

Automotive parts - Antenna for vehicle - Part 3: Performance items and measuring methods

1. Scope

This standard specifies the performance items and their measuring methods of an automotive antenna that is used for receiving AM, FM and TV broadcasting, receiving and transmitting telephone calls, and receiving a global positioning system (GPS) signal and of amplification equipment (hereinafter referred to as "amplifier") that is inserted in the circuit of the automotive antenna.

Note:

Exclusively designed antennas for ETC, keyless entry, DSRC, or wireless LAN, etc. and antennas that are not commonly used are not covered by the specification.

2. Normative reference

The following standards contain which, thorough reference in this Standard, constitute provisions of this Standard. The most recent editions of the standard indicated below shall be applied.

JASO D507-1	Automotive parts—Antenna for vehicle—Part 1 : Glossary of terms relating to car antenna
JASO D801	Glossary of terms relating to electronic systems and parts for automobiles

3. Definitions

Definitions of main terms used in this standard shall be based on **JASO D507-1** and **JASO D801** and as follows.

3.1

Antenna coupler

A matching box for measuring an induced voltage of a test antenna. Inserted between the test antenna and the field strength meter and used for synchronization through impedance matching.

3.2

Antenna overall gain

A value for expressing transmission and reception capability of an antenna. Refers to overall performance of an antenna including characteristics of equipment and part provided with an antenna such as an amplifier, cables and connectors. Expressed as the reference antenna ratio or the absolute gain value.

3.3

Antenna factor

- a) A conversion factor for correcting the measured antenna gain for each frequency. Includes parameters such as effective length, impedance conversion ratio, and mismatch loss.
- b) A ratio between the field strength of an incoming wave and the input voltage to the measurement receiver. A correction value for converting the antenna open terminal voltage into field strength.

3.4

LCR meter

Measuring equipment for determining impedance, inductance, capacitance by applying a signal to a circuit configured by inductor, capacitor and resistance and measuring voltage at both terminals of the specimen and a current value. Also used for measuring an antenna system capacity of an AM antenna, etc.

3.5

Circular polarization antenna

An antenna capable of efficiently transmitting and receiving a polarization of which the field vector has a horizontal component and a vertical component with phase difference between them.

3.6

Reference antenna

An antenna, with a known absolute gain value, used as reference when determining an antenna gain, or an antenna overall gain. Includes rod antenna, loop antenna, half-wave dipole antenna, and horn antenna, etc.

3.7 Q meter

- a) Equipment for measuring a resonance rate of an antenna itself or an antenna connected with a high radio-frequency coaxial cable.
- b) Equipment for measuring high radio-frequency performance of a part used in a resonance circuit, etc. Used for measuring the Q value and capacitance of a capacitor according to the resonance method.

3.8

Elevation angle

An angle expressing displacement in the vertical plane direction when testing or measuring the antenna directivity characteristics or evaluating the result after measurement.

3.9

Signal generator

Equipment for generating signals with stable arbitrary frequency and strength.

3.10

Spherical measurement

Measurement of the hemispherical directivity characteristics for a hemisphere including the test antenna as the center and the distance between transmitter and receiver as a certain radius.

3.11

Spectrum analyzer

Measuring equipment for measuring change in a high radio-frequency signal as spectrum in a particular frequency domain.

3.12

Intermodulation distortion (Intermodulation)

A phenomenon in which two interference waves aligned at equal intervals above or below a desired signal on the frequency axis generate distortion in a high radio-frequency amplifier circuit, etc., and the frequency of the desired signal becomes the same as that of the 3rd order distortion and thus the desired signal is interfered with the 3rd order distortion.

3.13

Log periodic antenna

An antenna, with a number of elements corresponding to individual frequencies, a wide frequency band, and

relatively sharp directivity, having a structure in which impedance and radiation characteristics repeat periodically in proportion to logarithm of the frequency.

3.14

Dynamic range

A value for expressing reproduction capability of a high radio-frequency signal. Expressed as the ratio between the maximum value and the minimum value in the unit of decibel (dB).

