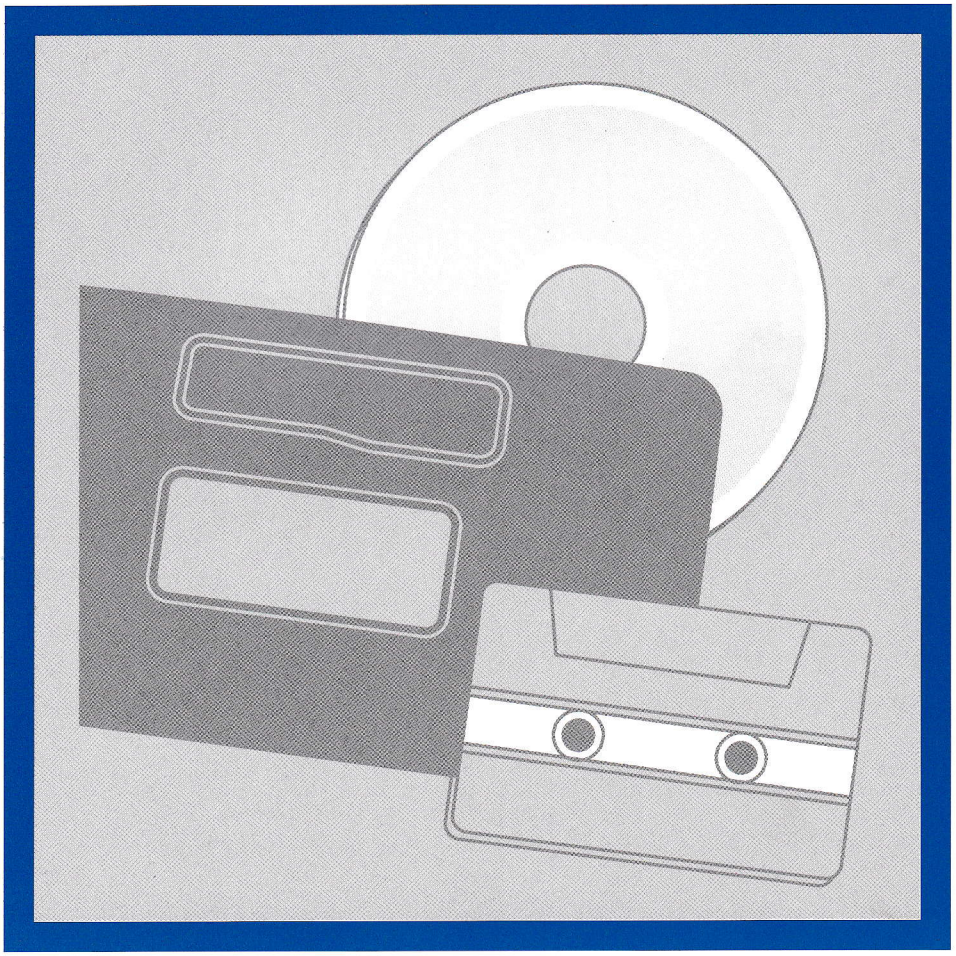
T10

Technical Service Training

Infotainment

Curriculum Training TC4012031H

Fundamentals



Student Information

CG 8012/S en 05/2002

In recent years Ford has introduced a large number of new audio systems which offer major improvements in performance and functionality. The range comprises powerful radio cassettes, CD players and CD autochangers plus amplifiers and loudspeaker systems.

Modern communications technology also brings a large number of additional options in the combination of different systems (e.g. navigation system, telephone, multimedia, telematics).

This publication describes the fundamentals of radio reception, navigation, antenna systems, anti-theft protection, loudspeaker systems and interference suppression components.

The complete course on Infotainment consists of two training modules:

- **Infotainment "Fundamentals", CG 8012/S, TC4012031H**
- Infotainment "Service and Diagnostics", CG 8013/S, TC4012032H

Please remember that our training literature has been prepared solely for FORD TRAINING PURPOSES.

Repair and adjustment operations **MUST** always be carried out according to the instructions and specifications in the workshop literature.

Please make extensive use of the training courses offered by Ford Technical Training Centers to gain extensive knowledge in both theory and practice.

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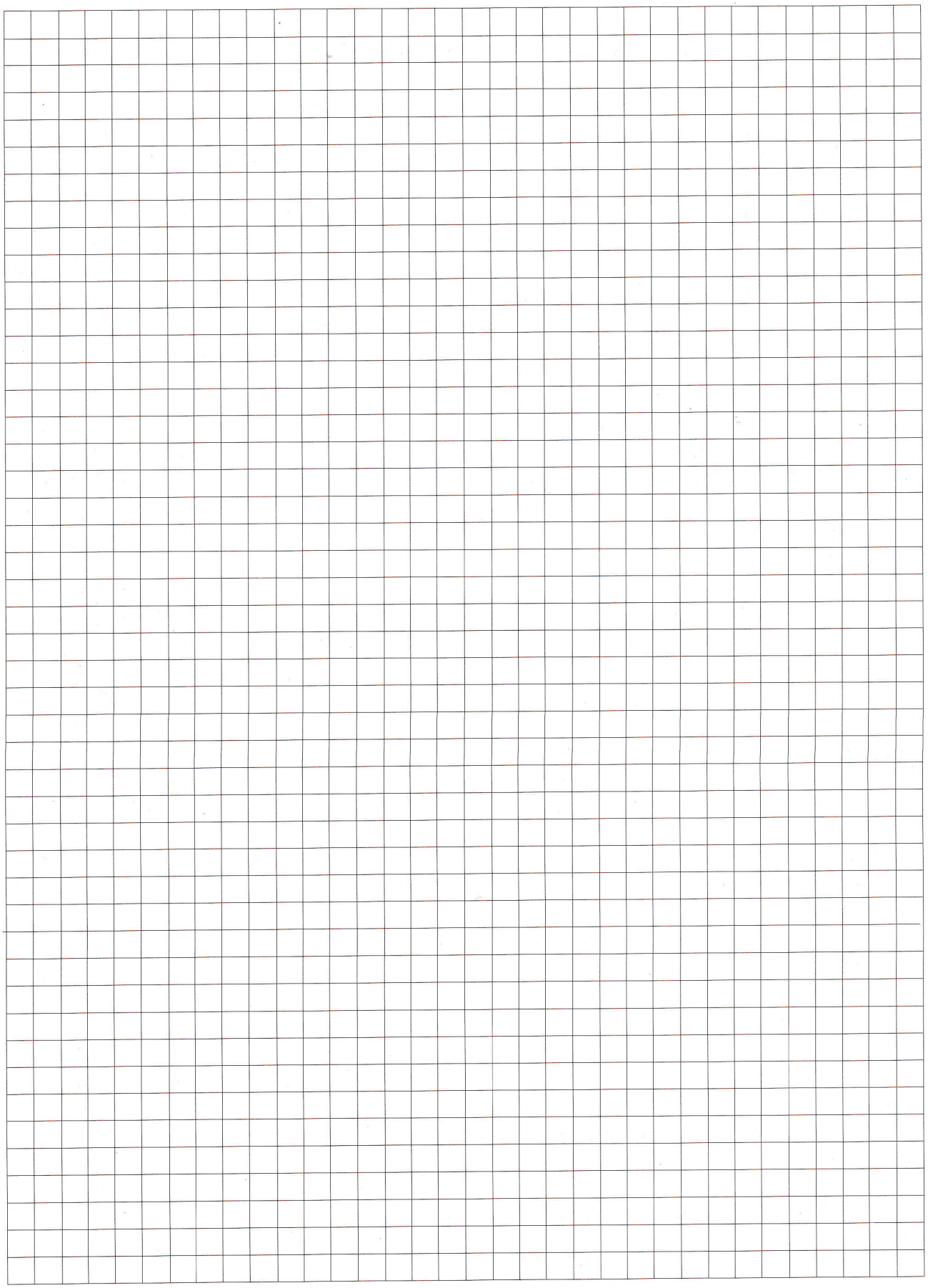
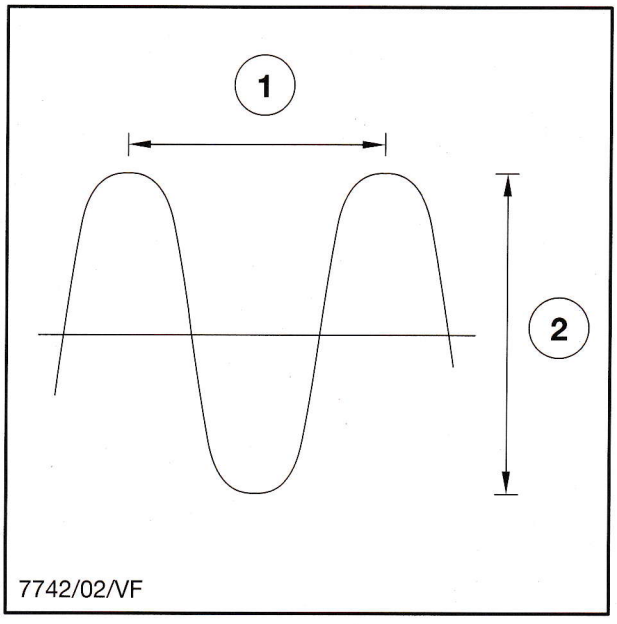


Waves

- A wave can be observed for example when a stone is thrown into water. The state of the water changes and this change is continued.
- Different types of waves are required for radio transmission from the transmitter to the listener:
  - A radio transmitter broadcasts electromagnetic waves. These propagate at the speed of light (300,000 km/s).
  - The radio waves are received by the audio unit through the antenna, converted into electrical signals and passed along wiring to the loudspeakers.
  - The loudspeakers convert the electrical signals into sound waves. These are propagated at the speed of sound (approx. 340 m/s) and reach the listener.

Wavelength and amplitude

- The distance from one wave crest to the next is called the wavelength.
- The distance from the peak of a wave crest to the lowest point of a wave trough is the amplitude of the wave.

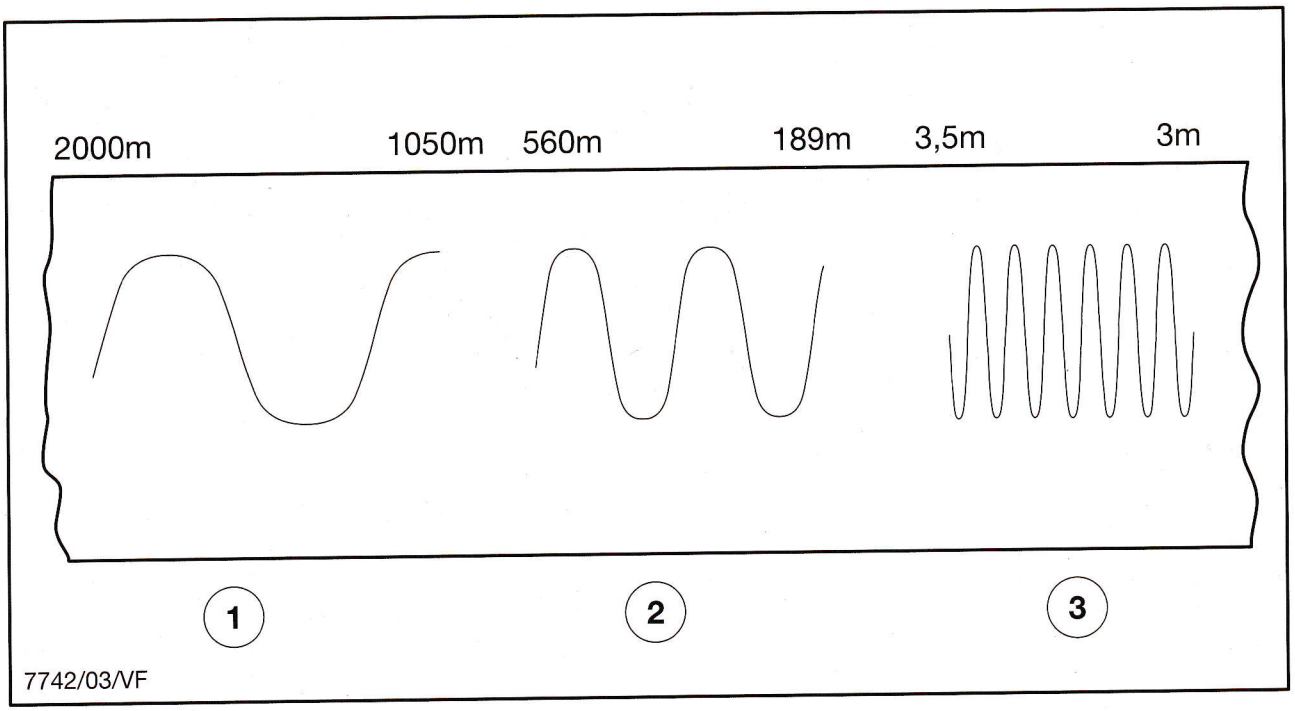


1 Wavelength
2 Amplitude

Oscillations

- Oscillations are changes in state which are repeated in the course of time.
- The number of oscillations per second gives the frequency. The frequency is measured in hertz (Hz).
- The electromagnetic waves which are used for radio transmission have the following wavelengths and frequencies:

