



Radioenheter i Fordon

Jonas Bremholt

jonas.bremholt@ri.se

010-516 5438

RISE Research Institutes of Sweden

RISE



Radioenheter i Fordon

- Contents
 - RED
 - Definitions
 - Exempted devices
 - Essential requirements
 - The RED Guide
 - Vehicles
 - TGN 01 Radio modules and products using Radio modules
 - TGN 33 The RED as applied to Vehicles
 - TGN 31 Multi Transmitters
 - ETSI Standards dealing with Radio modules

Note: The information provided in this presentation is based on Draft versions of the referenced TGNs, the information might be outdated when new versions becomes available.

Radio Equipment Directive (RED) 2014/53/EU

- The Radio Equipment Directive 2014/53/EU (RED) applies to radio equipment, as defined in Article 2 of Directive 2014/53/EU.
- Definitions
 - **radio equipment:** means an electrical or electronic product, which intentionally emits and/or receives radio waves for the purpose of radio communication and/or radiodetermination, or an electrical or electronic product which must be completed with an accessory, such as antenna, so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radiodetermination;
 - **radiodetermination:** means the determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to those parameters, by means of the propagation properties of radio waves;
 - **manufacturer:** means any natural or legal person who manufactures radio equipment or has **radio equipment designed or manufactured**, and markets that equipment under **his name or trade mark**;

■

Radio Equipment Directive (RED) 2014/53/EU

- Equipment not covered by RED
 - Radio equipment used by radio amateurs
 - Marine equipment falling within the scope of Council Directive 96/98/EC (1).
 - Airborne products, parts and appliances falling within the scope of Article 3 of Regulation (EC) No 216/2008 of the European Parliament and of the Council (2).
 - Custom-built evaluation kits destined for professionals to be used solely at research and development facilities for such purposes.
 - **Vehicles are NOT exempted!**

Radio Equipment Directive (RED) 2014/53/EU

- Article 3 Essential requirements
 - Radio equipment shall be constructed so as to ensure:
 - 3.1(a) Safety
 - 3.1(b) EMC
 - 3.2 “Radio performance”
 - Radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference.

Radio Equipment Directive (RED) 2014/53/EU

- 3.3 Radio equipment within certain categories or classes shall be so constructed that it complies with the following essential requirements:
 - (a) radio equipment interworks with accessories, in particular with common chargers;
 - (b) radio equipment interworks via networks with other radio equipment;
 - (c) radio equipment can be connected to interfaces of the appropriate type throughout the Union;
 - (d) radio equipment does not harm the network or its functioning nor misuse network resources, thereby causing an unacceptable degradation of service;
 - (e) radio equipment incorporates safeguards to ensure that the personal data and privacy of the user and of the subscriber are protected;
 - (f) radio equipment supports certain features ensuring protection from fraud;
 - (g) radio equipment supports certain features ensuring access to emergency services;
 - (h) radio equipment supports certain features in order to facilitate its use by users with a disability;
 - (i) radio equipment supports certain features in order to ensure that software can only be loaded into the radio equipment where the compliance of the combination of the radio equipment and software has been demonstrated.

RED Guide

- 1.6.3.10 Radio equipment installed in vehicles
- Where **radio equipment is installed in vehicles** such as cars, caravans, trains, etc (normally **falling under a type approval legislation**), the radio equipment **has to comply with the RED** unless the specific equipment falls within any of the exceptions of the RED. **That radio equipment must comply with the requirements of both the RED and all applicable EU acts.**

RED Guide

- 1.6.3.10 Radio equipment installed in vehicles
- The person **who places** on the EU market the radio equipment is the **responsible manufacturer**, as defined in the RED and is responsible for compliance when the radio equipment is installed in accordance with the instructions. The **risk assessment** of the radio equipment should **take into account its intended purpose**.

RED Guide

- 1.6.3.10 Radio equipment installed in vehicles
- The person who installs the radio equipment, already placed on the EU market, shall follow the instructions. He shall be considered as the manufacturer of the radio equipment when the vehicle is made available if:
 - the compliance is impacted because the instructions provided for the radio equipment were not followed; or
 - the intended function or performance of the radio equipment is modified.

Radio module

- Radio Module Assessment

- A Radio module must be assessed and CE marked to the RED regardless of whether the radio module is available openly on the **public market**, or supplied exclusively through a **business-to-business contract**.
 - A radio module must be assessed for **its intended use**.
 - The radio module manufacturer must consider **the range of possible conditions** such as; **input voltage, temperature and other environmental conditions** which may apply in the **final environment of use**.
 - Any items which could **affect RED compliance**, such as **critical accessories, antennas, antenna assembly, software versions, etc.**, shall be documented in the radio module's **installation instructions** and on the **radio module's EU declaration of conformity**.
- It is essential for the radio module manufacturer to clearly document in the **installation instructions**, how the module has been assessed and **the conditions for compliant use**.