3.15

Equivalent-to-ground floor

A generic term of a floor surface, in an anechoic chamber or a measurement facility equivalent to it, with an electric performance plane equivalent to an outdoor ground.

3.16

Main plate

A metal plate used for simulating a vehicle body in an antenna evaluation test other than testing or measuring with an antenna mounted on the vehicle.

3.17

Linear polarization

A generic term of a plane wave of which the field vector is vertical (a vertical polarization), or horizontal (a horizontal polarization) with respect to the ground.

3.18

Field strength meter

Equipment for measuring an induced voltage of an antenna.

3.19

Field uniformity

A distribution pattern, in an anechoic chamber or a measurement facility equivalent to that, in which radiation fields from the transmitting antenna are uniformly distributed at the position where the test antenna is installed or within a predetermined area in the vicinity of the antenna. Particularly, when the test antenna is installed linearly opposed to the transmitting antenna, refers to a degree of deviation of field strength in a predetermined area including the height, width, and depth directions of the floor face, etc. around the installation position of the test antenna.

3.20

Network analyzer

Equipment for measuring transmission and reflection characteristics of a high radio-frequency signal in a high radio-frequency circuit network, etc. Mounted with a built-in signal generator and also used for measuring voltage, electric power of a high radio-frequency signal, etc.

3.21

NF meter

Equipment used for measuring noise figure for an amplifier, receiver, etc. Used for measuring a noise figure of equipment or a system with a noise source with known frequency characteristics connected to the input side of the amplifier, etc.

3.22**High impedance conversion probe**

Equipment, with sufficiently high impedance characteristics for 50-Ω resistance at the input side, capable of measuring frequency characteristics, spectrum, etc without affecting a high frequency line.

3.23**Height pattern**

A pattern on a graph showing a fluctuation by measuring the degree of influence in the installation height direction of a direct wave from the transmitting antenna and a reflected wave generated at the floor face, the side face, etc., in an anechoic chamber or a measurement facility equivalent to it.

3.24**Bias tee**

Equipment used for separating an electric power source and a signal for measurement purpose when an electric power source is superimposed on an output coaxial cable of the amplifier-mounted antenna. Superimposing of an electric power source is employed for a GPS antenna, an AM/FM antenna and a TV antenna.

3.25**Azimuth angle**

An angle expressing displacement in the horizontal plane direction when testing or measuring the antenna directivity characteristics or evaluating the result after measurement.

3.26**Horn antenna**

An antenna with a structure having required opening created by enlarging the cross section of a rectangular or circular waveguide tube.

3.27**Non-reflecting floor**

A generic term of a floor face, in an anechoic chamber or a measurement facility equivalent to it, using a wave absorber so as not to generate a reflected wave or so as to significantly attenuate it even if an electromagnetic wave from the transmitting antenna is radiated to the floor face, thereby preventing the receiving antenna from being affected by the reflected wave.

4 Measurement items

The measurement items for antenna performance shall be in accordance with **Table 1** depending on antenna conditions, accessories and the subject communication system.

Table 1 List of measurement items

Measurement subject	Subject communication system	Measurement item
Car antenna	AM broadcast	Overall gain
		Antenna system capacity
	FM / TV broadcast	Overall gain
		Directivity
	Telephone	Output VSWR
		Overall gain
Single unit antenna	AM broadcast	Directivity
		Output VSWR
	FM / TV broadcast	Overall gain
		Antenna system capacity
	Telephone	Overall gain
		Directivity
	GPS	Output VSWR
		Overall gain
	GPS	Directivity
		Axial ratio
		Output VSWR
		Gain
Single unit amplifier	AM broadcast	Out-of-band characteristics
		2nd and 3rd order intermodulation distortion
		Consumption current
		Gain
	FM / TV broadcast	Out-of-band characteristics
		Noise figure
		2nd and 3rd order intermodulation distortion
		Consumption current
		Output VSWR
		1 dB compression point
	GPS	Input-output isolation
		Gain
		Noise figure
		Consumption current
		Output VSWR
		Attenuation characteristics

5. Measuring method

5.1 Measuring method for car antenna

Performance of a car antenna shall be measured at a connecting terminal of a high radio-frequency coaxial cable (hereinafter referred to as "coaxial cable") to a receiver or a transmitting and receiving device. If an amplifier is used, a voltage specified for the amplifier shall be applied. If an electric power source is to be superimposed, I connect Bias tee so that it is appointed, and please carry this out. Record the car antenna equipment status, the specification of the measuring equipment, the measurement conditions, and the measuring method, etc. together with the measurement results.