Wave band	Wavelength	Frequency range
Long wave (LW)	2000 – 1050 m	150 – 285 kHz
Medium wave (MW)	560 – 189 m	535 – 1605 kHz
Very high frequency (VHF)	3.5 – 3 m	87.5 – 108 MHz
GSM	33 cm – 1 mm	900 MHz – 300 GHz
GPS	19.05 cm – 24.45 cm	1227.6 MHz – 1575.42 MHz



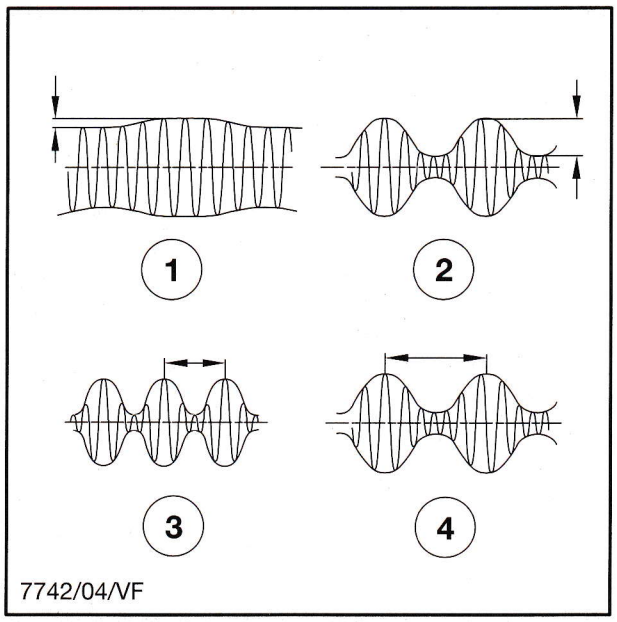
1 Long wave (LW)
2 Medium wave (MW)
3 Very high frequency (VHF)

Modulation

- To broadcast speech or music by radio waves, the signal must be transmitted on a carrier frequency. This process is called modulation.

Amplitude modulation (AM)

- With amplitude modulation (AM) the amplitude, or magnitude of the signal, is changed to transmit the information. The magnitude of the change determines the volume of the music, the frequency of the change the pitch.
- This type of modulation is used for LW and MW. Therefore, these wavebands are often combined under the designation AM.
- The disadvantage of amplitude modulation is the relatively poor sound quality because atmospheric and other interference affects the amplitude of the signals above all.



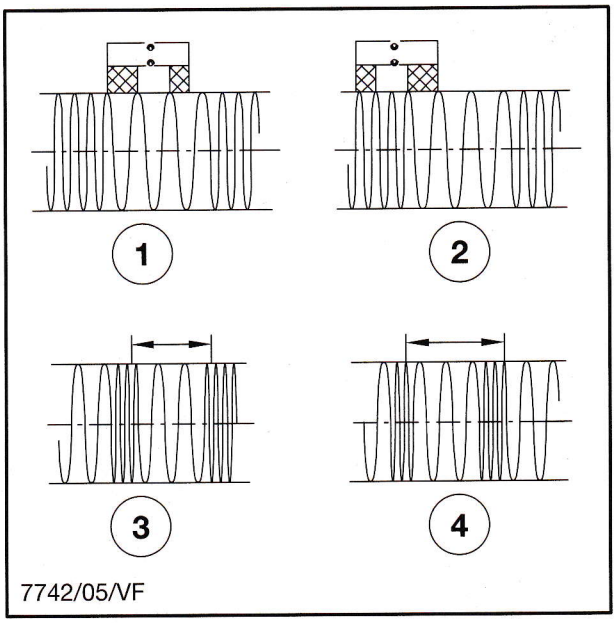
AM (illustration of principle)

1 Quiet note
2 Loud note
3 High note
4 Low note

Modulation (continued)

Frequency modulation (FM)

- With frequency modulation (FM) it is not the amplitude of the carrier signal which is changed but its frequency. The magnitude of the frequency change determines the volume, the frequency of the frequency change the pitch.
- FM is used with VHF. Often FM is also used as the name for the VHF waveband.
- The advantages of frequency modulation are:
  - high quality sound
  - possibility of stereo reception
  - reduced susceptibility to interference
- With FM the amplitude of the signals plays no part; therefore it can be limited or clipped with a suitable circuit.
- The main disadvantage is the short range of VHF (FM) transmitters due to the specific characteristics of VHF waves.



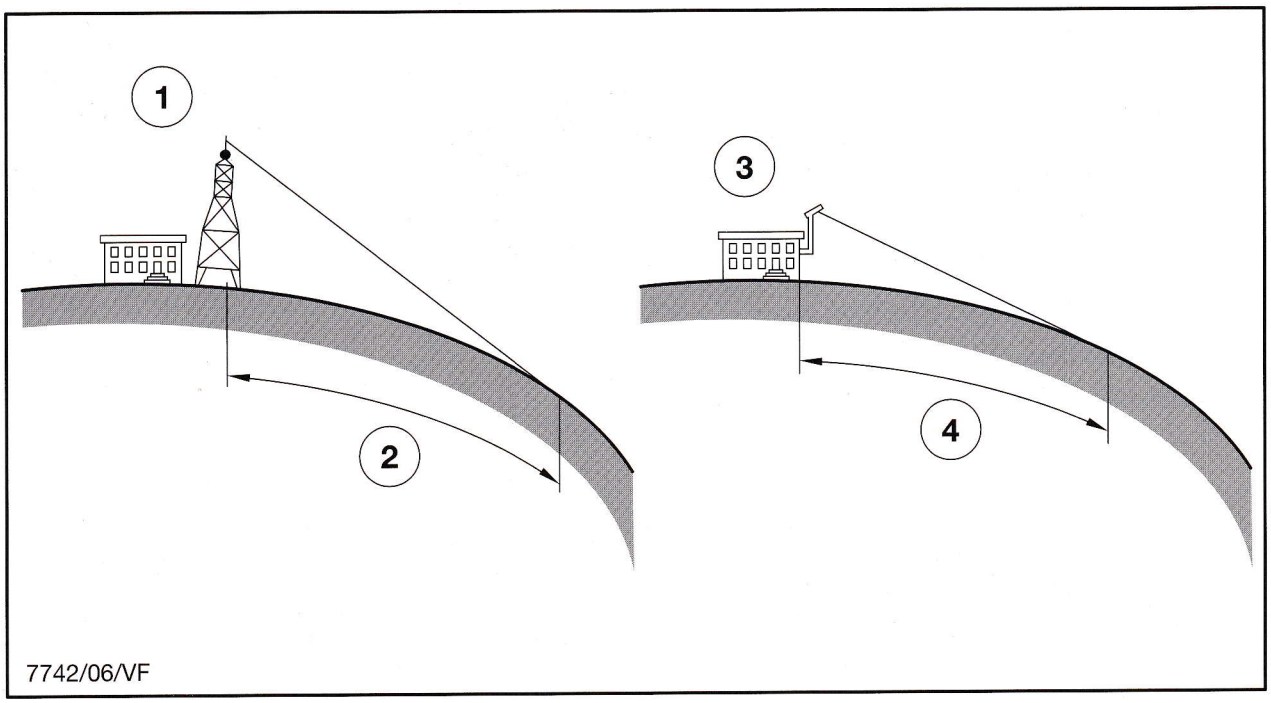
FM (illustration of principle)

1 Quiet note
2 Loud note
3 High note
4 Low note

VHF (FM) transmission

Range of a VHF (FM) transmitter

- VHF (FM) transmitters are usually located at the highest possible points in a region. The reason for this is the straight line propagation of the VHF (FM) signals and their limited range.
- In normal environmental conditions the range of VHF (FM) transmitters is approximately 40 – 50 km.
- The range of local transmitters can be reduced to 20 km by transmission power restrictions and low lying transmitter locations.



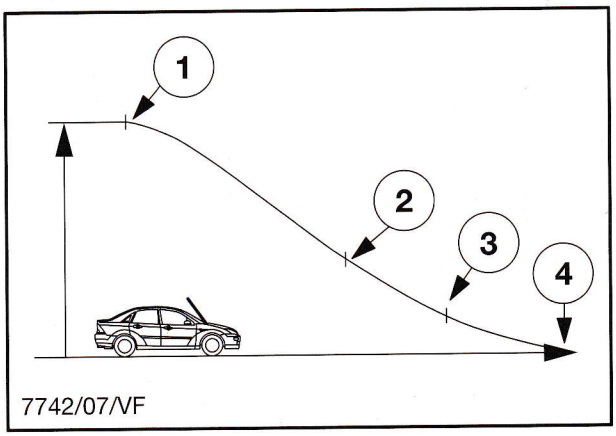
Different range of VHF (FM) transmitters

1 High transmitting mast/high transmission power
2 Range approx. 40 – 50 km
3 Local transmitter/lower transmission power
4 Range approx. 20 km

Causes of poor VHF (FM) reception

Distance from the transmitter

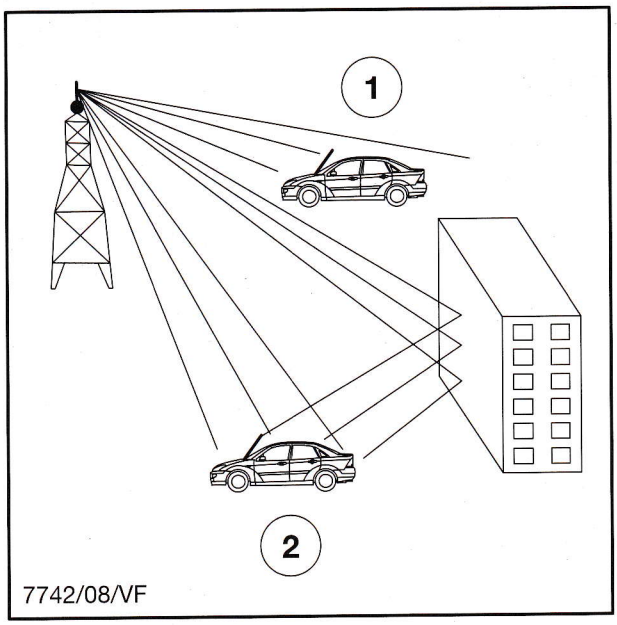
- A greater distance from a VHF (FM) transmitter always means poorer reception as well. The strength of the field, or the strength of the signal of the transmitter, decreases with the distance.
- Mono reception is still possible at a greater distance from a VHF (FM) transmitter than stereo reception.



1 Perfect stereo reception
2 Good mono reception
3 Lower limit of mono reception
4 Limit of use

Reflection und interference

- VHF (FM) signals are reflected by buildings, mountains or other objects. The reflected signals can affect the original signals and thus impair reception. This effect is called interference.
- Interference can occur both with strong and with weak input signals. The problems caused can range from minimal interference to different distorted noises.
- Ford audio systems are equipped with suppression circuits which counteract many of these problems and attenuate them.



