

Handling 3.2

GSM-R Terminal filter Technical Specification

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1 INTRODUCTION

Trafikverket has an overall responsibility for the Swedish road and railway network. As a part of that we develop the railway into a competitive part of the Swedish transportation system for companies, private persons and for the environment. Large investments are now made in the railway and the aim is clear: Trafikverket shall meet the societies and customers' demands for an effective, available, safe and environment friendly railway.

1.1 Scope

The introduction of technologies as UMTS and LTE in the 900 MHz frequency band has caused interference in the GSM-R networks. In Sweden, Trafikverket (the Swedish Transport Administration) faces this problem, as the Swedish frequency regulator PTS has changed the licensing conditions for the public mobile network operators by allowing wideband technologies. Implementation of these technologies in the public mobile networks has started and Trafikverket expects major interference.

1.1.1 The two problems

1.1.1.1 Unwanted emission from public mobile network systems into the GSM-R frequency band

In Sweden, this is solved by a mutual agreement between Trafikverket and the public mobile network operators on limited unwanted emission from public mobile network base stations, and by Trafikverket increasing the signal level in the Swedish GSM-R system MobiSIR.

1.1.1.2 Strong wideband signals

Approved, ETSI compliant GSM-R equipment installed in railway vehicles cannot handle strong wideband signals from public mobile network systems (e.g. UMTS and LTE) in nearby frequency bands.

This is solved by installing protective filter functions or filters at the GSM-R terminals CAB radio and EDOR.

1.1.2 Overall information

This technical specification defines the filters required to solve the problem with strong wideband signals.

Trafikverket will be the agreement part, ordering of filters will be performed by Trafikverket and sub-ordering parties. The sub-ordering parties are the railway operators and suppliers. Ordering quantities for the sub-ordering parties cannot be stated. Trafikverket or sub-contractors will perform the installation of the filters. Technical support and documentation may be required by Trafikverket or by Trafikverket contracted parties.

2 TENDER

Requirements denoted with:

- **MR (Mandatory Requirement)** is mandatory and must be fulfilled for the tender to be object for further assessment.
- **DR (Descriptive Requirement)** is mandatory and must be accomplished, in the tender, for the tenderer to be object to further assessment.

MR 1 The fulfilment of requirements, MR and DR, shall be stated in document “3.1 Anbudsformulär” (Tender form)

MR 2 All mandatory (MR) and descriptive requirements (DR) shall be described in a separate document named “Beskrivning av kravuppfyllnad” (Description of Compliance) and must not refer to other documents. Any template may be used.

2.1 Bid price

The tenderer may bid on:

- Bid 1: Total price for position 1,2 and 3 in table 1 (Band pass filter)

And / Or

- Bid 2: Total price for position 4,5 and 6 in table 2 (Low pass filter)

The bids (Bid 1 and Bid 2) will be evaluated separately, so it might be two separate contracts with two different tenderer or one contract with one tenderer.

Validating measurements will be done by Trafikverket on samples of delivered products.

MR 3 In document “3.1 Anbudsformulär” the tenderer shall price Bid 1 and/or Bid 2 as specified in Table 1 and Table 2.

Type 1, Band pass filter		
Position	Amount	Description
1	60	Type 1, Band pass filters only (without the switchable function), including mounting brackets.
2	20	Switching function only for Type 1 Band pass filter, including mounting brackets and cables between switching function and filter
3	20	Signal injectors including D-sub connectors for the connecting cable, for the Type 1 Band pass filter.

Table 1

Type 2, Low pass filter		
Position	Amount	Description
4	50	Type 2, Low pass filter only (without the switchable function), including mounting brackets.
5	15	Switching function only for Type 2 Low pass filter, including mounting brackets and cables between switching function and filter.
6	15	Signal injectors including D-sub connectors for the connecting cable, for the Type 2 Low pass filter.