5.1.1 Antenna receiving AM broadcast waves

On-board performance of an antenna receiving AM broadcast waves shall be expressed by the overall gain and the antenna system capacity.

5.1.1.1 Overall gain

5.1.1.1.1 General

Measure the received levels of the reference antenna and the car antenna using a broadcast wave. Calculate the overall gain by determining the relative value of the car antenna with respect to the reference antenna.

The measurement environment and the major measurement conditions shall be in accordance with **Table 2**.

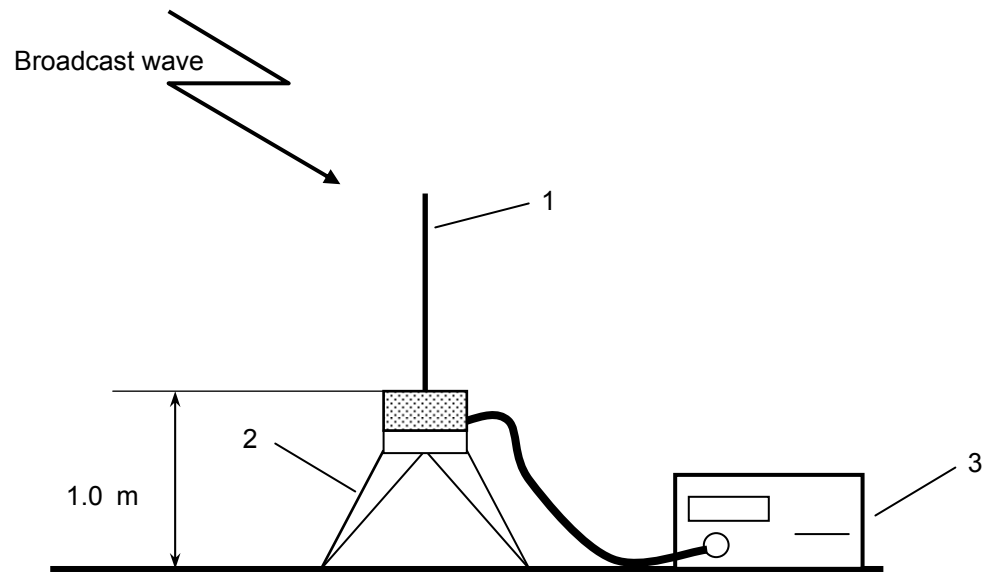
Table 2 Measurement environment and major measurement conditions

Items	Conditions
Broadcast wave used for measurement	Broadcast wave, with the minimum field strength of 50 dB μ V/m or more, free from field fluctuation that may affect performance during measurement is desirable.
Exogenous noise	No external noise that may affect the measurement is allowed.
Field uniformity	No reflective object that may affect the measurement is allowed in the vicinity. It is desirable that field uniformity of broadcast wave be within ± 5 dB.
Measurement center of vehicle	The vehicle center shall be aligned to the position where the reference antenna is installed.
Measurement frequency	Frequencies for at least 3 broadcast waves that are representative of the frequency characteristics of the antenna shall be selected.
Operation status of an amplifier when used	Measurement shall be made in the state where no distortion is generated by strong input to the amplifier. If an amplifier with an AGC circuit is used, the AGC circuit shall not be operated.

5.1.1.1.2 Method of measuring received level of reference antenna

The reference antenna shall be an antenna with a known antenna factor. Set the height of the antenna to a specified value, such as 1.0 m from the ground at the root of a rod antenna, and 1.3 m from the ground at the center of the loop of a loop antenna. Use conversion connectors, cables, etc. as specified or recommended by the antenna manufacturer.