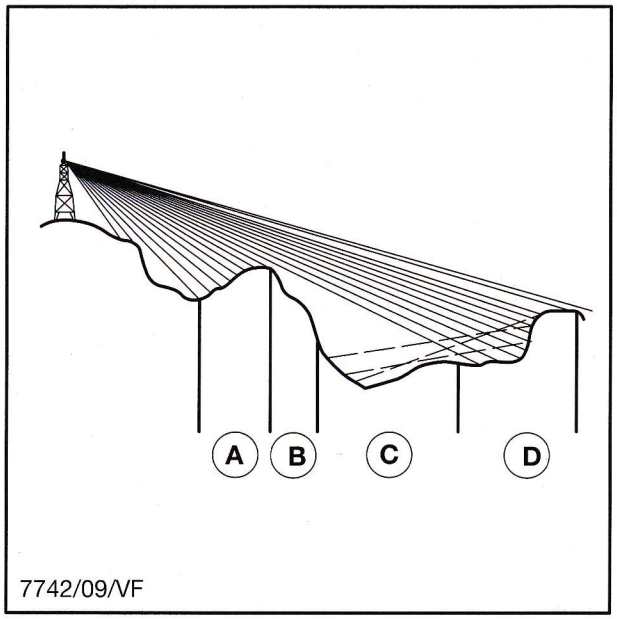
1 Trouble-free reception
2 Disturbed reception due to interference

Causes of poor VHF (FM) reception (continued)

Unfavourable reception areas

- In the figure on the right, good VHF reception can be expected in area (**A**) as the distance to the transmitter is very short and no disturbing obstructions are present.
- No reception is possible in area (**B**) as no signals reach this area (signal hole).
- Poor reception with distortion due to reflected waves can be expected in area (**C**).
- Good reception can be expected again in area (**D**), provided the distance to the transmitter is not too great.
- VHF (FM) reception is of excellent quality given powerful transmitters and no environmental obstructions.
- However, as disturbing factors are frequently present, the audio system must be tuned to the nearest and most powerful VHF (FM) transmitter to guarantee high quality reception.
- With weak input signals, the stereo reception is automatically switched to mono which makes the signal clearly audible again.

Note: With customer concerns about radio reception, the reception area should always be determined precisely.



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Reception areas

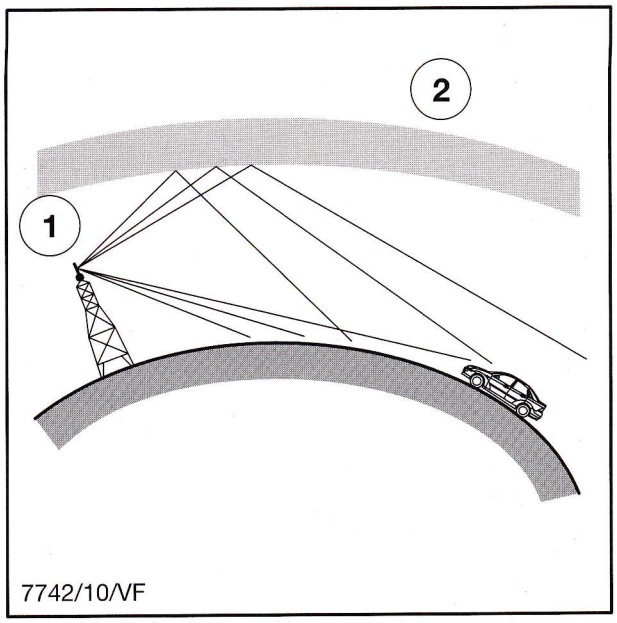
A Good reception
B No reception – signal hole
C Poor reception – reflected waves
D Good reception

Medium and long wave

- The transmission quality of medium wave (MW) and long wave (LW) is poorer than that of very high frequency (VHF).
- Stereo reception is not possible with medium wave and long wave.
- However, medium wave and long wave offer great ranges.

Medium wave (MW)

- Medium wave signals propagate along the surface of the earth. In addition, they are reflected on the layers of the ionosphere (80 to 400 km above the surface of the earth).
- The height of the ionospheric layers and the reflected output fluctuate in the course of the day, dependent on sunshine. This produces different reflection and reception conditions.
- Distant reception over several hundred kilometres is possible, particularly at night. This is advantageous for reception of foreign transmitters. However, at the same time nearer transmitters operating on the same frequency are prone to interference.
- Unusual weather conditions can give distant transmitters very great ranges. This phenomenon can impair the reception of nearer transmitters through interference.



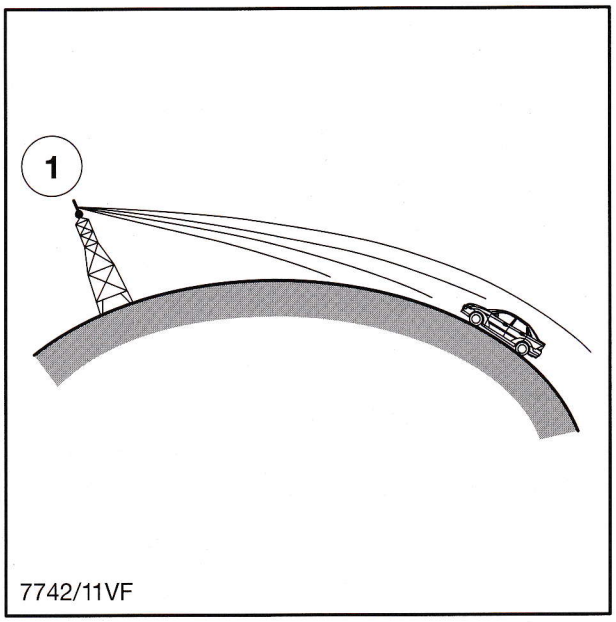
Medium wave transmission

1 MW transmitter
2 Ionosphere

Medium and long wave (continued)

Long wave

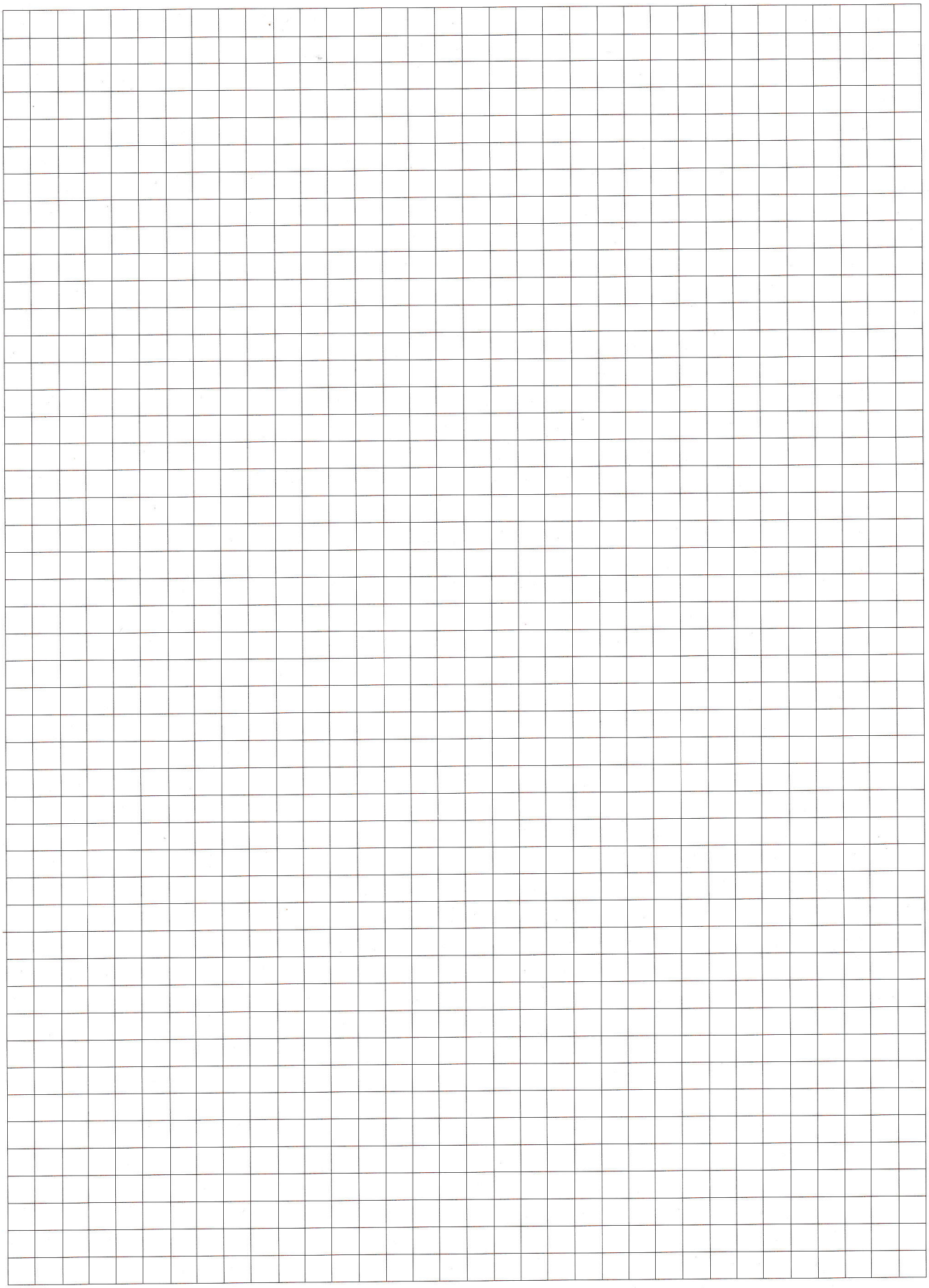
- Long wave signals propagate along the surface of the earth. They can be received over great distances (approximately 500 km).
- Long wave signals are not affected by the time of the day. However, they are very prone to atmospheric and manmade interference.

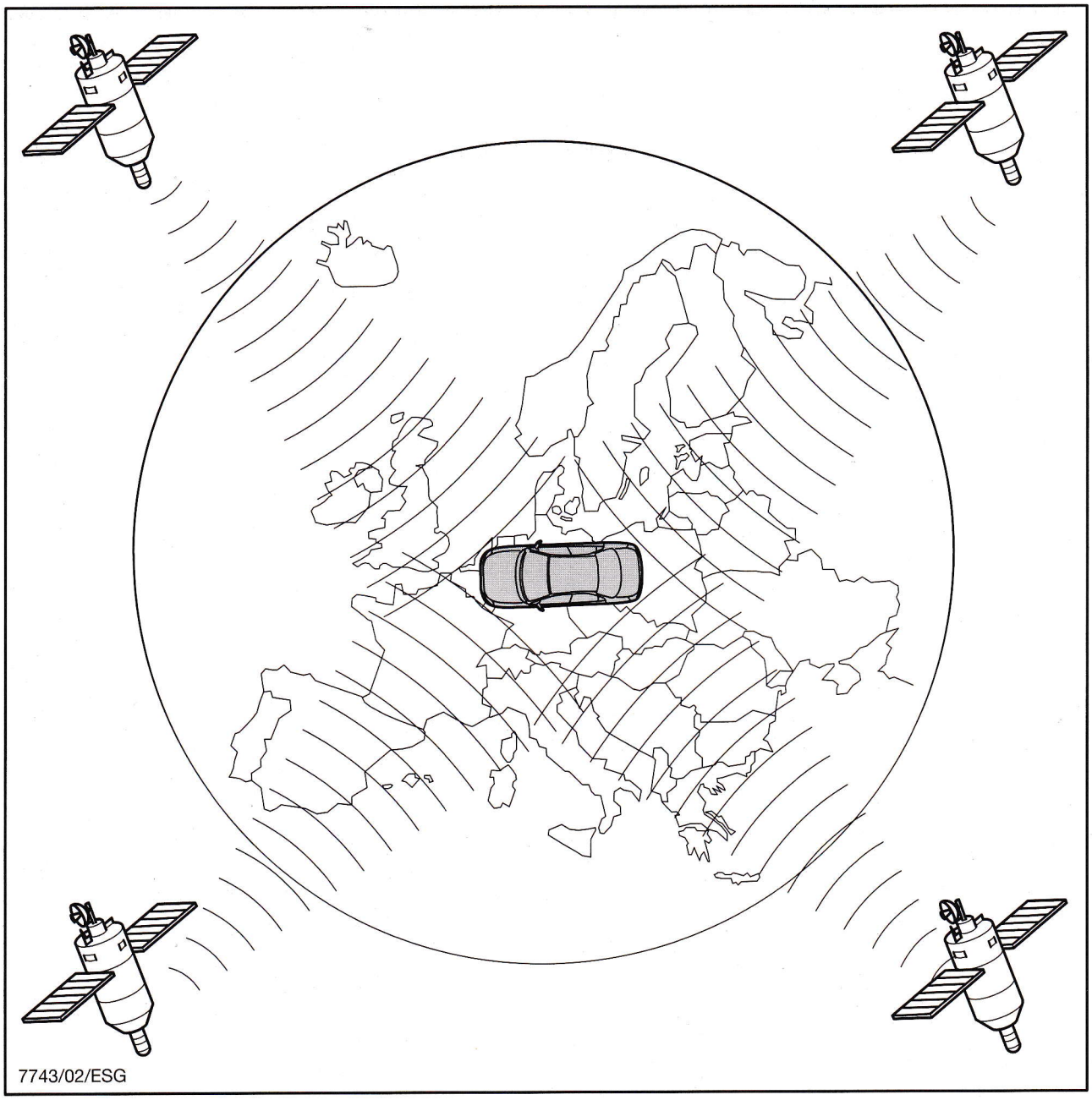


Long wave transmission
1 LW transmitter

Causes of poor medium and long wave reception

- Problems with medium and long wave reception can be caused by high-voltage cables, fluorescent lamps, traffic lights and other industrial equipment.
- Storms and lightning are the most frequent natural source of interference.
- Any interference is particularly audible with transmitters with weak reception.