Table 2

MR 4 The tenderer shall attach their price list in document “3.1 Anbudsformulär” where all items, mandatory (specified as MR requirements) as well as described (specified as DR requirements) are clearly defined and priced. In the price list the following, at the least, shall be priced:

For Bid 1: (Type 1 Band pass filter)

- filter type 1, band pass filter only
- switching functions and cables between switching function and filter for the type 1, band pass filter
- filter type 1, band pass filter assembled with switching function
- signal injectors including D-sub connectors for the connecting cable

For Bid 2: (Type 2 Low pass filter)

- filter type 2, low pass filter only
- switching functions and cables between switching function and filter for the type 2, low pass filter
- filter type 2, low pass filter assembled with switching function
- signal injectors including D-sub connectors for the connecting cable

Common for both Bid 1 and Bid 2:

- coaxial cable (per metre)
- torque able coaxial connectors
- necessary tools required for mounting the connector
- prefabricated cables, with mounted connectors, in different lengths. (1, 2, 5 and 10 metre lengths)
- coaxial adapters from TNC-male to N-female
- repairs

3 TECHNICAL REQUIREMENTS

3.1 General system description

3.1.1 Strong wideband signals

Approved, ETSI compliant GSM-R equipment installed in railway vehicles cannot handle strong wideband signals from public mobile network systems (e.g. UMTS and LTE) in nearby frequency bands. The GSM-R terminal receiver gets blocked by the strong wideband signals.

When the specifications for GSM and GSM-R were developed (in the 1980's for GSM and in the early 1990's for GSM-R), wideband 3G and 4G signals were not considered. The condition at the time was that a GSM-R terminal's receiving range should cover the entire 900 MHz frequency band (876 - 915/921 - 960 MHz). This made use of public GSM network systems during the roll-out of national GSM-R networks possible (roaming) as well as use of public networks on lines not planned for expansion of GSM-R.

The reports (e.g. CEPT EC 96) forming the basis of the decision to introduce wideband technologies in the 900 MHz frequency band were not thorough enough to give a correct picture of the impact on the GSM-R systems.

Therefore protective filter have to be installed in-line with the antenna system for the CAB-radio to prevent blocking to occur. In the case that roaming to public operators will be used a protective filter with switching function will be installed.

3.2 Type 1, Passive downlink and uplink Band pass filter

Note: The requirements (MR and DR) in this chapter (3.2) are mandatory for the Type 1 Band pass filter only.

Prerequisites

The ER-GSM band frequency allocation is, uplink 873 – 880 MHz and downlink 918 – 925 MHz

MR 5 The filter shall comply with EN 50 155, relevant parts.

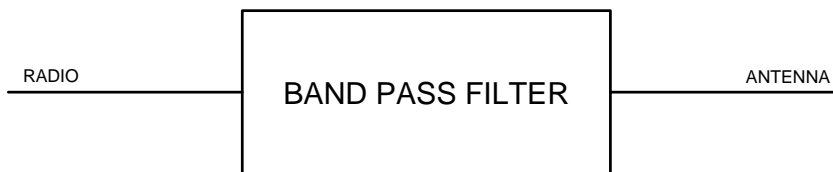


Figure 1

3.2.1.1 Band pass filter filtering characteristics

MR 6 The filtering characteristics shall comply with Table 3 under all, in this document, mentioned or referred conditions.

Frequency range, MHz	Attenuation (dB)	Return Loss (dB)
0 – 872.0	≥ 40	n.a
873.0 – 880.0	≤ 2.0	≥20
882 – 917	≥ 40	n.a
918.0 – 925.0	≤ 2.0	≥20
925.5 – 926.2	≥ 30	n.a
926.2 - 930.0	≥ 40	n.a
930.0 – 2700	≥ 50	n.a

Table 3 – Band pass filtering characteristics

3.2.1.2 IM (Inter-Modulation) requirements

MR 7 Applying two CW-signals with 20 W each (2 x 20 W (+ 43 dBm)) in the ER-GSM up- or downlink shall not produce IM-products higher than – 150 dBc with the output port terminated in 50 Ohms. This shall be archived even with the switching function in place.