As shown in **Figure 1**, measure the received voltages V_{ref} dB μ V of the reference antenna regarding the broadcast wave at each selected measurement frequency.



1 Reference antenna

2 Table^{a)}

3 Field strength meter, etc.

Note: ^{a)} The material shall be non-conductive.

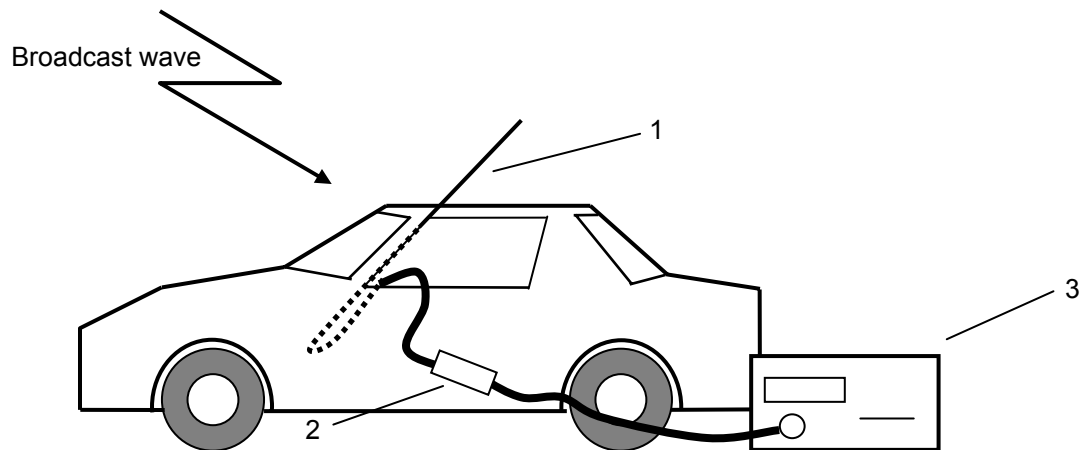
**Figure 1 AM broadcast wave receiving measurement system of reference antenna
(example of rod antenna)**

5.1.1.1.3 Method of measuring received level of car antenna

Connect a high impedance conversion probe or an antenna coupler, etc. determined by the parties involved in transmission and reception to the terminal of the coaxial cable of the car antenna. Use a field strength meter, etc. to measure the received voltage of a broadcast wave at each selected frequency (see **Figure 2**).

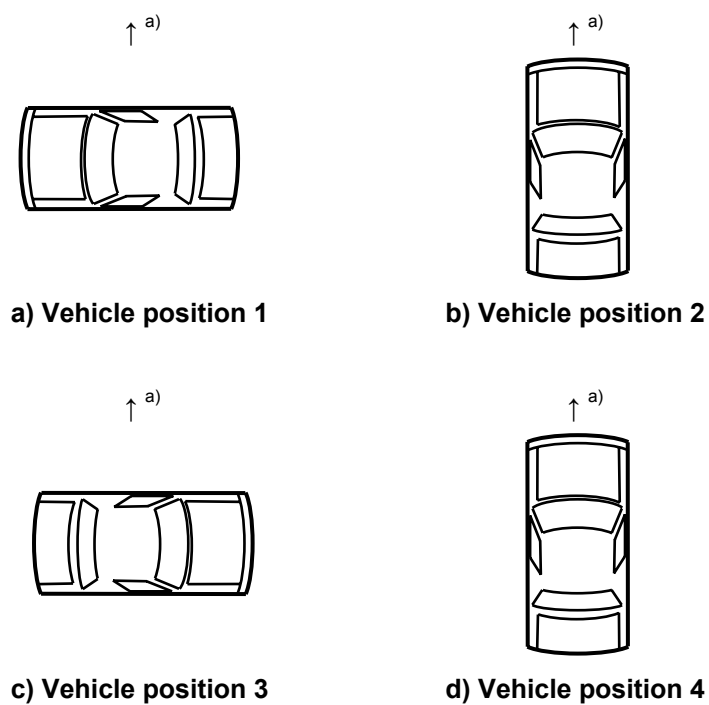
Carry out measurement in the state the vehicle is oriented in 4 directions at 90-degree intervals as shown in **Figure 3**. Next, determine the individual received voltages $V_{\text{ant-1}}$, $V_{\text{ant-2}}$, $V_{\text{ant-3}}$ and $V_{\text{ant-4}}$ (dB μ V), and calculate the mean antenna received voltage V_{ant} dB μ V by obtaining the arithmetic mean value of the four results.