- The term "navigation", from the Latin "navigare" = to travel at sea, originally covered all activities connected with sailing ships.
- Nowadays, **navigation** in the field of motoring is taken to mean location of a vehicle and determination of the direction and distance of the destination and the required measures to reach this destination as rapidly as possible.

- Precise calculation of the vehicle data supplied is fundamental for perfect navigation.
- Increasing road traffic and associated congestion, environmental pollution, energy consumption, expense and stressful situations make active traffic management with active route guidance an expedient item of vehicle equipment.
- Navigation systems make road maps superfluous as the navigation system always provides guidance to the destination by the shortest or fastest route. Turns are indicated in good time so that the driver can adjust to the traffic situation in plenty of time.
- If a turn is missed, the system advises the driver to turn round or very quickly calculates an alternative route.
- Searching for and deciphering dirty road signs written in foreign languages is a thing of the past as the destination is reached effortlessly.

Histoy of GPS

- 1974 saw the start of the demonstration and trial phase with 6 satellites which ran until 1979. This meant that navigation was possible for 4 hours every day in North America.
- Between 1979 and 1982 the system was expanded to 11 satellites which allowed continuous trial operation worldwide.
- In 1982 the system was planned to expand to 24 satellites with 4 satellites in 6 different orbits.
- Nowadays, 24 satellites are available for navigation and positioning. This allows navigation and positioning worldwide. The orbits are not symmetrical and can be varied.
- The satellites orbit the earth at an altitude of approximately 21,000 km. The earth orbiting time of each satellite is approximately 12 hours.

Operation of the Ford radio navigation systems

- The radio navigation systems combine the functions of a navigation system and a radio with RDS.
- The operating concept for selection of functions is menu-oriented.
- After entering the required destination, the user receives recommendations as to the route to be followed visually through the display and acoustically through speech output in order to reach the destination easily and safely.
- If the ignition key is removed while the system is switched on, the system is switched off.
- The positioning and route guidance are provided with the assistance of maps in a database held on a CD-ROM.
- The road network data held on the CD-ROM is used during navigation so with almost all the systems fitted the CD-ROM remains in the system during navigation.
- A high degree of accuracy within a radius of 5 metres is achieved through intelligent software and system technology (**navigation by dead reckoning**).
- The driving instructions are given through the loudspeakers of the radio system and optionally by showing a route map or symbols on the colour screen.
- Certain functions should not or cannot be operated while the vehicle is moving. All the available functions are described in detail in the operating instructions.

Route guidance

- The destination is entered in the system before driving off. The navigation computer with an integral CD-ROM drive calculates the shortest or fastest route on the basis of the digital road map held on the CD-ROM.
- During the journey, a natural voice gives driving instructions in good time before turns or required changes of lane.
- Appropriate directional arrows appear on the display to assist the driver. The system works with a "forward-looking" approach and allows sufficient reaction time according to the vehicle speed.
- Very precise positioning of the vehicle on the road network is necessary to ensure that the driving instructions are given at the correct time. This is achieved through sensors. The distance covered is measured by means of the driving signal from the VS sensor or the wheel sensors.
- A gyro sensor incorporated in the system also supplies directional information. At the same time, the position of the vehicle is tracked by a GPS receiver.
- Allowing for these three sources of information, the position of the vehicle is compared continuously with the road on the digital map held on the CD-ROM. This process is called **map-matching**.
- Driving instructions are no longer issued as long as the vehicle is in a region which is not mapped digitally.
- Instead, the display shows an arrow which indicates the heading to the entered destination and the current distance to the destination (as the crow flies).
- This information is provided solely by the GPS receiver.

Dynamic route guidance

- The moment the navigation unit receives information about obstacles (traffic jams or road closures or the like) on the calculated route via TMC, an alternative route is calculated automatically or on request according to the model, and the route guidance is adjusted accordingly.

Speech output

- The speech output comes through the loudspeakers installed in the vehicle. Radio/CD operation is suppressed for the speech output.
- The acoustic driving recommendations are stored on the CD-ROM. There is a choice of several european languages.
- The speech data for the acoustic driving recommendations is loaded from the CD-ROM into the speech memory. This is done at the time of the predelivery inspection, after reconnection of the power supply and when a different language is selected.
- The speech data is available after the initial installation is completed immediately the system is switched on.
- When the language is changed, the speech data is reloaded into the navigation computer from the navigation CD-ROM.
  A change of language takes approximately 30 seconds.

Menu text

- The language of the menu text depends on the selected speech output.
- With English there is a choice of "metric" or "imperial" measurement systems.

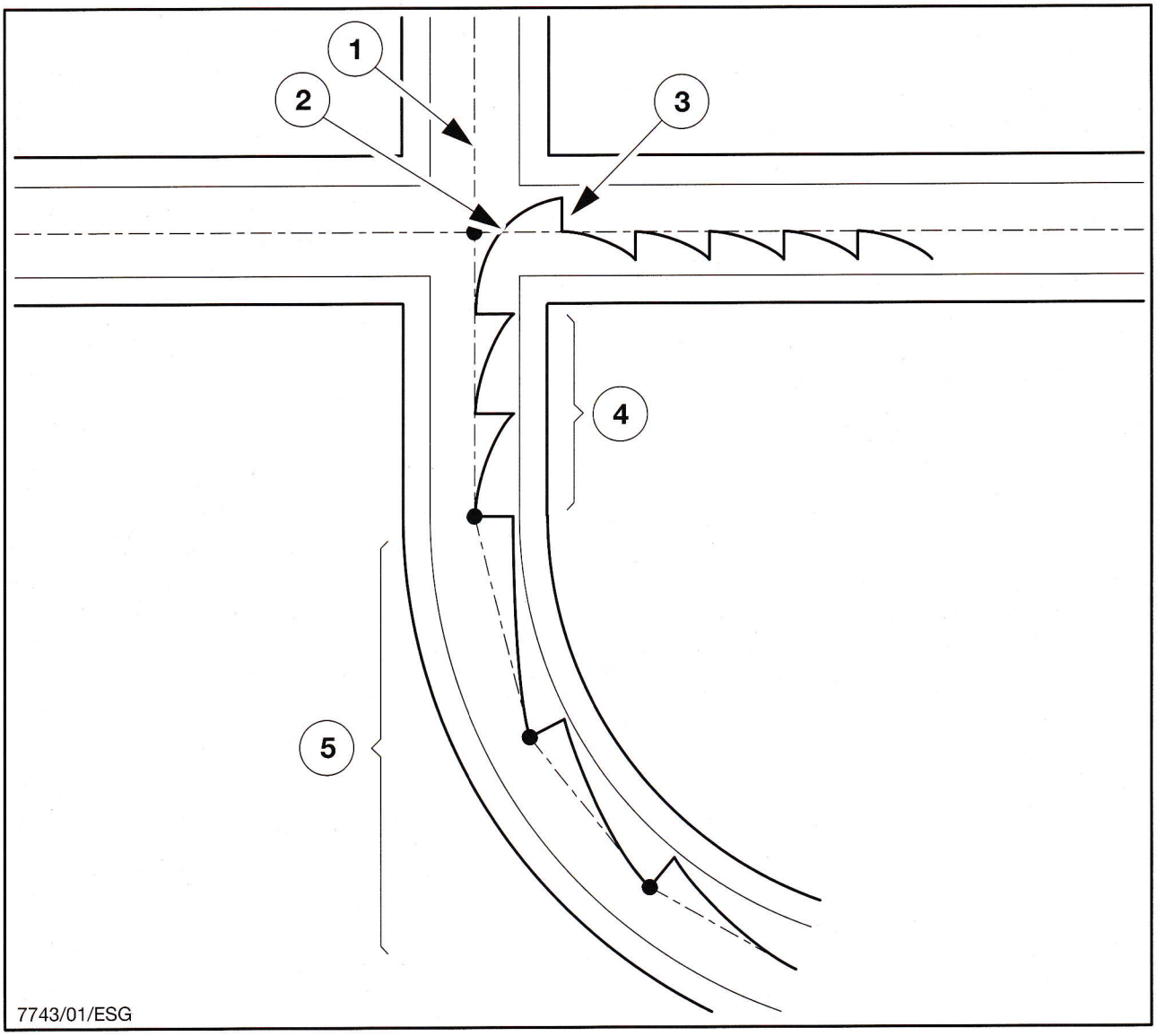
Digital map

- The routes, maps and vocabulary for the driving instructions are stored in digital form on the CD-ROM for the navigation computer.
- These digital road maps are superior to conventional road maps in terms of precision and detail.
- The digital map is based on official maps, satellite and aerial photographs. Information of relevance to traffic is obtained by visiting the site.
- The map contains a detail road network with all the usable roads and a linking road network between places.
- Some Ford navigation systems are designed so that they automatically load specific information for the user from the CD-ROM, such as for example the addresses of Ford dealers.

Multipath map-matching

- The GPS establishes where the vehicle is momentarily located in an area of between 30 and 100 m.
- The navigation computer then loads this area of the map into the working memory from the navigation CD-ROM.
- Then, **multipath map-matching** is used to calculate which of the possible paths the vehicle is on in the map area and in which direction it is **moving**.
- During route planning, the fastest or shortest route to the destination is established by producing and comparing different routes.
- The position is continuously updated. The position data established by means of the sensors is compared with the data held on the navigation CD-ROM and corrected (**navigation by dead reckoning**).
- Fully automatic position correction and precision of location are maintained even outside digitised areas (countries, cities, regions). Outside the area of the map, the direction of the destination is indicated by a directional arrow although no information specifically dependent on the location is given.

Navigation by dead reckoning



1 Ideal line of road network

2 Driving line established by sensors

3 Correction of measured driving line when turning

4 Correction of measured driving line when travelling in a straight line

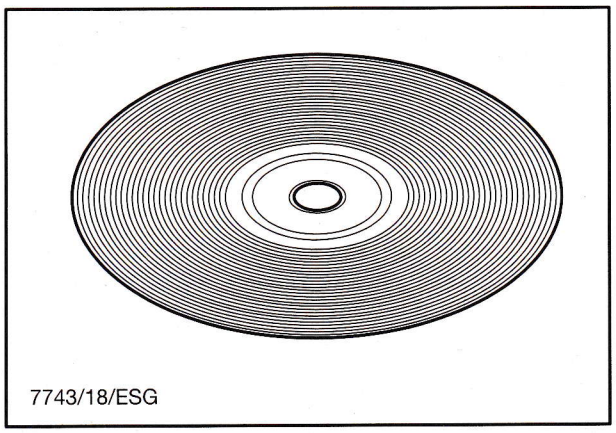
5 Correction of measured driving line when negotiating a bend

Note: The differences are greatly exaggerated for clarity.

