate countermeasures in case of temporary echoes.

The data speaks clearly and shows that the R&S®TLU9 GapFiller works to consistently deliver high signal quality – even in static echo situations where the R&S®smartEC option is not necessarily required. In this manner, echo levels up to 25 dB are canceled most solidly* (Fig. 2). Another key feature is the input sensitivity, which is extremely high at –80 dBm. At 17 μs, the echo window is three times as wide as that of the R&S®XLx8000, which means that echoes from distant reflectors can also be taken into account by the cancellation mechanism. Steep-edged filters attenuate adjacent channels by 80 dB at ±4.115 MHz to eliminate any appreciable influence due to other DTV signals or even mobile network signals.

Ultimately, however, only one thing counts: the measurable and visible signal quality. The modulation error ratio (MER) is one measure of the quality. For static echoes, the R&S®TLU9 GapFiller delivers up to 7 dB higher MER values compared with its predecessor product and up to 5 dB higher MER values compared with recognized competitor products (Fig. 2). The improvement is even more dramatic for dynamic (Doppler) echoes (Fig. 3). Here, MER values of over 30 dB are possible even at a Doppler frequency of 20 Hz on a stable basis – an increase of 10 dB and more compared with conventional products.

* Since a gap filler gets its input signal from a remote terrestrial transmitter and rebroadcasts the signal with significantly higher power in the local environment, thereby producing echoes, the echo level can significantly exceed the received level of the regular signal.

Start gap filling without worrying

On the one hand, network operators have an obligation to their customers, the program providers, who want to make sure their viewers have high-quality coverage. On the other hand, the actual costs required to achieve and maintain high network quality should be as low as possible. All of these issues can be reconciled only if the gap fillers deliver high-quality signals under all operating conditions while supporting the required level of predictability and ensuring low operating costs. The ideal gap filler works according to the motto: install and forget. The R&S®TLU9 GapFiller is the first product of its kind to satisfy this requirement. Network operators can rely on its predictability in deployment scenarios – just like with large transmitters. Thanks to its excellent characteristics and the new R&S®smartEC feature, it fulfills its coverage mandate maintenance-free and with a continuous focus on outstanding signal quality in every environment. As an added bonus, the product is also energy-efficient. Energy cost savings of up to 25 percent can be attained.

In the technology sector, there is a catchy name for innovations such as the R&S®TLU9 GapFiller: a game changer.

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The new R&S®TLU9 GapFiller provides resolutions to many challenging customer situations

Example: High operational cost

Caused by

- ▮ Many widely spaced gap filler locations
- ▮ Changing echo characteristics

Features of the R&S®TLU9 GapFiller

- ▮ Continuous self-optimization based on R&S®smartEC

Resulting customer benefits

- ▮ Reduced need for technical personnel
- ▮ Significantly reduced operating costs

Example: Interferences from adjacent channels

Caused by

- ▮ Adjacent channels with high signal level
- ▮ LTE interference
- ▮ Dynamic interference from adjacent channels

Features of the R&S®TLU9 GapFiller

- ▮ Integrated input filter in a very early stage of signal processing (prior to A/D converter and gain control)
- ▮ Suppression of direct adjacent channels by 80 dB

Resulting customer benefits

- ▮ Greatly improved robustness against all adjacent-channel and out-of-channel influences
- ▮ Better signal quality
- ▮ No added costs caused by external input filters