Measurement may be carried out at positions along a circle rotating around the reference antenna position as shown in **Figure 4** unless such measurement positions affects the measurement results.



- 1 Car antenna
- 2 High impedance conversion probe, or antenna coupler, etc.
- 3 Field strength meter, etc.

Figure 2 AM broadcast wave received level measurement system of car antenna



Note: ^{a)} Directions in which the reference antenna is installed

Figure 3 Individual vehicle positions at measurement

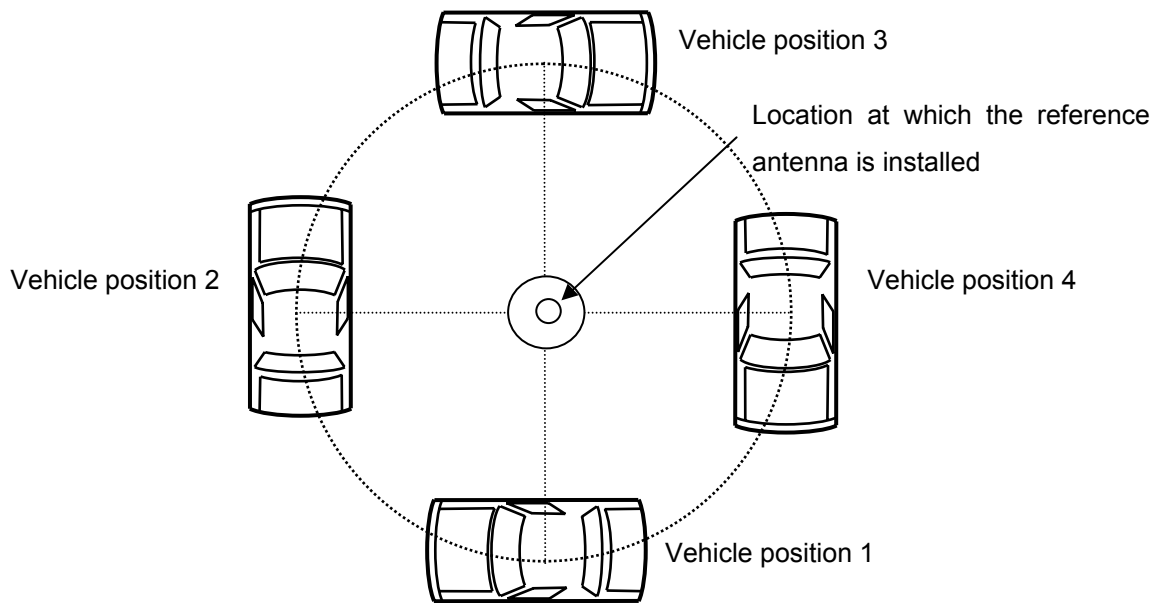


Figure 4 Vehicle measurement positions centered around reference antenna position

5.1.1.1.4 Calculation of overall gain

The overall gain of the car antenna shall be determined as the reference antenna ratio or the antenna effective height in accordance with the following equation.

$$VR = V_{ant} - V_{ref}$$

or

$$EH = V_{ant} - V_{ref} + AF$$

where,

VR: reference antenna ratio (dB)

V_{ant} : mean received voltage of car antenna (dB μ V)

V_{ref} : received voltage of reference antenna (dB μ V)

EH: antenna effective height [dB (m)]

AF: antenna factor of reference antenna

If necessary, calculate the mean value for the overall car antenna by determining the arithmetic mean value of the reference antenna ratios or the antenna effective heights at the individual frequencies.