- The paths established by multipath map-matching consist of an idealised road network.
- Precise navigation is possible on a predetermined road network by navigation by dead reckoning.
- The navigation computer simulates the journey on the road network held on the CD-ROM so that the system can issue driving recommendations.
- The distance covered is measured with the wheel sensors and the changes in direction with a rotation angle sensor.
- However, there are certain differences between the vehicle movements established with the sensors and the path actually followed.
- The differences between the supposed position of the vehicle and the possible position established from the location of the road on the stored map are constantly corrected by the navigation computer. This process is called navigation by dead reckoning.
- The principle of navigation by dead reckoning is employed in all the systems fitted in Ford vehicles.

Navigation CD-ROM

- The following information is stored on the navigation CD-ROM for navigation:
  - town plans and town and street names
  - connecting roads between the towns
  - acoustic vocabulary and menu text memory
- The memory capacity is approximately 600 MB.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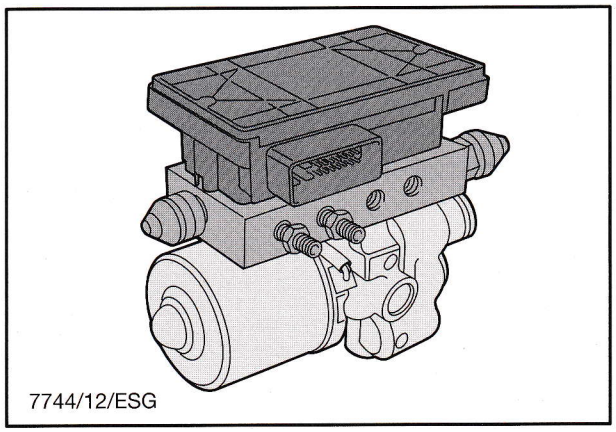
ABS module/wheel sensor

- The distance covered is established by picking up the wheel speed information at the interface of the ABS module or via a databus (speedometer signal).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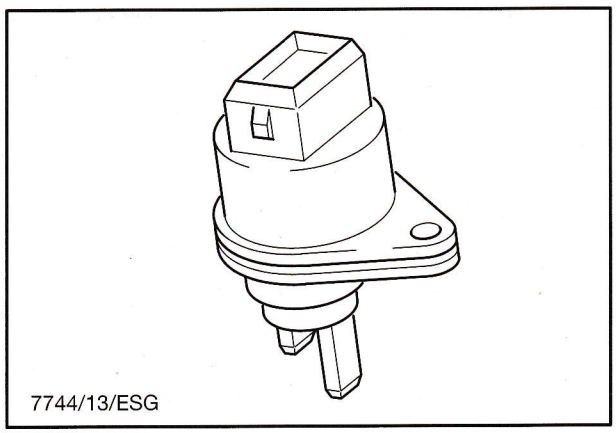
Reversing light switch

- As the wheel sensor signal does not indicate whether the vehicle is travelling forwards or in reverse, this is established by means of the switching contacts of the reversing light switch.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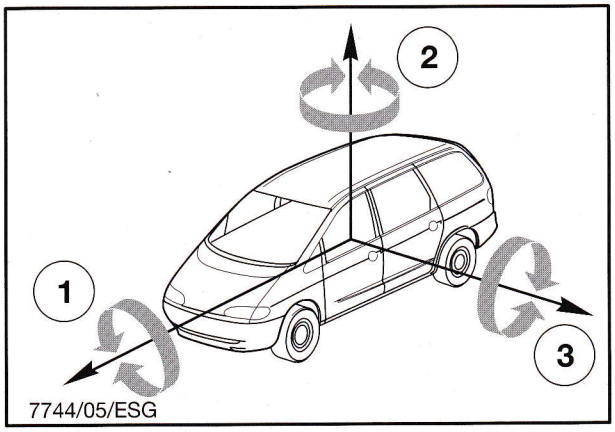
Rotation angle sensor (GYRO)

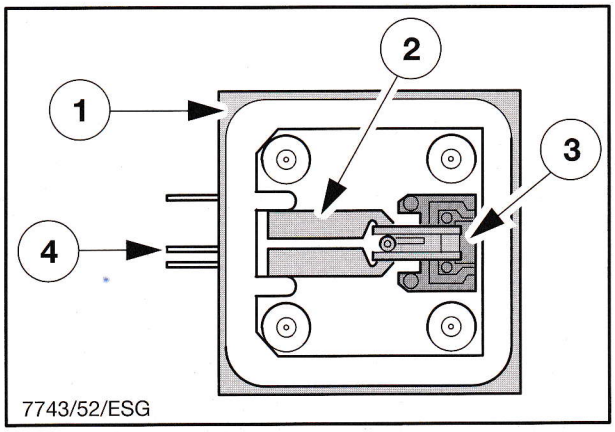
- The navigation computer requires the information about the vehicle movements in order to be able to trace the path followed on the digital CD-MAP.
- The rotation angle sensor is used to measure the rotational movements of the vehicle about its vertical axis when turning or negotiating bends.
- The rotation angle sensor is integrated in the navigation unit and takes the place of the compass that was previously installed.



Vehicle axes

1 Longitudinal axis (roll)
2 Vertical axis (yaw)
3 Transverse axis (pitch)

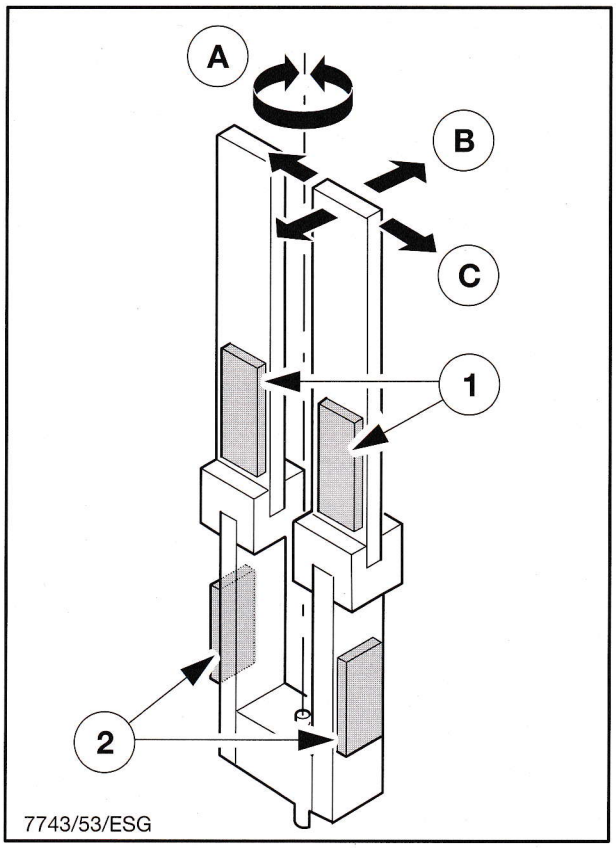
- The GYRO consists of a device shaped like a tuning fork with four piezo electric elements and sensor electronics.
- The two lower piezo electric elements are made to vibrate by an electronic unit, together with the assembly to which they are connected.
- The two upper piezo electric elements are used to measure acceleration when the vehicle changes direction.



Rotation angle sensor (GYRO)

1 Sensor housing
2 Pickup
3 Sensor electronics
4 Connecting plug

- The pickup is made to vibrate in the kilohertz range with the piezo electric elements.
- If the oscillating assembly is turned on its axis of rotation (identical to the vertical axis of the vertical), this twists in the upper area.
- The twisting of the piezo electric elements produces a voltage.
  An electronic unit located in the sensor housing converts this voltage into a voltage signal corresponding to the turning movement and transmits it to the navigation computer.
- The navigation computer now calculates the heading of the vehicle from the information supplied by the wheel and rotation angle sensors.
- The great advantage of determining the direction by means of GYRO lies in its insensitivity to magnetic influences.



Pickup of rotation angle sensor

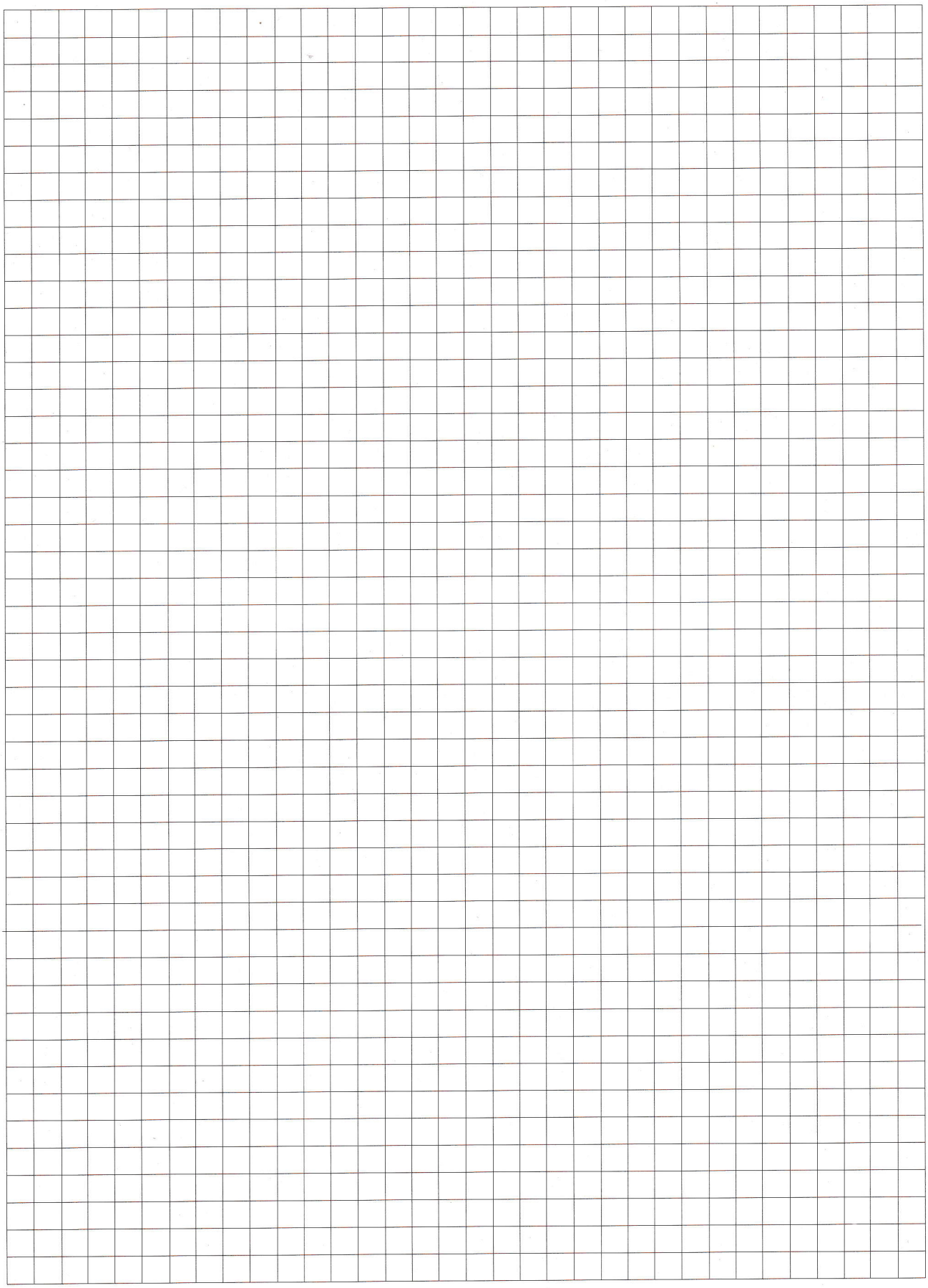
A Turning axis (vertical axis of vehicle)

B Direction of twist

C Direction of induced vibration

1 Piezoelectric element to measure acceleration

2 Piezoelectric element to stimulate vibration



Antenna systems

- Antennas are used to pick up and transmit signals. There are various types of antenna systems.