Final Radio Product

- A final radio product is the combination of host product and radio module.

According to the RED Guide at the time of issuing this REDCA TGN; **the combination of radio module and host product will become a final radio product and subject to assessment to the RED** if, at the time of placing on the market, the radio module equipment is already:

- Incorporated into the host product; **and**
 - Permanently attached to the host product in such a way that it cannot be easily accessed and readily removed.
- Note: According to the RED Guide at the time of issuing this REDCA TGN: In cases where the radio module or radio equipment is installed into a **vehicle (subject to type approval)**; the host **vehicle** does not become a final radio product and therefore is **not subject to assessment to the RED**. In such cases, **the radio module remains the CE Marked radio device**, even if permanently installed within the vehicle at the time of placing the vehicle on the market.

Final Radio Product Assessment

- When installing a radio module into a host product, and if the host product was not used at the time of original assessment of the radio module, some assessment or testing will be required at the final radio product level.
- Many of the test cases used to show compliance with Article 3 of the RED are specific to the host environment. This applies to the EMC assessments, the product safety assessments, and any radio performance assessments which could be affected by a change to the relevant parameters.
- In all cases, an assessment of the final radio product must be made to the requirements of Article 3 of the RED.
- In general, there is a desire to **avoid unnecessarily repeating the radio performance** (Article 3.2) assessment at the final radio product level, if compliance can be justified on the basis of technical analysis, test data and information provided by the radio module manufacturer to the final radio product manufacturer. **However, Radiated spurious emission tests should be performed on Final product level and if the antenna is internal test of radiated output power is recommended.**

Final Radio Product Assessment

- Radio performance according to Article 3.2 of the RED applies to the final radio product and a full assessment will be required at the final radio product level; **but that does not necessarily mean full radio testing** must be performed on the final radio product. **Some radio tests performed on the radio module may provide confidence** of radio compliance of the final radio product.
- The decision to accept test data from the radio module, by the manufacturer of the final radio product, for applicability to the final radio product, is at the discretion and responsibility of the manufacturer of the final radio product.

TGN 33 DRAFT Technical Guidance Note on the RED as applied to Vehicles

■ Scope

- This Technical Guidance Note (TGN) has been written to ensure a **uniform approach** is used by all Notified Bodies and manufacturers regarding the process to **determine the applicability of the RED to vehicles and demonstrating compliance**.
- This TGN also provides guidance regarding the relationship between Type Approval legislation, RED and other EU acts when the **vehicle incorporates radio equipment and becomes a final radio product**, as defined in REDCA TGN 01.
- This TGN deals with the assessment of the final radio product (vehicle) “radio equipment” which contains one or more specific components (radio).

TGN 33 RED as applied to Vehicles

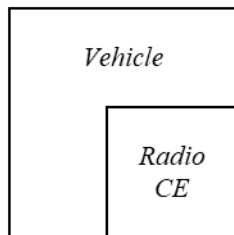
- **Definitions:**
- **Radio Module** The guidance provided in TGN 01 is directly applicable to radio modules used on vehicles. The radio module manufacturer needs to. **ensure that their assessment takes into account the intended operating environment and use of the vehicle and covers all applicable Article 3 requirements**
- **Host Product (Vehicle)** Mobile machine with one or more traction motors, or towed platform, which is intended to carry persons, goods or used for material extraction/handling. If the host is subject to Type Approval then it is still considered as a host
- **Final Radio Product¹ (combined equipment)**
A final radio product is the combination of a radio module(s) and the host product/vehicle which provide an end function for its users.

TGN 33 RED as applied to Vehicles

- **OEM v Aftermarket products** It is important to demarcate between the responsibility between a vehicle as supplied by a manufacturer and aftermarket products that can be fitted by end users and/or dealerships.
 - The OEM (Vehicle manufacturer) **must ensure** that their vehicle complies with the **applicable legislation** when making available to the market (including RED compliance for radios)
 - An aftermarket radio equipment **must also meet the applicable legislation**. The person who installs the radio equipment on the host, which has been previously been placed on the EU market, shall follow the installation instructions provided by the radio module manufacturer
 - The installer of the aftermarket radio module shall be considered as the manufacturer of the final radio product if:
 - the compliance of the host is impacted because the instructions provided for the radio equipment were not followed; or
 - the intended function or performance of the host product is modified.