5.1.1.2 Antenna system capacity

5.1.1.2.1 General

Measure the antenna system capacity at a place where the capacity is not affected by broadcast wave or exogenous noise.

5.1.1.2.2 Measuring method

Carry out the measurement using a Q meter or an LCR meter as shown in **Figure 5** to determine the capacity (pF) at the terminal of the coaxial cable.

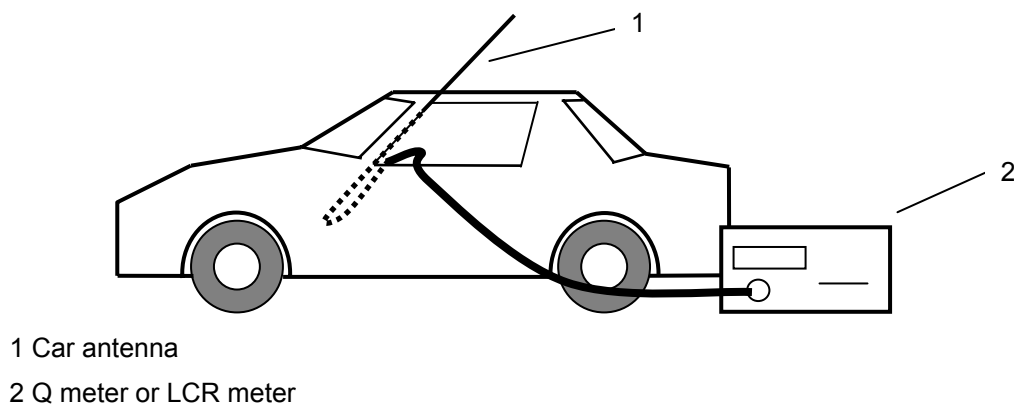


Figure 5 Measurement system of car antenna system capacity

5.1.2 Antenna receiving FM / TV broadcast waves

On-board performance of antenna receiving FM / TV broadcast waves shall be expressed by the overall gain, the directivity and the output VSWR.

5.1.2.1 Overall gain and directivity

5.1.2.1.1 General

For the overall gain and the directivity, measure the received levels of the reference antenna and the car antenna, using an anechoic chamber or a measurement facility equivalent to it. Next, determine the directivity from the antenna gain for each azimuth angle of the car antenna, and subsequently calculate the overall gain. The measurement environment and the major measurement conditions shall be in accordance with **Table 3**.

Table 3 Measurement environment and major measurement conditions

Items	Conditions
Measurement environment	Measurement shall be made in an environment in which four parameters are known: the field uniformity, the height pattern, the dynamic range, and the floor face specifications (of an equivalent-to-ground floor or a non-reflecting floor). It is desirable that the field uniformity be within ± 3 dB, and the dynamic range be 40 dB or more in the measurement frequency range.
Measurement center of vehicle	The vehicle center shall be aligned with the measurement position of the reference antenna. However, if an offset between the vehicle center and the car antenna center would affect the antenna performance, the measurement may be made by installing the vehicle so as to reduce the effect of the offset.
Passenger load on vehicle	No load shall be applied normally.
Type of transmitting antenna	An antenna capable of transmitting a linear polarization shall be used.
Height of transmitting antenna	The height of the transmitting antenna measured from the reference antenna shall be within 0 to 10 degrees in elevation angle.
Polarization plane of transmitting antenna	Basically, a horizontal polarization shall be used. Alternatively, a vertical polarization, etc. may be added through agreement among the parties involved in transmission and reception.
Distance between transmitting and receiving antennas	The distance shall satisfy the field uniformity, and the distance shall not be changed during the measurement.
Interval of measurement frequency	The interval shall be 1 MHz for the FM band, and between 1 MHz to 30 MHz for the TV band (VHF, UHF).
Interval of whole circumference measurement angle	The interval shall be from 1 to 10 degrees that can equally divide the circumference.
Operation status when amplifier is used	Measurement shall be made in the state where distortion is not generated by strong input to the amplifier. If an amplifier with an AGC circuit is used, the AGC circuit shall not be operated.
Load conditions on antenna other than the measured antenna	Opening and end terminals shall be determined by the parties involved in transmission and reception.
Indication in absolute quantity	Whether to use the voltage ratio dB μ V or the electric power ratio dBm shall be determined by the parties involved in transmission and reception.
Unit	dBd shall be used. dB μ V indication may be used through agreement among the parties involved in transmission and reception.