Rod antenna

- Rod antennas should not be used inside the vehicle because the sheet steel body cuts out electromagnetic waves almost completely. However, rod antennas mounted on the outside of the vehicle not only pick up the radio signals more easily, they also pick up the interference.
- The length of an antenna must be in a certain ratio to the wavelength of the signal to ensure good reception.
- Accordingly, the length of the antenna should actually vary for the different wavelengths. However, it has been found that a rod length of 90 – 100 cm is ideal for reception of VHF (FM) signals and is also a favourable length for AM signals.
- Rod antennas are used in the current Ford vehicles (except for the Escort Cabriolet, Galaxy and Maverick).

Side window antenna

- Antennas incorporated in the side windows are used on the Galaxy up to the '98 MY and the Maverick.
- On the Galaxy there is an antenna signal amplifier on the roof longitudinal member at the rear on the right-hand side. The power supply comes through the core of the antenna cable.

Rear window antenna with antenna module

- Some Ford vehicles are equipped exclusively or additionally with rear window antennas with their own antenna module. These modules perform the following functions:
  - distribute the current for the heated rear window over the entire surface of the window to ensure uniform heating;
  - receive the radio waves through the heater elements;
  - separate the radio signals received from the heating current;
  - transmit the signals received via the antenna cable to the radio;

GPS antenna

- The navigation antenna (GPS antenna) is used to receive and amplify the digital GPS satellite signals.

GSM antenna

- This is used to send receive GSM mobile telephone frequencies.

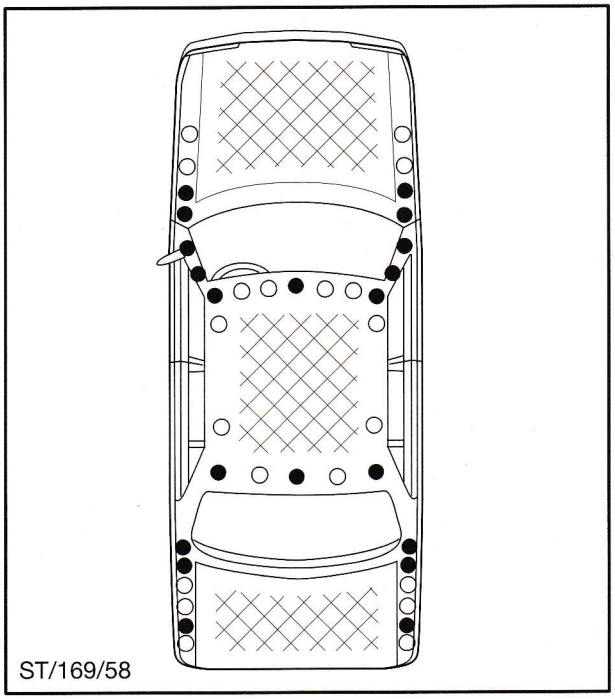
Triplex antenna

- This is a multipurpose antenna for GPS satellite reception, GSM mobile telephone operations and car radio reception.

Antenna systems (continued)

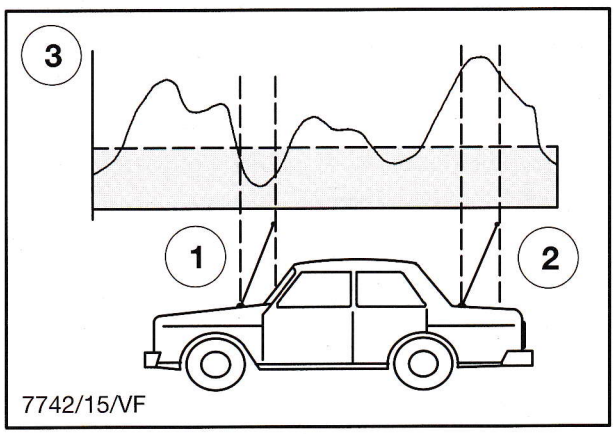
Location

- The best location for the antenna depends on the shape of the body of the particular vehicle. Favourable locations are normally at the edges of the body.
- The highest antenna level (signal strength) is to be expected at the locations marked with dark spots in the illustration on the right.



● Favourable location
o Less favourable location
x Location to be avoided

- The strength of the transmitted signals (field strength) changes considerably in the VHF (FM) waveband even over short distances. Therefore, there are frequently appreciable fluctuations in reception when travelling slowly.
- Such fluctuations can be reduced by installing two antennas located in different places (antenna diversity). When this is done, the signal of the antenna delivering the stronger signal alone is used.
- Audio systems with a diversity antenna system are marked by a double antenna symbol on the front cover.



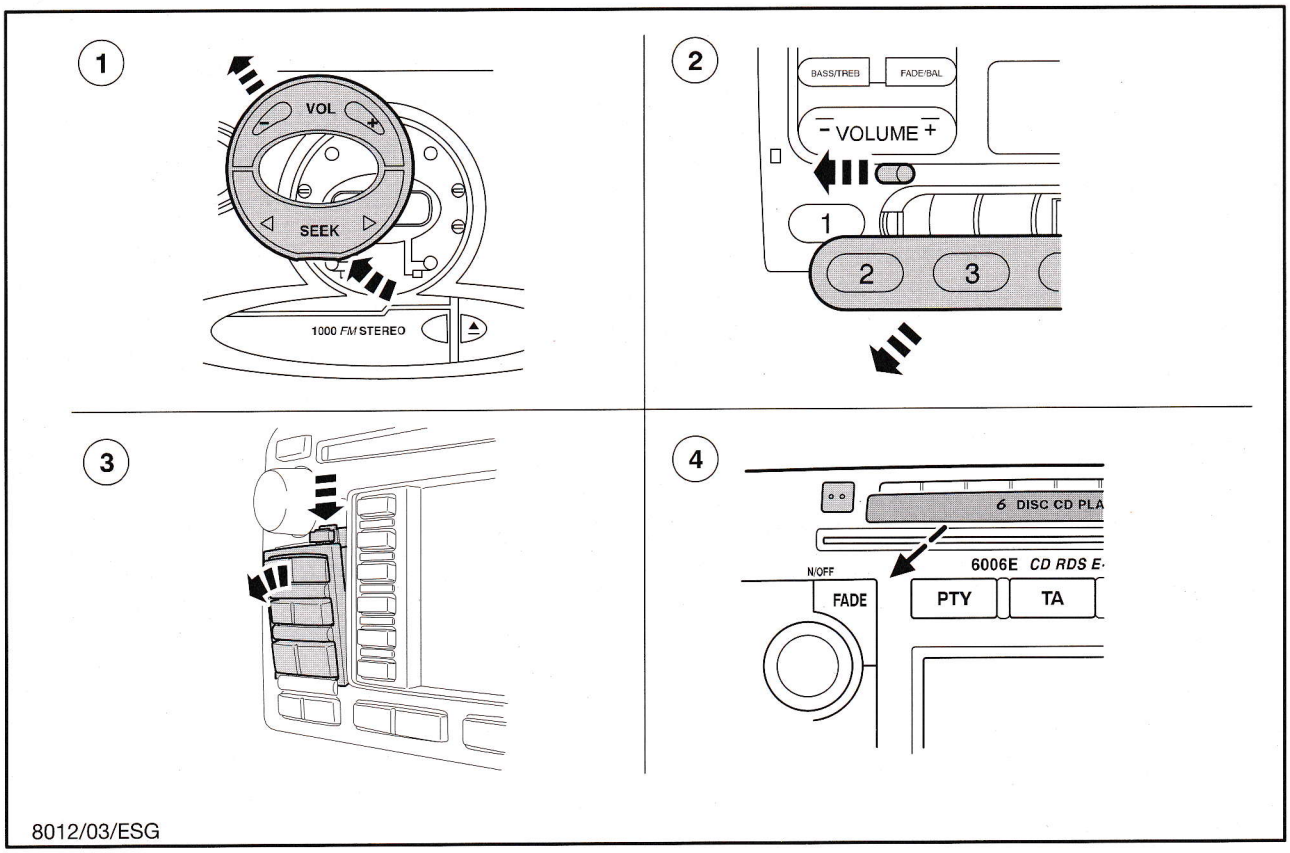
1 Antenna with poor reception
2 Antenna with good reception
3 Signal strength

Removable control unit

- Most of the Ford audio systems have a removable control unit without which the system will not work.
- The removable control unit can be unlocked, detached and removed from the vehicle.

Note: When removed, control units can get dirty and may not be refitted correctly. Damaged or dirty electrical contacts can cause customer concerns.

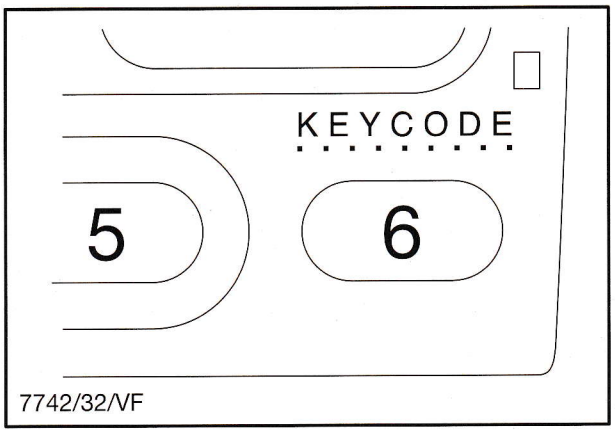
- If a customer loses a control unit or it is damaged, a replacement control unit can be ordered. It is advisable to obtain the following data:
  - name and address of the owner
  - vehicle identification number
  - audio system model
  - identification document (e.g. personal identification or drivers licence)
  - proof of purchase of the audio system or vehicle.



1 Control unit for series 1000
2 Control unit for other series
3 Control unit for VNR 9000
4 Control unit for 6006E/9006

Anti-theft protection number (Keycode)

- Whenever the power supply to a Ford audio system is cut, this initially will not work. First, the correct anti-theft protection number (keycode) must be entered. The only exceptions to this are series 1000 and 2000 systems which do not have an anti-theft protection number.
- The keycode is to be found on the keycode card supplied when the vehicle is delivered.



Note: The keycode card should be kept in a safe place and never in the vehicle.

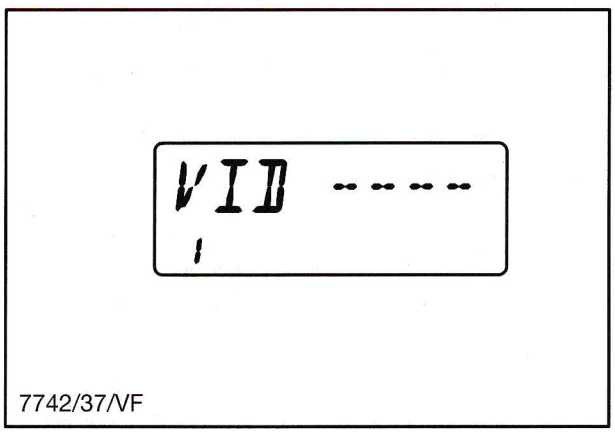
- The customer is allowed to make a limited number of attempts to enter the keycode. The number of attempts made is indicated in the display.
- After every further failed attempt at entering the keycode, a waiting time must be allowed to elapse before a further attempt is made.
- In the display the message "WAIT XX" appears and then counts down to "0" while the ignition is switched on. A further attempt to enter the keycode is only possible after this time.
- After further failed attempts, the message appears "LOCK 10", "LOCKED" or "SAFE". The audio system can no longer be unlocked by the customer and must be taken to a Ford dealer for this.
- The Ford dealer has the means to unlock the system and make up to three further attempts to enter the keycode.

Requesting keycode via OASIS/GSEVIN

- Before using the option of making additional attempts at entering the keycode, the Ford dealer must
  - get the customer to provide proof of ownership,
  - check the keycode is correct through OASIS/GSEVIN.
- The procedure for obtaining keycode information through OASIS/GSEVIN is described in the current service literature.
- The keycode for RNS IV systems and the systems installed in the Galaxy with a monochrome display or multicolor display can only be obtained through the Ford Hotline.
- The keycode for Becker systems can only be obtained through the Becker Hotline.

