TECHNICAL SPECIFICATION

ISO/TS 21609

First edition
2003-10-15

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

Reference number
ISO/TS 21609:2003(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

ISO/TS 21609 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

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 handheld 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050, *International Electrotechnical Vocabulary (IEV)*

3 Terms, definitions and abbreviated terms

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

3.1 Definitions

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 The equipment supplier could 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 could 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.

The installation shall comply 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 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	*Road vehicles — Electrical disturbances by conduction and coupling*
ISO 10605	*Road vehicles — Test methods for electrical disturbances from electrostatic discharge*
ISO 11451	*Road vehicles — Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy*
ISO 11452	*Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy*
ISO 13766	*Earth-moving machinery — Electromagnetic compatibility*
ISO 14982	*Agricultural and forestry machinery — Electromagnetic compatibility — Test methods and acceptance criteria*
CISPR 12	*Vehicles, motorboats and spark-ignited engine-driven devices — Radio disturbance characteristics — Limits and methods of measurement*
CISPR 25	*Radio disturbance characteristics for the protection of receivers used on board vehicles, boats, and on devices — Limits and methods of measurement*

Table 2 — Selection of EMC regulations for vehicles and equipment

Standard	Title
95/54/EC	*Commission Directive 95/54/EC of 31 October 1995 adapting to technical progress Council Directive 72/245/EEC on the approximation of the laws of the Member States relating to the suppression of radio interference produced by spark-ignition engines fitted to motor vehicles and amending Directive 70/156/EEC on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers*
ECE-R 10	*Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility*
1999/5/EC	*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*
ECE-R 97	*Uniform provisions concerning the approval of vehicle alarm systems and of vehicles with regard to their alarm systems*
CFR Title 47 Part 15	*Telecommunication, Radio Frequency Devices*

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, may 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 may 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	*Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements*
Draft EN 301 489-3	*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*
Draft EN 301 489-5	*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)*
Draft EN 301 489-6	*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*
Draft EN 301 489-7	*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 DCS)*
Draft EN 301 489-12	*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)*
Draft EN 301 489-13	*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)*
Draft EN 301 489-15	*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*
Draft EN 301 489-16	*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*
Draft EN 301 489-18	*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*
Draft EN 301 489-22	*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*
RSS-119	*Land mobile and fixed radio transmitters and receivers, 27.41 MHz to 960 MHz*
RSS-128	*800 MHz Dual-mode TDMA cellular telephones*
RSS-129	*800 MHz Dual-mode CDMA cellular telephones*
RSS-136	*Land and mobile station radiotelephone transmitters and receivers operating in the 26,960 – 27,410 MHz general radio service band*

5 Installation

5.1 Installation process

Care shall be taken in

— choosing the antenna,

— siting 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 $\geqslant \lambda/4$ (λ = wavelength) from any opening, such as a sunroof or windows. Care shall be taken when siting 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 $\geqslant \lambda/4$ at the lowest frequency band used (see Table 4).

Table 4 — Approximate frequency-to-wavelength conversion

Frequency f MHz	Wavelength λ cm	 $\lambda/4$ cm
50	600	150
80	375	94
150	200	50
450	66	17
600	49,5	12
900	33	8
1800	16,5	4

The antenna should not be located close to any electrically resonant structure.

Care shall be taken when siting the antenna close to another, existing antenna. It is necessary to separate them by $\geqslant \lambda/4$ for transmit frequencies $f \leqslant 600$ MHz and $\geqslant \lambda$ for transmit frequencies $f > 600$ MHz (see Table 4).

The antenna should be located as high as possible, the ideal location being on the roof of the vehicle. Any other location could have a marked effect on the radiation pattern of the antenna.

5.2.2 Ground-plane provision

When the antenna installation is to be carried out on a non-metallic surface:

— a ground-plane-independent antenna can be fitted directly to any surface (glass-fibre etc.) or onto a mounting bracket which may be supplied by the manufacturer;

— a standard antenna can be used with a ground plane fitted to the underside of the panel, for example a metallic plate complying with dimensions given in Table 4.