3.2.1.3 Band pass filter requirements

MR 8 Power capability with the filter unterminated shall be at least 20 W even in by pass mode (filter out of circuit).

- MR 9 The filter system impedance shall be 50 Ohm.
- MR 10 All coaxial connectors shall be N-female and may be placed on any face.
- MR 11 There shall be a mounting bracket, with the possibility of different drilling templates, on which all equipment is mounted.
- MR 12 MTBF shall be $\geq 1\ 000\ 000$ h.
- MR 13 There shall be a grounding post on the filter and on the mounting bracket.

3.2.1.4 Dimensions

- MR 14 The maximum size of the filter shall be 350 x 350 x 150 mm, connectors excluded.
- MR 15 The maximum weight shall be less than 15 kg.
- DR 1 The actual size of the filter shall be stated.
- DR 2 The actual weight of the filter shall be stated.

3.3 Type 2, Passive Low pass filter

Note: The requirements (MR and DR) in this chapter (3.3) are mandatory for the Type 2 Low pass filter only.

Prerequisites

The ER-GSM band frequency allocation is, uplink 873 – 880 MHz and downlink 918 – 925 MHz.

MR 16 The filter shall comply with EN 50 155, relevant parts.

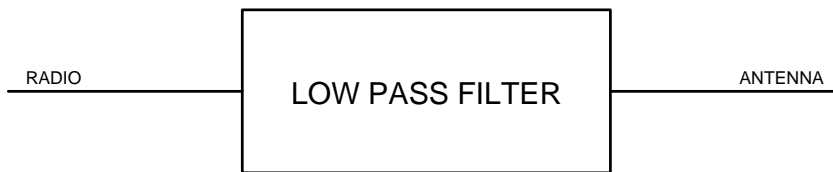


Figure 2

3.3.1.1 Low pass filter filtering characteristics

Frequency range (MHz)	Attenuation (dB)	Return Loss (dB rel. 50 ohms)
873.0 – 880,0	≤ 2.0	>15
918,0 – 924,8	≤ 2.0	>15
924.9	≤ 3.0	>12
925.4	≥ 15	n.a
926,0 – 960	≥ 30	n.a

Table 4 – Low pass filtering characteristics

3.3.1.2 IM (Inter-Modulation) requirements

MR 17 Applying two CW-signals with 5 W each (2 x 5 W (+ 37 dBm)) in the ER-GSM up- or downlink shall not produce IM-products higher than – 150 dBc with the output port terminated in 50 Ohms. This shall be archived even with the switching function in place.

3.3.1.3 Low pass filter requirements

MR 18 The filtering characteristics shall comply with Table 4 under all, in this document, mentioned or referred conditions.

MR 19 Power capability with the filter unterminated shall be at least 10 W, even in by pass mode (filter out of circuit).

- MR 20 The filter system impedance shall be 50 Ohm.
- MR 21 All coaxial connectors shall be N-female and may be placed on any face.
- MR 22 There shall be a mounting bracket, with the possibility of different drilling templates, on which all equipment is mounted.
- MR 23 MTBF shall be $\geq 1\ 000\ 000$ h.
- MR 24 There shall be a grounding post on the filter and on the mounting bracket.

3.3.1.4 Dimensions

- MR 25 The maximum size of the filter shall be 300 x 200 x 100 mm, connectors excluded.
- MR 26 The maximum weight shall be less than 5 kg.
- DR 3 The actual size of the filter shall be stated.
- DR 4 The actual weight of the filter shall be stated.