Vehicle identification number

- Stolen audio systems seized by the police are often very difficult to return to the original owner.
- Therefore, some models have a facility for entering the vehicle identification number.
- Vehicle identification numbers with up to 16 digits can be entered.



Request to enter vehicle identification number

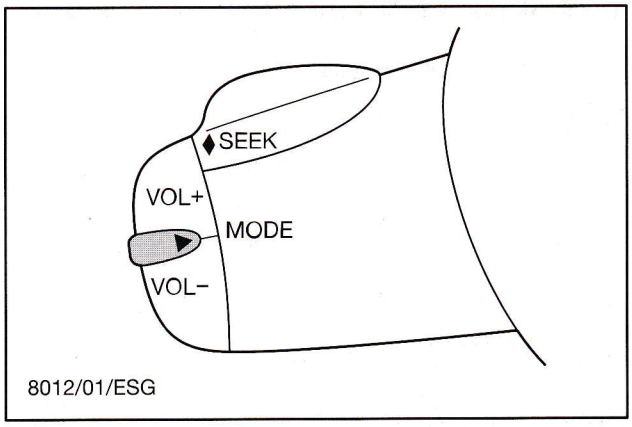
Note: Ford audio systems use the combination of letters VID as an abbreviation for the vehicle identification number. Apart from the actual vehicle identification number (VIN), the vehicle license plate for example can also be entered to perform the security check.

Displaying vehicle identification number

- With the modern Ford audio systems, the number, if stored, appears in the display after the power supply is connected.
- To display the stored vehicle identification number, the appropriate menu function is selected. If no number is stored, the message "NO VID" appears in the display.

Audio remote control

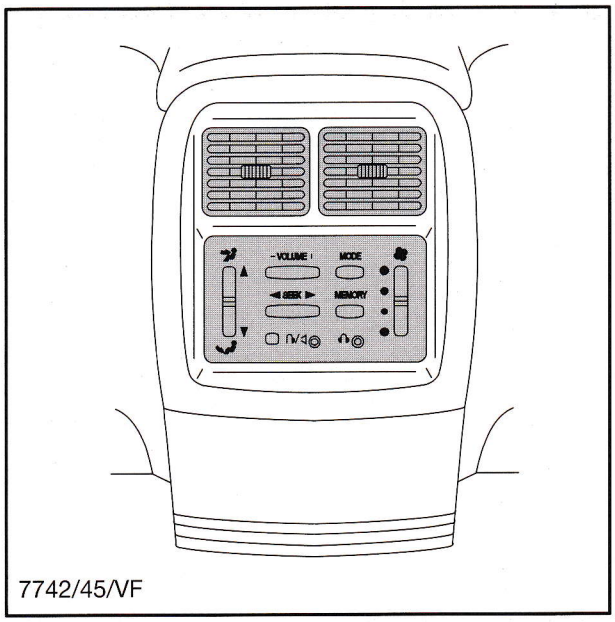
- Remote controls for installation on the steering column are available for most current vehicles. On the Mondeo for example, the remote control can be used for the following functions:
  - to set the volume ('VOL')
  - to seek an alternative transmitter ('SEEK')
  - to change the music track ('SEEK' when playing a CD)
  - to change the stored station ('PRESET/DISC')
  - to change the CD ('PRESET/DISC' when playing a CD)
  - to switch off the traffic announcements (briefly press 'AM/FM')
  - to change waveband (hold 'AM/FM' depressed for a longer time)



Remote control

Remote control in the rear

- When equipped with the series 7000 audio system, the Explorer from the '98 model year onwards is available with an integral audio control unit for operating the audio system from the rear seats.
- This control unit can be activated or deactivated from the audio system. "RICP ON" or "RICP OFF" appears in the display.

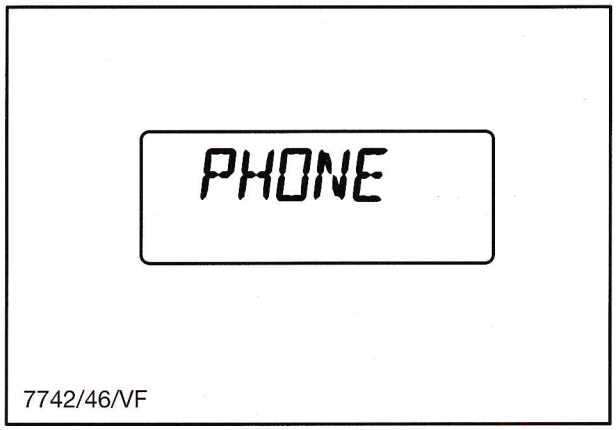


Explorer remote control

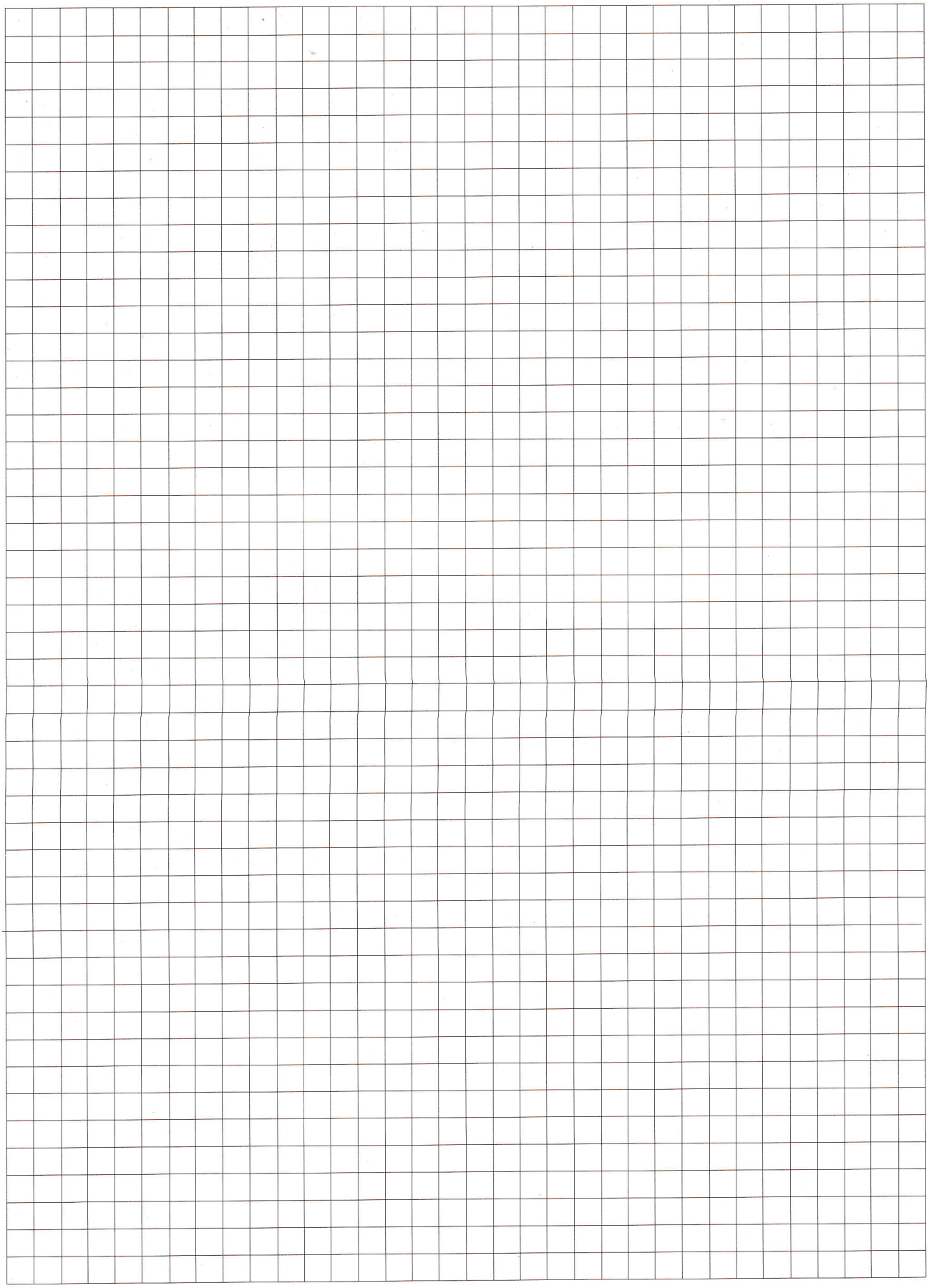
Telephone muting

- Some Ford audio systems can be connected to a suitable mobile telephone by means of a connection kit.
- Suitable mobile telephones send a muting signal to the audio system.
- When a call is received or made, the signal causes the audio system to
  - mute radio operation,
  - stop cassette operation,
  - stop CD operation or CD autochanger operation.
- "PHONE" is shown in the display of the audio system for the duration of the conversation.
- On completion of the telephone conversation, the audio system returns to the previous operating mode.

Note: Kits are available for retrofitment of mobile telephone connections with a muting function.



Display during a telephone conversation

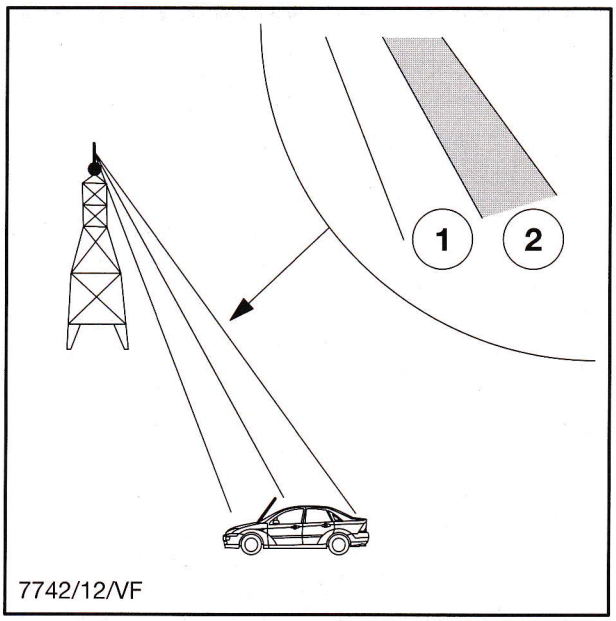


Meaning of RDS

- The radio data system (RDS) allows digital data to be transmitted in addition to the audio signals in the VHF (FM) waveband. Radio systems equipped with an RDS decoder evaluate the digitally coded signals. With this data, RDS offers a large number of functions.

Note: RDS is a joint European development. Even so, not all the functions are available in every country.

Note: Testing of RDS functions by local radio stations can sometimes result in nonsensical displays appearing on RDS receivers.



Signal transmission with RDS

1 Audio signals
2 Digital data

RDS functions

Program service

- The listener is shown the name of the tuned radio station in the display of the audio system with RDS. Up to 8 characters can be shown at a time.

Traffic program identification (TP)

- When the tuned station transmits traffic announcements, TP appears in the display on the audio system.

Traffic announcement identification (TA)

- When the radio station just tuned transmits a traffic announcement and the driver so wishes, the audio system can switch from playing a cassette or playing a CD to receive the traffic announcement and switch from low volume to normal volume.

Traffic message channel (TMC)

- The radio data system (RDS) has been significantly enlarged by the incorporation of TMC which transmits a new generation of traffic messages.

- The TMC is based on a news service. The traffic messages are continuously picked up – automatically by sensors on motorways and by the police. The messages reach the radio stations without any time lag. They are coded digitally, differentiated according to road sections and direction of travel, and broadcast inaudibly.

- The data telegram is converted into coherent news by the car radio. The system selects traffic messages according to routes and traffic areas. It disregards messages which do not relate to an area within a radius of approximately 50 km of the instantaneous position of the vehicle.