5.2.3 Fitting the antenna

5.2.3.1 “On-glass” antennas

Care shall be taken to ensure the antenna is mounted clear of the window heater elements, decorative coating, washer/wiper and integral screen receiver antenna where fitted. Before fitting an on-glass antenna, refer to manufacturer’s instructions and recommendations. In some cases, fitting may constitute a safety hazard and may invalidate the vehicle manufacturer’s warranty. On-glass antennas might not be suitable for vehicles with double-glazed screens, reflective coatings or other special glass.

If interference occurs to the “in-road-vehicle” entertainment equipment or other vehicle electrical equipment, repositioning or use of a different type of antenna should be considered.

Scrupulous cleanliness shall be observed and care shall be taken to avoid touching the adhesive surfaces or the glass after cleaning prior to fixing. Care shall be taken to ensure that the glass is within the specified temperature range when fixing the antenna mount in order to obtain a good bond.

5.2.3.2 Special and temporary antennas

These can include combined (dual or multi-frequency), ground-plane-independent, low profile, boot lip, magnetic and window clip types. Where applicable, the antenna manufacturer’s instructions should be followed with due regard to the vehicle manufacturer's instructions and limitations.

On temporary mount types, care shall be taken with routing the coaxial cable through door/boot openings to minimize risk of damage to the cable.

Combined antennas may be supplied with a separate diplexer unit which should be securely fixed in a location where it is protected against ingress of water and other particles.

5.3 Antenna cable

Coaxial cable connectors shall be used. Shielded and low-loss antenna cable that is impedance matched for the equipment (VSWR < 1,5) shall be used to provide a continuous run between antenna and radio equipment. Excess coaxial cable shall not be coiled, as this may affect the tuning of the antenna as well as producing electrical interference. If possible, the antenna cable should be cut to the correct length.

5.3.1 Routing of the feeder cable

The cable should be routed so as to avoid sharp bends and, where possible, existing vehicle wiring and electronic modules. Safety-sensitive electronic control units (e.g. airbag and ABS systems), circuits and harnesses shall not be used for parallel wiring. If it is necessary to cross other wiring, cross at right angles.

If an extension feeder cable is required, suitable coaxial cable shall be used and correctly terminated with good quality, low-loss connectors. If the antenna cable provided is too short, wherever possible the cable should be replaced by a suitable feeder cable of correct length. Extending the length of the feeder cable will result in additional losses, particularly at frequencies > 800 MHz.

Ensure that the feeder cable is not strained or distorted by, for example, excessive tightening of cable ties. When vehicle trim is replaced, make sure that the panels do not trap the feeder cable. Additional care should be taken when installing a glass mount antenna to the rear screen of a hatch-back type vehicle to allow opening and to prevent damage to the feeder cable.

5.3.2 Fitting of the coaxial connectors

Fit the correct antenna connectors at each end of the feeder cable to match the equipment using either crimp or soldered connectors as appropriate. In the case of crimp connectors, use only the correct crimping tool. Ensure that the joints are electrically and mechanically sound.

Before and after replacing any vehicle trim, which may have been removed to install the antenna, it is advisable to carry out the antenna checks specified in 6.1.

5.4 Installation of radio equipment

5.4.1 Mounting of equipment in the vehicle

The following requirements and recommendations are applicable to the installation of radio equipment in the vehicle.

— It shall conform with equipment and vehicle manufacturer's instructions.

— Equipment shall not be able to be damaged or its ventilation restricted. Special care should be taken to ensure that equipment cannot be damaged by ingress of water.

— Access to vehicle equipment in the load storage area shall not be barred, e.g. by wheeljack, fire extinguishers or spare wheel.

— The connections to the equipment should be easily accessible in order that the equipment may be removed for operation in transportable mode, or for repairs and servicing.

— It shall not hinder the operation of airbags or other safety equipment.

5.4.2 Routing of cables

5.4.2.1 General

Where possible, all cables should pass inside or underneath trim and through mouldings in such a way as to afford maximum protection. If necessary, use sleeving, a proprietary protector and/or cable ties where required.