3.4 Switching function (for the passive downlink and uplink band pass filter and/or the low pass filter).

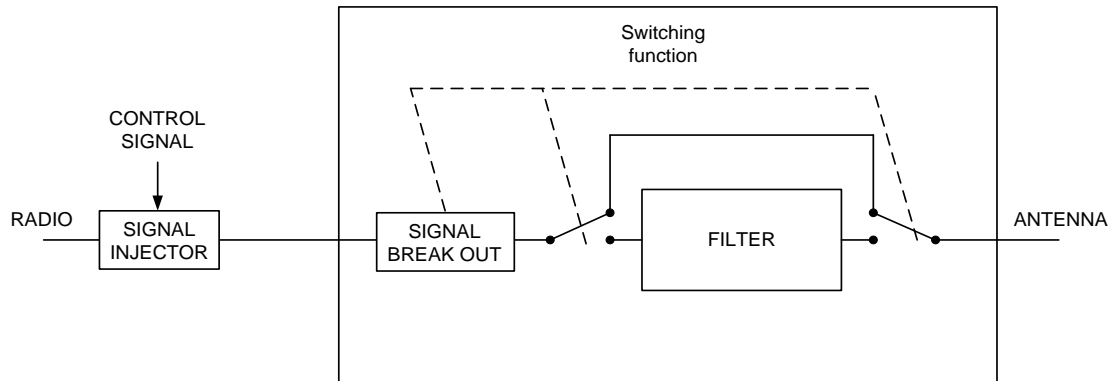


Figure 3

- MR 27 The tenderer shall offer a switchable filter function where the filter is used for filtering and a function to bypass the filter when wanted is possible. The switching function shall be external to the filter.
- MR 28 Non active state shall be filter in circuit.
- MR 29 Active state shall be bypass of filter.
- DR 5 The tenderer shall describe the switching function.
- MR 30 The bypass functions shall be maneuvered by a DC control signal.
- MR 31 There shall be a yellow signal indicator (i.e. LED) indicating “active state”.
- DR 6 The tenderer shall state the signal injector power consumption. (excluding the switching function)
- MR 32 Loss of control signal shall lead to “non active state” i.e. filter in circuit.
- MR 33 The control signal shall be fed via the signal injector into the coaxial cable to the switching function.
- MR 34 MTBF shall be $\geq 200\,000$ h
- DR 7 The tenderer shall state the total MTBF of the switching function together with the filter in question.
- MR 35 All coaxial cable connectors shall be N-male.
- MR 36 All fixed coaxial connectors shall be N-female and may be placed on any face.
- MR 37 There shall be a mounting bracket on which all equipment are mounted (switching function, filter etc.)

- MR 38 It shall be possible to completely remove all switching function components and use only the filter.
- DR 8 Describe how the switching functions components are to be removed.

3.4.1.1 Dimensions of the switching function

- MR 39 The maximum size shall be 100 x 100 x 80 mm, connectors excluded.
- MR 40 The maximum weight shall be less than 2 kg.
- DR 9 The actual size of the switching function shall be stated.
- DR 10 The actual weight of the switching function shall be stated.

3.5 Signal injector

- MR 41 The signal injector shall be installed in a shielded enclosure.
- MR 42 The connector for the control signal shall be 9 pin D-sub, male mounted in the box and female on the connecting cable. Pin 1 – 5 minus (-) and pin 6 - 9 plus (+). No other signals or supply voltages are available in the connector.
- MR 43 The polarity of the pinning in the D-sub connector shall be clearly marked on the enclosure.
- MR 44 The D-sub connector shall be marked “Control”.
- MR 45 The DC control signal shall be +24 VDC.
- DR 11 The tenderer shall state the signal injector power consumption. (excluding the switching function)
- MR 46 There shall be a yellow signal indicator (i.e. LED) indicating “active state”.
- MR 47 All coaxial connectors shall be N-female.
- MR 48 The coaxial connector shall be clearly marked, connector towards CAB-radio shall be marked “Radio” and connector towards filter shall be marked “Filter”.
- MR 49 There shall be a DC-block towards the “Radio” connection.
- MR 50 There shall be a short circuit protection towards the “Filter” connection.
- MR 51 There shall be a mounting bracket for the signal injector.
- MR 52 Ingress Protection shall comply with IP 53 or better.
- MR 53 MTBF shall be $\geq 500\,000$ h.