5.1.2.1.2 Method of measuring received level of reference antenna

The reference antenna shall be a half-wave dipole antenna with a known antenna factor. The height shall be determined by the parties involved in transmission and reception and be within the range of 1.0 m to 2.5 m from the ground at the center of the reference antenna.

Install horizontally the reference antenna with a length matched to a predetermined measurement frequency to the center of a turn table. Use a transmission output with the dynamic range at measurement of the car antenna being taken into consideration so as to observe the received level using a network analyzer, etc. Adjust the orientation of the reference antenna, and assume the maximum received level as the received voltage V_{ref} dB μ V of the reference antenna (see **Figures 6 and 7**).

Repeat the measurements in the same procedure also at other measurement frequencies.

If an attenuator is inserted at the output terminal of the antenna or in the middle of the measurement cable, compensate loss resulting from the insertion.

When additionally measuring a vertical polarization, set the transmitting antenna and the reference antenna vertically, and measure the received voltage of the reference antenna in the same procedure as that for a horizontal polarization.

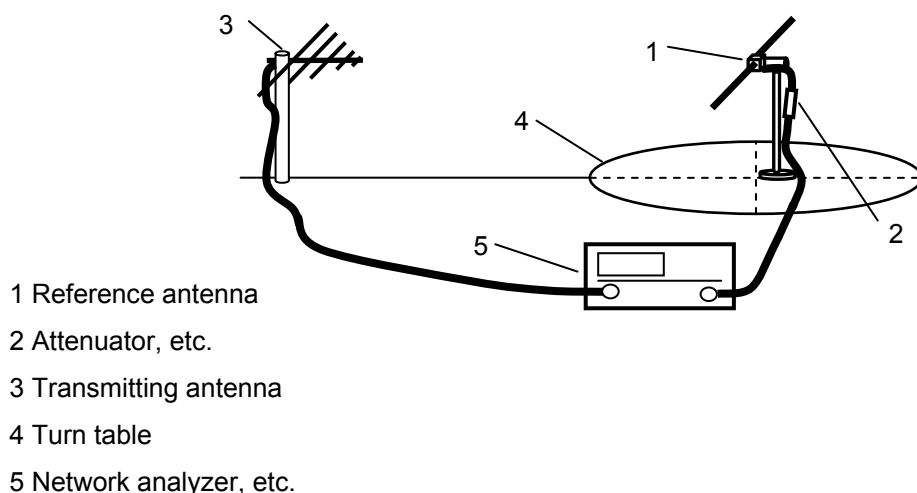


**Figure 6 FM / TV band measurement system of reference antenna
(example where network analyzer is used)**

