

## Next Generation of Triorail GSM-R Modules

Triorail has defined GSM-R new to cope with challenging neighborhood radio interferences.

The new 5<sup>th</sup> generation of Triorail GSM-R technology provides great benefits to the railway industry. This new generation gives access to an unprecedented receiver performance, which exceeds the recommended ETSI Professional Mobile Standard by far.

### The history of the emergence of a new module generation

The GSM-R networks with the natural spread along the railway tracks are in competition with the publicly operated GSM and UMTS/LTE networks in the 900 MHz range. There are increasingly common failure situations on the GSM-R side, which are created by the increasing infrastructure deployment on the public side. The worst cases are where a strong powering base station of a public network operator has been placed at the handover area of two adjacent GSM-R radio cells. Occurring IM3 interferer may look like shown in the following figure (1). For more background information, see box on the left.

*The demand for a better receiver performance is deemed inevitable for most of the GSM-R applications.*

*GSM-R terminals are threatened by strong radio interferences caused by public GSM900 and UMTS/LTE900 networks.*

*90% of all interference problems are caused by IM3 and UMTS/LTE900 self-intermodulation. IM3 is the intermodulation of 3<sup>rd</sup> order and is caused by virtual signals created by pairs of public EGSM900 carriers. These signals can interfere with wanted (GSM-R) signals. This does not happen in the air, but it is created in the receiver front-end amplifier of the terminals. Additionally to that UMTS/LTE is broadband and causes IM3 with itself. Receiver blocking and wideband noise of public carriers cause a minority of problems. Most of European railways are suffering from these problems and solutions are urgently required.*

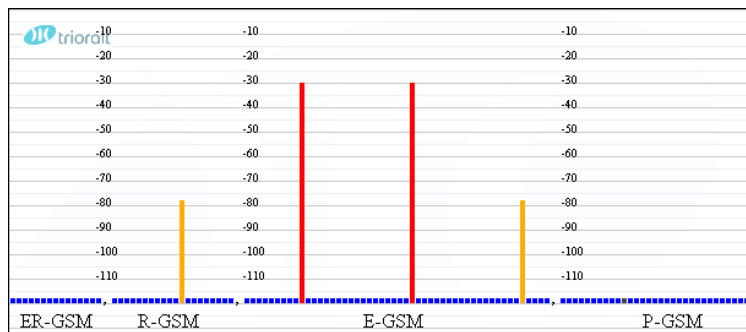


Fig. 1 IM3

The two red marked carriers of the EGSM 900 band produce the two orange IM3 interferers. The left interferer falls into the GSM-R ('R-GSM') band.

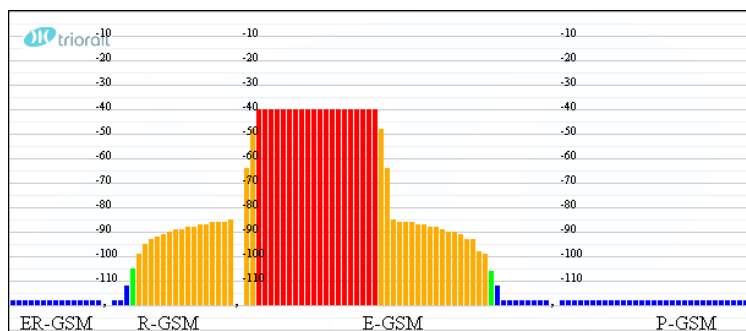


Fig.2 UMTS 900 self-intermodulation

The red marked carriers of the UMTS 900 band create a whole paling of interference signals (orange) which are generated by self-intermodulation. The GSM-R band gets affected and disturbed.

### What are the solutions?

A possible solution is the introduction of external filters between the GSM-R terminal and the antenna system.

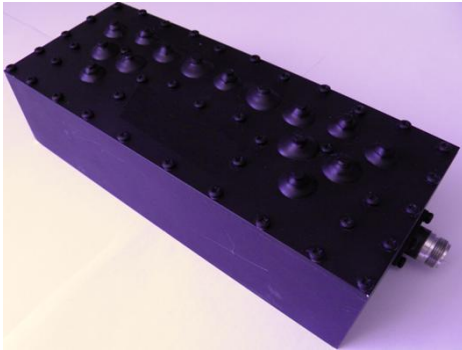


Fig. 3 Example GSM-R external filter

This solution has some drawbacks:

- The external filters have the size of a shoebox and some are even larger.
- The external filters are very expensive; price range of 1800 to 5400 €
- Roaming from GSM-R to public GSM and back is difficult and requires additional external RF coax-relays.