3.5.1.1 Dimensions of the signal injector

- MR 54 The maximum size shall be 50 x 50 x 40 mm, connectors excluded.
- MR 55 The maximum weight shall be less than 300 g.
- DR 12 The actual size of the signal injector shall be stated.
- DR 13 The actual weight of the signal injector shall be stated.

3.6 Cable and connectors

- MR 56 All coaxial connectors shall be of N-type.
- MR 57 All coaxial cables shall, at least, conform to IEC 61034-1 "Low smoke production" and IEC 60754-2 "Halogen free cables corrosiveness of combustion gases".
- MR 58 The coaxial cable shall be double shielded (e.g. M17-RG-214) or have a solid braid, i.e. standard RG-213 or RG-8 type are not compliant.
- MR 59 The tenderer shall offer coaxial cable per metre.
- MR 60 The tenderer shall offer torque able coaxial connectors per piece.
- MR 61 The tenderer shall offer necessary tools required for mounting the connector.
- MR 62 The tenderer shall offer prefabricated cables, with mounted connectors, in different lengths. (1, 2, 5 and 10 metre lengths)
- MR 63 All prefabricated cables shall be intermodulation measured according to MR 7.
- MR 64 Coaxial adapters from TNC-male to N-female shall be offered.

3.7 Environmental requirements

- MR 65 Altitude shall comply with EN 50 125.1 sub clause 2, class AX.
- MR 66 Temperature shall comply with EN 50 155, 4.1.2 , T3
- MR 67 Shock and Vibration shall comply with EN 50 155, 4.1.3
- MR 68 Relative Humidity shall comply with EN 50 155, 4.1.4
- MR 69 The filter shall comply with EN 50 155, applicable parts of clause 12, Dry heat, Damp heat cyclic, Vibration
- MR 70 Ingress Protection shall comply with IP 54 or better unless otherwise stated.

4 INSTALLATION

Installation and commissioning will be performed on behalf of Trafikverket.

- MR 71 There shall be alternatives for installation, i.e. mounting brackets and assemblage templates for installation in different locations.
- DR 14 The tenderer shall describe the different alternatives for installation.

5 DOCUMENTATION

- MR 72 A filter plot shall be delivered together with every filter. The plot shall include parameters S11, S12, S21 and S22, in excel format.
- MR 73 The tenderer shall provide reference documentation, containing system description, specifications, block diagrams and all necessary information to install, commission, and maintain the equipment.
- MR 74 All documentation and certificates shall be in Swedish or English.
- MR 75 In case alterations are made, updated documentation shall be delivered. Trafikverket shall receive at least one copy of new releases of manuals and reference documentation.
- MR 76 The documentation shall be delivered in digital form. File format Adobe PDF or other well-known file format may be used.

6 SERVICE AND SUPPORT

6.1.1 Support

- DR 15 The tenderer shall provide a description of service and support services available for Trafikverket including:
- Help desk with technical support
 - Repairs
- MR 77 The technical help desk shall be available workdays Monday to Friday 8.00-17.00 CET all year round by e-mail and telephone.
- MR 78 The technical help desk shall have technical knowledge about, at least, filters, switching functions and signal injectors.
- MR 79 The tenderer shall have a case management system, with access for Trafikverket, where order status, faults, technical queries and repair status can be followed.

6.1.2 Repairs

- MR 80 The tenderer shall repair or replace all faulty units during the period of guarantee without any expenses for Trafikverket or sub ordering part.
- MR 81 The tenderer shall repair or replace all faulty units during at least three (3) years after the units have been discontinued.
- MR 82 The tenderer shall state repair and replacement charges for faulty units after the period of guarantee for the units in an attached item price list.
- MR 83 The tenderer shall within forty (40) days repair or replace faulty units both within the scope of the period of guarantee and after the same.
- MR 84 The tenderer shall guarantee the continuous hardware compatibility between replaced spare parts and the installed units.