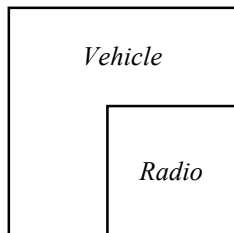
Vehicles subject to Type Approval

- Certain vehicles for use on the public highway must be Type Approved before they can be registered and used. There is various European Union Legislation presently in force covering such vehicles:
 - 2007/46/EC Whole Vehicle Framework Directive
 - 2013/167/EU Agricultural and Forestry Vehicles and their Trailers
 - 2013/168/EU 2 or 3 Wheeled Vehicles and Quadricycles
- The radio module remains the CE Marked radio device if integrated in accordance with the instructions.



Vehicles not subject to Type Approval

- Vehicles that are not designed for use on the public highway are not subject to Type Approval and are therefore **subject to any applicable directives and/or regulations**. Examples include: the Machinery Directive (2006/42/EC as amended), the ATEX Directive (2014/34/EU) etc.
- In the case of CE marking, **compliance must be documented for all applicable directives, including the RED**. In this case the manufacturer must consider carefully what possible impact the Radio Equipment may have on the functional performance of the vehicle and make the case for compliance on this basis with appropriate risk analysis in their Technical Documentation.
- There is a wide variety of vehicular types which are **not subject to Type Approval**, because they are **not primarily intended for use on the public highway**. Examples of such vehicles include: Mining, Earthmoving, Construction and Access Machinery, Leisure vehicles and Fork-Lift Trucks, etc. may also fall within this category.
- The CE marking of final product