The silver bullet to solve IM3 and Blocking problems caused by EGSM900 and UMTS/LTE 900 carriers is to introduce a solution at the GSM-R module level. Triorail's fifth module generation provides such a solution with advanced receiver performance.



Fig. 4 GSM-R Module TRM-5

This smart remedy has certain advantages:

- ✓ Improvement and higher IM3/Blocking immunity on PCB component level only.
- ✓ There is no extra space for large external filters required.
- ✓ Roaming from GSM-R to public GSM and back possible without restrictions.
- ✓ Tremendous cost savings compared to any external filter solution.

The fig. 5 on the next page illustrates the interferer situation due to an adjacent UMTS carrier without any measure ('Outdated receivers'), with external antenna filter and with Triorail's fifth module generation ('Triorail TRM-5 and TRC-5'). The comparison picture shows such strong IM3 interference facing the outdated GSM-R receiver that any communication on GSM-R is interrupted. It further shows that the external filter solution and the new module generation by Triorail are providing similar good results: communication on GSM-R is working without any interruption.

External antenna filter    Triorail TRM-5/TRC-5    Outdated Receivers    EGSM 900

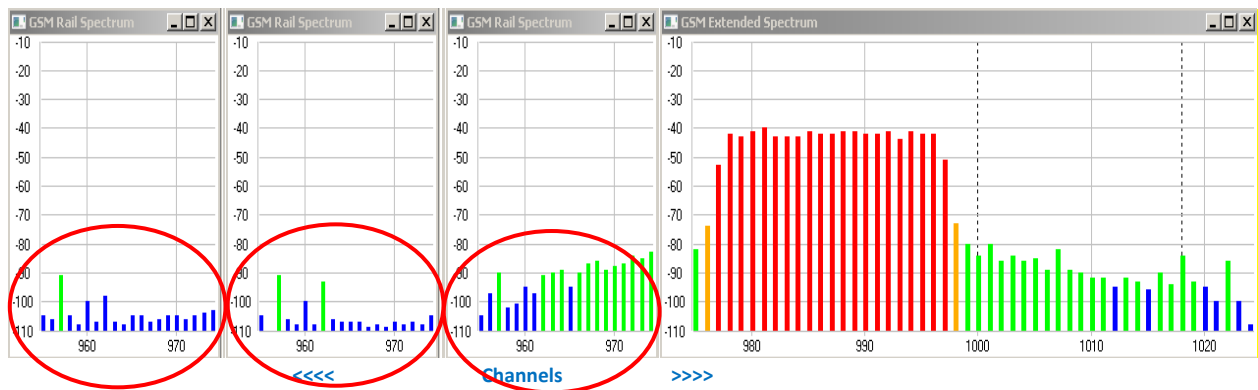


Fig. 5 Solution and result comparison

[Note: A rarely occurring strong wide-band noise, generated from a public mobile network, can be controlled only at the base station.]

### Advanced receiver technology by Triorail

The new module and terminal generation enters with a huge step forward in receiver performance. This new generation features an IM3 immunity improvement of up to 60dB compared with the ETSI professional mobile standard. Fig. 6 shows the comparison between the modules TRM-5 and TRM-3.

TCH Channel 961 (922.4 MHz)

Interferer A Channel 25 (940.0 MHz P-GSM)

Interferer B Channel 113 (957.6 MHz P-GSM)