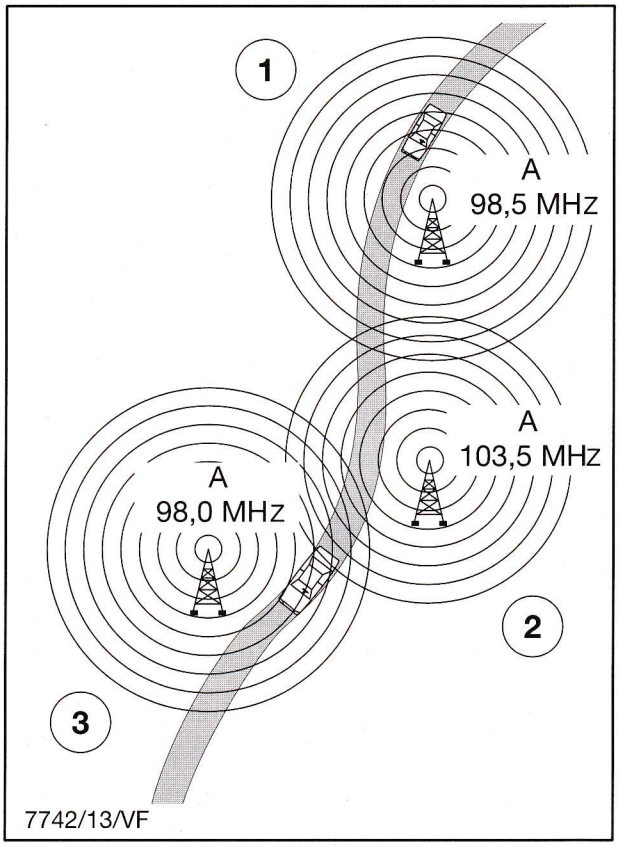
- The TMC reports the event, the location and the nature of the traffic obstruction. The message is stored in the TMC receiver and can be called up by pressing a button, e.g. "tailback after accident on the A2 in the direction of Berlin after the Ziesar junction, length of tailback 8 km".

- As long as a TMC station is received, the contents of the TMC memory are continually updated and after about 15 minutes stored messages are invalidated or deleted from the memory and replaced by later messages (FIFO principle).

Alternativee frequencies (AF)

- Radio stations often have different transmitters operating on different frequencies. The individual transmitters transmit a list of the alternative frequencies for the same radio station.
- When the AF function is switched on, the audio system can compare the signal strength of these alternative frequencies and switch to the frequency with the strongest signal or to the nearest possible frequency worth receiving.
- Example: A radio station A broadcasts on different frequencies. On leaving the transmitting area 1 using a frequency of 98.5 MHz, the signal of the transmitter becomes too weak and the audio system seeks alternative frequencies, and has a choice of 103.5 MHz (area 2) or 98.0 MHz (area 3).

Note: Momentary muting can occur when changing to a new reception frequency.

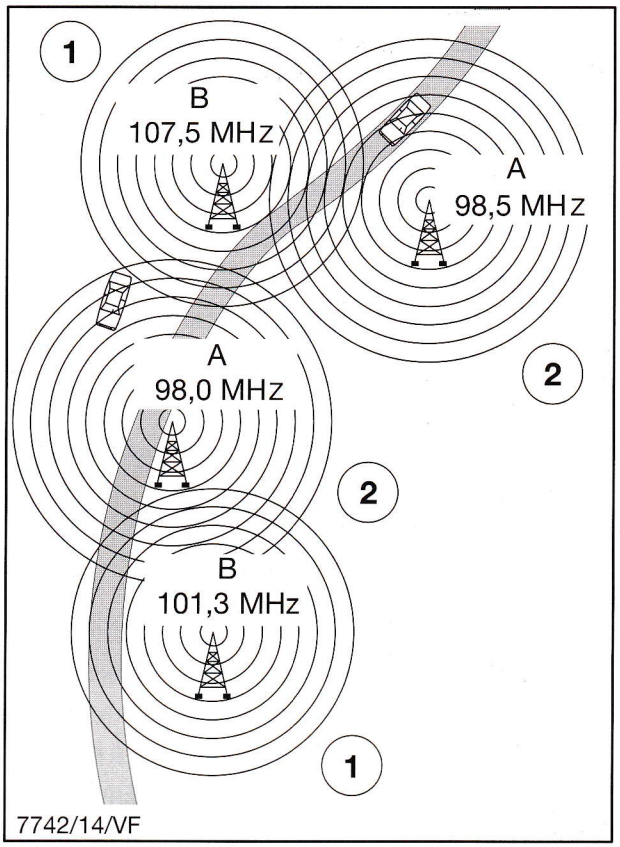


1-3 Transmitting areas of radio station A with alternative frequencies

- In certain situations, audio systems can briefly switch to a different radio station because a transmitter of a different radio station is also using the same alternative frequency. This occurs above all
  - at high altitudes (where more distant stations can also be received),
  - when weather conditions increase the range of transmitters (which also allow the reception of more distant transmitters),
  - in regions near a border (where transmitters of foreign radio stations use the same frequency).

RDS enhanced other networks (EON)

- With RDS with EON (enhanced other networks), transmitters of other radio stations in a network are also sought if the tuned radio station is not transmitting any traffic announcements.
- Therefore, an audio system with RDS-EON monitors the transmitters of linked radio stations broadcasting traffic announcements in the vicinity with the aid of the alternative frequencies also transmitted.
- When the traffic announcement function is switched on, traffic announcements from these transmitters may interrupt cassette playback, CD playback or the radio programme currently tuned.
- In certain regions the EON traffic announcements may be too much. With the LOCAL function only traffic announcements from local transmitters are received. In the DISTANT mode the EON radio accepts traffic announcements from a wider area.



Traffic announcement reception with RDS-EON

A/B Radio stations in a network

1 Transmitter with traffic announcements

2 Transmitter without traffic announcements

Note: These possible auxiliary functions are not supported by all transmitters.

Program identification (PI)

- A radio station transmits a special identifier, the PI code. The radio compares the PI code of the current transmitter with the PI code of the alternative frequencies. This ensures that a change of frequency does not lead to an undesired change of programme.

Note: If after switching to an alternative frequency an audio system initially receives the transmitter of the wrong radio station, this is established through the different PI code. The radio needs some time to do this. If customers complain about this, they should be told that the problem is fundamental and that there is no fault in the equipment. In areas of extremely poor reception, the RDS should be temporarily switched off.

- The PI code and alternative frequencies are also stored for the station buttons in the radio. If a station button is pressed and no signal is found, the audio system seeks the alternative frequencies with the same PI code and selects the frequency with the strongest signal.

Program type (PTY)

- Radio stations can broadcast a programme type identification (PTY). Programme types can be for example:

Display	Program type
NONE	Not fixed
NEWS	News
AFFAIRS	Current affairs
INFO	Information
SPORT	Sport
EDUCATE	Knowledge/Education
DRAMA	Drama
CULTURE	Culture
SCIENCE	Science
VARIED	Miscellaneous
POP M	Pop music
ROCK M	Rock music
M.O.R.M.	Music for motoring
LIGHT M	Light music
CLASSICS	Classical music
OTHER M	Other music

Alarm code (PTY 31)

- The programme type identification PTY 31 is reserved in some countries to identify a national emergency. As soon as the audio system receives this programme type identification, it interrupts any other signal and transmits the emergency broadcast.

Time/Date

- Audio systems with RDS can receive and display the time and date.

Random play (shuffle)

- The random play or shuffle function can be switched on or off. The corresponding message "SHUF--ON" or "SHUF--OFF" appears in the display.
- When the function is switched on, the tracks on the selected CD are played in random order. When a new track is selected, the playing time display is briefly replaced by "SHUF". When all the tracks on a CD have been played, the system selects the next CD and starts playing the tracks in random order.

Dynamic range compression

- Dynamic range compression can be switched on or off when playing a CD. The corresponding message "COMP--ON" or "COMP--OFF" appears in the display.
- When compression is switched on, loud music passages are reproduced at lower volume and quiet music passages are reproduced at higher volume so that the volume does not require continual adjustment with very dynamic pieces of music.

Autoreverse

- At the end of a tape the system automatically switches to play the other side of the cassette.

AutoStore

- With the AutoStore function the audio system starts the station search and stores the six strongest transmitter frequencies in the VHF (FM) waveband. When the AutoStore function is switched on, "A-ST" flashes in the display.

Automatic volume control (AVC, GALA, GAL)

- When the automatic volume control is switched on, the volume is adjusted according to the vehicle speed.

Note: Although the message in the display indicates that this adjustment may be possible, this function is not available in all vehicles.

Distortion limitation (CLIP)

- The function can be switched on or off. The corresponding message "CLIP--ON" or "CLIP--OFF" appears in the display.
- When the function is switched on, the output of the audio system is limited so as to prevent distortion due to overloading.
- In certain circumstances, the action of the CLIP function can lead to customer concerns about lack of volume or lack of bass from systems with a low power output.

Local/distant traffic announcements

- There is a choice of local or distant traffic announcements "TA--LOCAL" or "TA--DIST".
- In the LOCAL mode only traffic announcements from local transmitters are received. In the DISTANT mode the RDS-EON radio accepts traffic announcements from a wider area.

Alternative frequency search

- There is a choice of "AF--ON" or "AF--OFF".
- When the function is switched on, the audio system carries out a search if the signals of the tuned transmitter become weaker. However, in certain circumstances, this search operation can interrupt radio reception.

12/24 hour time display

- When the function is selected, there is a choice of "CLOCK--12" (12 hour time display) or "CLOCK--24" (24 hour time display).

Automatic music search (AMS)

- The function can be switched on or off. The corresponding message appears in the display.
- If the automatic music search (AMS) function is activated, when the '◀◀' or '▶▶' button is pressed the system moves to the next track in the chosen direction and starts to play it.

Note: There must be a gap of at least 3 seconds between the music tracks.

Dolby® noise suppression

- When this function is selected, the message "DOLBY NR" appears in the display. The function can be switched on or off with the 'SEEK' button.
- When the function is switched on, the Dolby symbol appears in the display and tape noise is reduced with the Dolby B® system.

News

- The function can be switched on or off. The corresponding message "NEWS" appears in the display.
- When the function is switched on, news is reproduced at the volume set for traffic announcements.

Traffic information memory (TIM)

- When the radio is switched on and a station broadcasting traffic announcements is selected, up to 9 traffic messages with a maximum total time of 4 minutes are automatically recorded in a digital memory.
- When the memory is full, the oldest messages are automatically overwritten.
- If a new traffic message is received while the TIM recording is being played, playback is interrupted and the new message is recorded. Messages more than 6 hours old after the system was switched on are automatically erased.
- When the radio is switched off, the traffic information monitoring can be activated for 16 hours by pressing the TIM button.
- When the system is switched on, TIM can be switched on or off. There is a choice of OFF, 2h and 16h. When TIM is switched on, traffic news from a tuned station which broadcasts traffic messages is also recorded after the system is switched off.

AF*	**A**lternative **F**requencies
AM*	**A**mplitude **M**odulation
AMS*	**A**utomatic **M**usic **S**earch
APID*	**A**dvanced **P**roduct **I**nformation **D**ocument
AVC*	**A**utomatic **V**olume **C**ontrol
CD*	**C**ompact **D**isc
CLIP	Distortion limitation
COMP	**Comp**ress
C/T*	**C**lock/**T**ime
DSP	**D**igital **S**ignal **P**rocessing
EON*	**E**nhanced **O**ther **N**etworks
FDS*	**F**ord **D**iagnostic **S**ystem
FM*	**F**requency **M**odulation
GAL/GALA	Automatic Volume Control
GPS*	**G**lobal **P**ositioning **S**ystem
GSM*	**G**lobal **S**ystem for **M**obile Communication
LW*	**L**ong **W**ave
MW*	**M**edium **W**ave
PI*	**P**rogram **I**dentification
PTY*	**P**rogram **T**ype
OASIS*	**O**nline **A**utomotive **I**nformation **S**ystem
RDS*	**R**adio **D**ata **S**ystem
TA*	**T**raffic **A**nnouncement
TIM	**T**raffic **I**nformation **M**emory
TMC*	**T**raffic **M**essage **C**hannel

TP*	Traffic Program	**VHF***	Very High Frequency
UKW	Ultra-Short Wave	**VIN**	Vehicle Identification Number