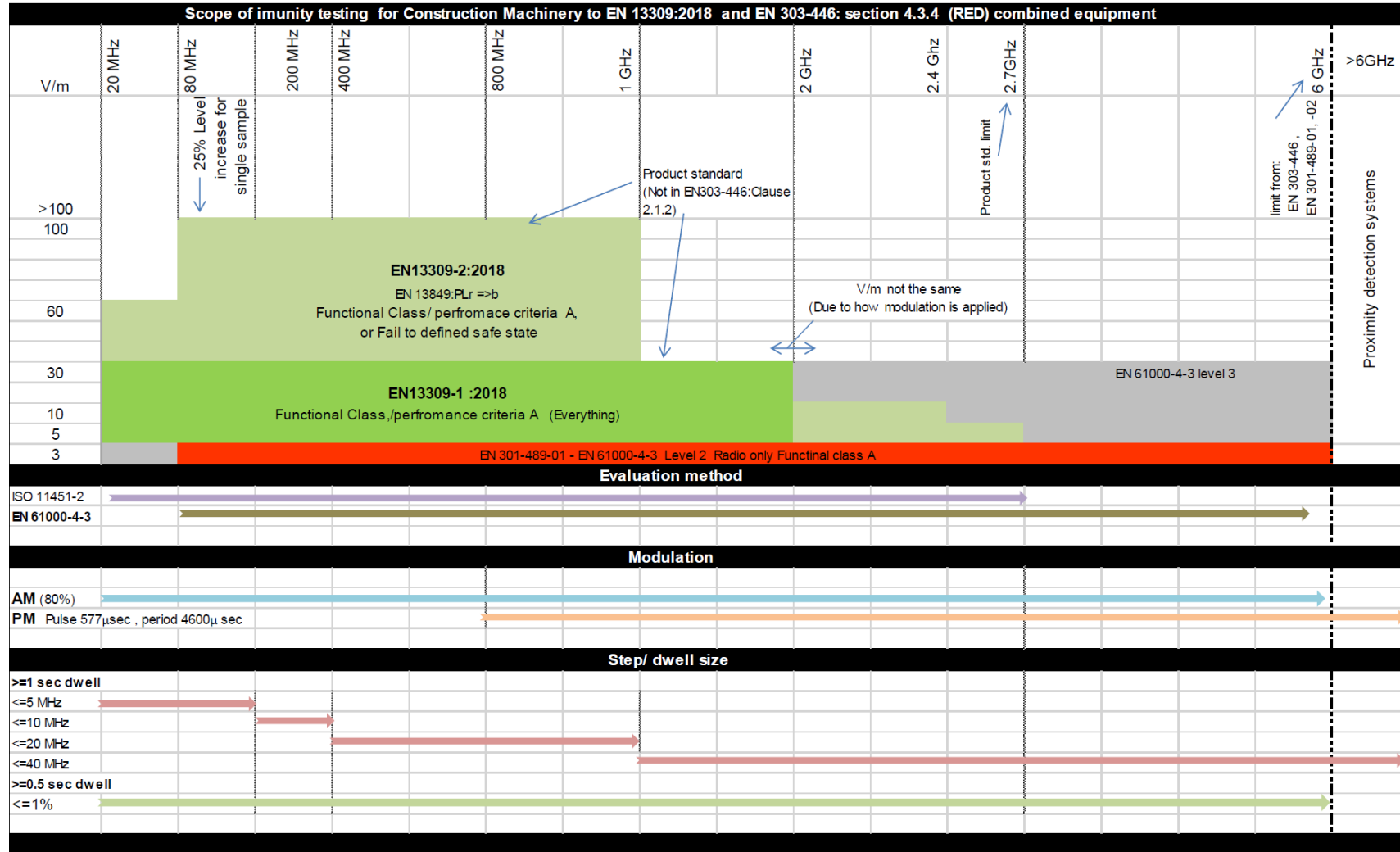


EMC Deltas

■ Differences in standards and background

- CEN and CENELEC adopt International standards written by IEC and ISO and form the basis of many of the EMC standards used by product manufacturers and ultimately as harmonised standards. **When a radio function is added to a host vehicle, then the radio performance needs to be monitored** and assessed. Radio performance standards for EMC are typically written by ETSI.
- ETSI EN 303 446-1/2 (draft) standards have been written to **provide guidance to manufacturers of what tests to perform** and the corresponding technical parameters (**levels, frequency range etc**). Drawing on this work, the following diagram has been prepared to highlight the overlap and differences in the documents from the standards writing bodies (ETSI/CEN/CENELEC/ISO/IEC) and to help manufacturers decide how to define a set of **EMC tests that will address both the EMC (non-radio functionality) and radio performance against the protection requirements** defined by the directive(s). The standards used below are applicable to earth moving machinery but is used as just an illustrative example.
- The illustrative example is limited to radiated immunity but the concept of what needs to be considered by the final radio product manufacturer needs to be considered for all of the applicable EMC assessments taking into account the practicalities of evaluating final radio products.

Illustrative example, Radiated immunity



Worst case from both Product standard and Radio standard

■ Frequency Range

- The determination over frequency range for testing should involve taking the **worst case frequency range** from the referenced standard(s) and/or supplementing this with additional frequencies or frequency ranges as determined by assessment of the host, radio module standards and environmental knowledge.

■ Test Level

- The **product standard** is considered as more appropriate for the test levels and **should be used as the basis of the test level over the frequency range that the product standard covers**, noting that there are different ways of presenting this information in standards (i.e. rms v peak conservation). The test level applied to the final radio product over the extended frequency range should be based on knowledge of the specific EM environment and other applicable standards, for example the corresponding ETSI standard that covers the upper frequency range.

■ Modulation

- The modulation types applied (AM,PM) applied to the final radio product should take into account the types of modulation used by interfering signals (which will include other radio transmitters) and be applied accordingly. Where there is a conflict in the modulation type to apply between the various standards, IEC/EN 61000-4-3 Annex A provides further guidance.

■ Step Size

- An assessment is required by the manufacturer to ensure that the requirements of the referenced standards have been considered and/or mitigated accordingly. Additional discrete frequencies may need to be considered on the final radio product or mitigated by other means (i.e. tests performed at module level).

REDCA TGN 31 Multiple transmitters and receivers

- This TGN deals with the assessment of the end product “radio equipment” which contains two or more radio components that can operate simultaneously.
- RF exposure should be considered (summed power)
- Transmitter considerations
 - Radiated Spurious Emissions should be performed on the final product in the worst case permutation(s) of simultaneously active transmitters
- Receiver considerations
 - Antenna locations
 - Co-location
 - The transmit/receive frequencies for 2.4 GHz WiFi and Band 40 LTE are immediately adjacent – so a 20 MHz wide WiFi signal from 2400-2420 MHz at 2 dBm/MHz transmitter can be collocated with an LTE receiver trying to receive a 2380-2400 MHz signal at -106 dBm/MHz
 - 2.4 GHz WiFi has a receiver blocking requirement of -34 dBm at 2523.5 MHz, but a band 7 LTE modem can transmit at +23 dBm.

ETSI Standards dealing with Radio modules

- ETSI EG 203 367 (v1.1.1; 2016-06)
 - Guide to the application of harmonised standards covering articles 3.1b and 3.2 of the Directive 2014/53/EU (RED) to multi-radio and combined radio and non-radio equipment
- EN 303 446-1 (v1.1.0; 2017-03)
 - ElectroMagnetic Compatibility (EMC) standard for combined and/or integrated radio and non-radio equipment Part 1: Requirements for equipment intended to be used in residential, commercial and light industry locations; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU
- EN 303 446-2 (v1.1.0; 2017-03)
 - ElectroMagnetic Compatibility (EMC) standard for combined and/or integrated radio and non-radio equipment Part 2: Requirements for equipment intended to be used in industrial locations; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU