
**Road vehicles — (EMC) guidelines
for installation of aftermarket radio
frequency transmitting equipment**

*Véhicules routiers — Guide sur la compatibilité électromagnétique
(CEM) pour l'installation en seconde monte d'équipements radio-
téléphone*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This second edition cancels and replaces the first edition (ISO/TS 21609:2003), which has been technically revised.

Road vehicles — (EMC) guidelines for installation of aftermarket radio frequency transmitting equipment

1 Scope

This Technical Specification gives requirements and recommendations for the installation in road vehicles of

- radio frequency (RF) transmitting and receiving equipment,
- “in-road-vehicle” mounting kits for transportable and hand-held RF equipment, and
- ancillary equipment associated with these.

As well as methods for installation, it establishes methods for minimizing the possibility of electromagnetic interference (EMI) between the installed equipment and the vehicle electrical and electronic systems.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)*

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3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 (all parts) and the following terms, definitions and abbreviated terms apply.

3.1.1

mobile equipment

receiver, transmitter or transmitter/receiver (transceiver) that is intended for installation and use in a vehicle, and powered by the main battery of the vehicle

3.1.2

ancillary equipment

any equipment required as part of the installation in addition to the radio

EXAMPLE Voltage converter

3.1.3

equipment supplier

supplier of the equipment to the installer

Note 1 to entry: The equipment supplier may be a dealer, distributor or manufacturer.

3.1.4

floating system

isolated ground return

3.1.5

ground plane

conducting plane of a minimum dimension proportional to the wavelength λ on which a panel mount antenna is fitted

3.1.6

installer

radio equipment installation technician

3.1.7

radiating element

part of an antenna which radiates the signal

3.1.8

vehicle supplier

supplier of the vehicle, who may be a dealer or the manufacturer/importer of the vehicle

3.2 Abbreviated terms

ABS anti-blocking system

CB citizen band

ECU electronic control unit

EMC electromagnetic compatibility

EMI electromagnetic interference

HT high tension (i.e. the high voltage circuits of the ignition system)

ICE in-car entertainment

PMR private mobile radio

RF radio frequency

RFI radio frequency interference

VSWR voltage standing wave ratio

4 General

Installation of RF-transmitting equipment shall be performed by competent personnel. The vehicle and RF transmitting equipment manufacturers' instruction manuals and installation notes shall be followed.

NOTE Vehicle manufacturer's instructions take priority in case of conflict.

It is the responsibility of the competent personnel to ensure the installation complies with national legal requirements for the installation and use of RF equipment in vehicles.

Installation shall be checked for possible interference between the RF-transmitting equipment and the vehicle electric systems in accordance with [6.3](#).

4.1 Customer liaison and installation requirements

4.1.1 General

The customer shall

- be advised to use a suitable antenna for the particular application and optimum position,
- be made aware of the various fixing locations and mounts available for the items to be fitted, and
- be asked whether or not an ignition switched supply to the equipment is required.

4.1.2 EMC requirements

After-market RF-transmitting equipment for installation in road vehicles shall fulfil the requirements of RF-product relevant EMC standards and road vehicle standards. Contact the road vehicle manufacturer and/or equipment supplier if necessary to ensure that the latest version is used.

The purpose of road vehicle EMC standards (see [Table 1](#)) and legal requirements ([Table 2](#)) is to ensure

- the protection of broadcast receivers in a residential environment from radio disturbances from vehicles at distances greater than 10 m,
- that vehicle RF-receivers have sufficient protection from unwanted emissions of other electric systems (RF-systems included) installed in the same vehicle, and
- that no vehicle functions are affected because of the susceptibility of RF-systems to radiated or conducted disturbances.