IM3

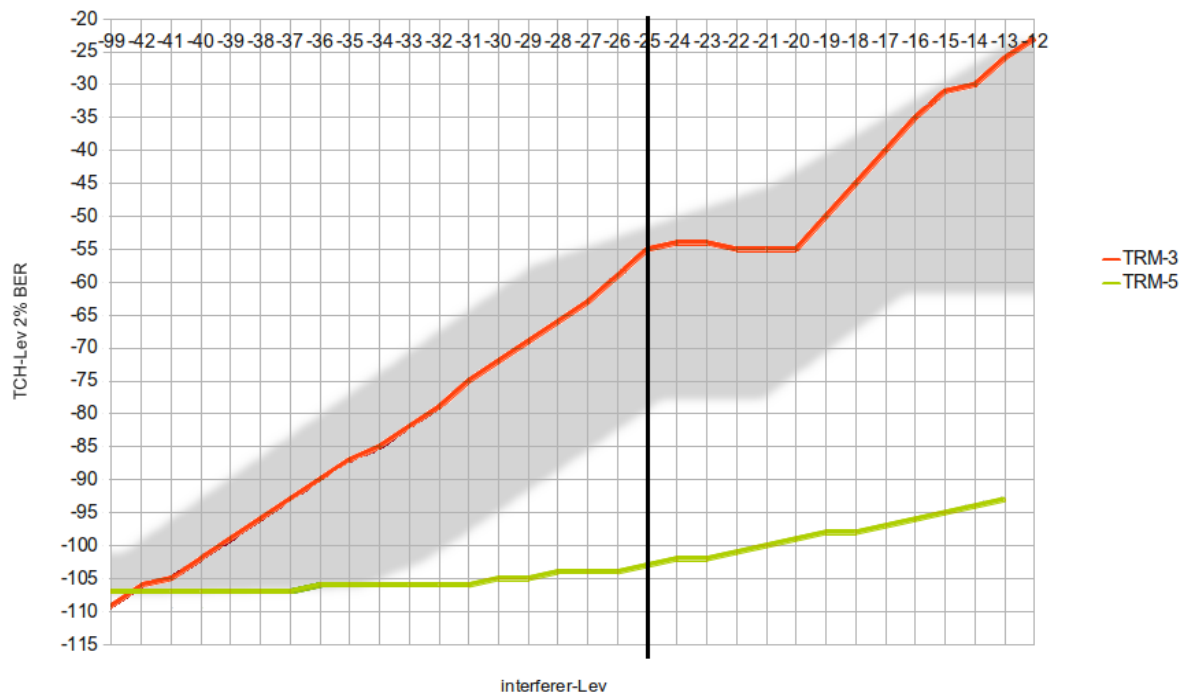


Fig. 6 Comparison TRM-5 versus TRM-3

**Caption Fig.6:** All level values are in dBm. TCH (traffic channel) receiving levels have been captured at 2% BER (bit error rate). The grey covered data area is the anonymized value range of all currently available GSM-R modules.

For those who are interested in further details of the IM3 impact on GSM-R, Triorail provides an IM3 simulation tool on the Internet.  
 Link: [www.triorail.com/trio-im3-sim](http://www.triorail.com/trio-im3-sim)

**EGSM-R, the GSM-R frequency band extension is supported by Triorail**

Triorail supports the extension of the GSM-R frequency band by additional 3 MHz with a variant of the new fifth module generation. The current capacity of 20 GSM-R carriers will be extended by further 15 carriers up to a total number of 35 carriers for GSM-R, which is called EGSM-R. Fig. 7 illustrates the new and current frequency assignment.

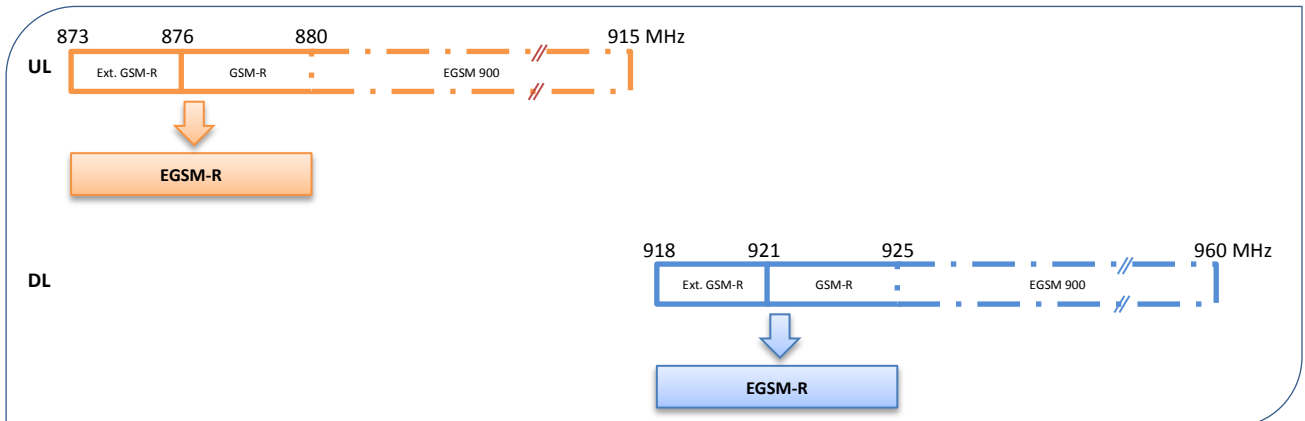


Fig. 7 Frequency assignment Europe: Extended GSM-R, GSM-R and EGSM 900

*Triorail supports and supplies the railway industry with innovative GSM-R products for more than 12 years.*

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