Next Generation of Triorail GSM-R Modules

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

The new 5th 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 3rd 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.

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.

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.
[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.

**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.
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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