Table 1 — ISO and IEC/CISPR EMC and RFI standards for road vehicles

Standard	Title
ISO 7637 (all parts)	<i>Road vehicles — Electrical disturbances from conduction and coupling</i>
ISO 10605	<i>Road vehicles — Test methods for electrical disturbances from electrostatic discharge</i>
ISO 11451	<i>Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy</i>
ISO 11452	<i>Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy</i>
ISO 13766	<i>Earth-moving machinery — Electromagnetic compatibility</i>
ISO 14982	<i>Agricultural and forestry machinery — Electromagnetic compatibility — Test methods and acceptance criteria</i>
CISPR 12	<i>Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of off-board receivers</i>
CISPR 25	<i>Vehicles, boats and internal combustion engines — Radio disturbance characteristics — Limits and methods of measurement for the protection of on-board receivers</i>

Table 2 — Selection of EMC regulations for vehicles and equipment

Standard	Title
ECE-R 10	<i>Agreement concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions</i> <i>Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility</i>
1999/5/EC	<i>Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity</i>
ECE-R 116	<i>Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions</i> <i>Uniform technical prescriptions concerning the protection of motor vehicles against unauthorised use</i>
CFR Title 47 Part 15	<i>Telecommunication, Radio Frequency Devices</i>

In addition to vehicle standards, RF-product specific EMC standards (see [Table 3](#)) are designed to ensure that

- the RF-system operates in environments specified in the applicable radio EMC standard, and
- unwanted emissions are controlled to a specific level.

4.1.3 Vehicle supplier's warranty

Installation of mobile radio equipment to any part of the vehicle, other than an authorized connection or mounting location, might invalidate the vehicle warranty. If in doubt, the vehicle or equipment supplier shall be consulted.

4.1.4 Electromagnetic and radio frequency interference

Full consideration shall be given to the positioning of mobile RF-transmitting equipment such that electromagnetic interference (EMI) and radio frequency interference (RFI) is minimized between the RF transmitting equipment being installed and the vehicle electrical and electronic systems.

Mobile equipment might include radio equipment, ancillary equipment, antenna and feeder cable.

4.1.5 Radio equipment and ancillary items

Prior to the installation of the radio equipment or any other ancillary items, it is essential that the vehicle manufacturer's and equipment supplier's instructions be followed, in order to ensure that the safe operation of the vehicle is not impaired.

Care shall be taken when planning the installation that any additional equipment used does not constitute a safety hazard and does not contravene safety regulations.

Care shall be taken to ensure that any microphone/handset lead is not installed such that the lead can interfere with the vehicle controls or driver.

Where a hand portable or transportable unit is installed in road vehicles, the correct car adapter kit specified for the product shall be used.

Table 3 — Selection of EMC product standards for RF equipment

Standard	Title
EN 301 489-1	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements</i>
EN 301 489-2	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 2: Specific conditions for radio paging equipment</i>
EN 301 489-3	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 40 GHz</i>
EN 301 489-4	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links, Broadband Data Transmission System Base stations, ancillary equipment and services</i>
EN 301 489-5	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 5: Specific conditions for Private land Mobile Radio (PMR) and ancillary equipment (speech and non-speech)</i>
EN 301 489-6	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 6: Specific conditions for Digital Enhanced Cordless Telecommunications (DECT) equipment</i>
EN 301 489-7	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and GPRS)</i>
EN 301 489-8	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 8: Specific conditions for GSM base stations</i>
EN 301 489-9	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 9: Specific conditions for wireless microphones, similar Radio Frequency (RF) audio link equipment, cordless audio and in-ear monitoring devices</i>
EN 301 489-10	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 10: Specific conditions for First (CT1 and CT1+) and Second Generation Cordless Telephone (CT2) equipment</i>
EN 301 489-11	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 11: Specific conditions for terrestrial sound broadcasting services transmitters</i>
EN 301 489-12	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 12: Specific conditions for Very Small Aperture Terminal, Satellite Interactive Earth Stations operated in the frequency ranges between 4 GHz and 30 GHz in the Fixed Satellite Service (FSS)</i>
EN 301 489-13	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 13: Specific conditions for Citizens' Band (CB) radio and ancillary equipment (speech and non-speech)</i>
EN 301 489-14	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 14: Specific conditions for analogue and digital terrestrial TV broadcasting service transmitters</i>
EN 301 489-15	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 15: Specific conditions for commercially available amateur radio equipment</i>
EN 301 489-16	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 16: Specific conditions for analogue cellular radio communications equipment, mobile and portable</i>

Table 3 (continued)

Standard	Title
EN 301 489-17	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for broadband data transmission systems</i>
EN 301 489-18	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 18: Specific conditions for Terrestrial Trunked Radio (TETRA) equipment</i>
EN 301 489-19	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 19: Specific conditions for Received Only Mobile Earth Stations (ROMES) operating in the 1,5 GHz band providing data communications</i>
EN 301 489-20	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 20: Specific conditions for Mobile Earth Stations (MES) used in the Mobile Satellite Services (MSS)</i>
EN 301 489-22	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 22: Specific conditions for ground based VHF aeronautical mobile and fixed radio equipment</i>
EN 301 489-23	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 23: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA and E-UTRA) Base Station (BS) radio, repeater and ancillary equipment</i>
EN 301 489-24	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 24: Specific conditions for IMT-2000 CDMA Direct Spread (UTRA and E-UTRA) for mobile and portable (UE) radio and ancillary equipment</i>
EN 301 489-25	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 25: Specific conditions for CDMA 1x spread spectrum mobile stations and ancillary equipment</i>
EN 301 489-26	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 26: Specific conditions for CDMA 1x spread spectrum base stations, repeaters and ancillary equipment</i>
EN 301 489-27	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 27: Specific conditions for Ultra Low Power Active Medical Implants (ULP-AMI) and related peripheral devices (ULP-AMI-P)</i>
EN 301 489-28	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 28: Specific conditions for wireless digital video links</i>
EN 301 489-29	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 29: Specific conditions for Medical Data Service Devices (MEDS) operating in the 401 MHz to 402 MHz and 405 MHz to 406 MHz bands</i>
EN 301 489-31	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 31: Specific conditions for equipment in the 9 kHz to 315 kHz band for Ultra Low Power Active Medical Implants (ULP-AMI) and related peripheral devices (ULP-AMI-P)</i>
EN 301 489-32	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 32: Specific conditions for ground and wall probing radar applications</i>
EN 301 489-33	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 33: Specific conditions for Ultra Wide Band (UWB) communications devices</i>

Table 3 (continued)

Standard	Title
EN 301 489-34	<i>Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 34: Specific conditions for External Power Supply (EPS) for mobile phones</i>
RSS-119	<i>Radio-transmitters and receivers operating in the Land mobile and fixed services in the frequency range 27,41 – 960 MHz</i>
RSS-128	<i>800 MHz Dual-mode TDMA cellular telephones</i>
RSS-129	<i>800 MHz Dual-mode CDMA cellular telephones</i>
RSS-136	<i>Land and mobile station radiotelephone transmitters and receivers operating in the 26,960 – 27,410 MHz general radio service band</i>

5 Installation

5.1 Installation process

Care shall be taken in

- choosing the antenna,
- mounting it in a recommended location,
- installing it correctly,
- ensuring that all connections in the antenna feeder are sealed to prevent dirt and water from entering the feeder and affecting its performance,
- ensuring that all connections are electrically tested after installation, and
- ensuring that a satisfactory VSWR reading is obtained.

5.2 Antenna

For transmitting systems with output power levels above 100 mW (peak), an external antenna is strongly recommended.

The external antenna and feeder cable shall be impedance matched with a VSWR < 1,5. The best position for an antenna is on the metallic roof, preferably towards the centre, but where possible with a distance of $\geq \lambda/4$ (λ = wavelength) from any opening, such as a sunroof or windows. Care shall be taken when mounting an antenna next to an existing one or when mounting antennas with magnetic bases, as this could affect the accuracy or operation of the compass on vehicles so equipped.

5.2.1 Radiation patterns and ground planes

In order to create a symmetrical, non-directional radiation pattern, an antenna needs to be mounted vertically on a horizontal ground plane with, ideally, a radius of $\geq \lambda/4$ at the lowest frequency band used (see Table 4).