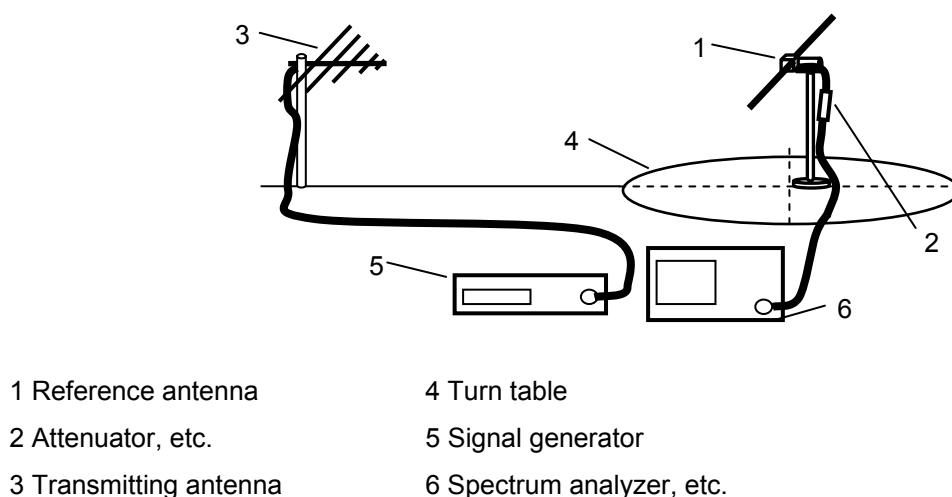


**Figure 7 FM / TV band measurement system of reference antenna
(example where signal generator and spectrum analyzer are used)**

5.1.2.1.3 Method of measuring received level of car antenna

Install the vehicle on the turn table. Insert an attenuator, etc. at the output terminal of the car antenna or in the middle of the coaxial cable. Use a network analyzer, etc. to measure the received voltage V_{ant} dB μ V for the same conditions as those at the measurement of the reference antenna at the selected frequency (see **Figure 8**).

Repeat the measurements at other measurement frequencies.

Rotate the turn table at a predetermined interval of angle, and repeat the measurements at every rotation interval at each measurement frequency.

If an attenuator is inserted, compensate the loss resulting from the insertion.

When additionally measuring a vertical polarization, set the transmitting antenna vertically, and measure the received voltage of the car antenna in the same procedure as that for a horizontal polarization.

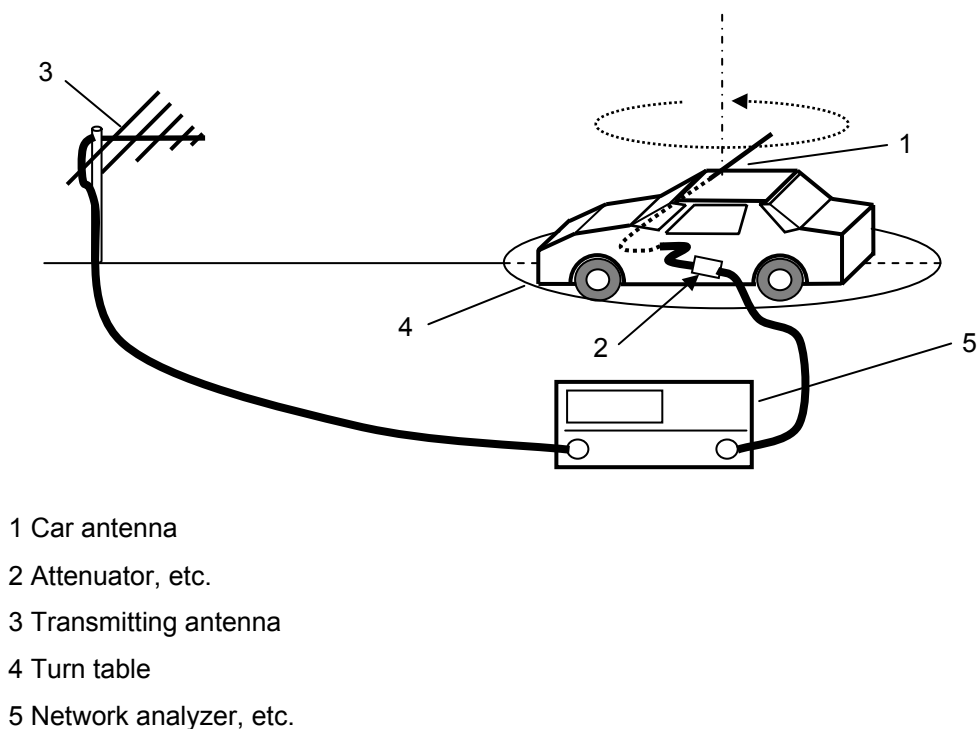


Figure 8 FM / TV band measurement system of car antenna (example where network analyzer is used)

5.1.2.1.4 Calculation of directivity and overall gain

The directivity and the overall gain shall be calculated as follows.

a) Calculation of directivity

Calculate the antenna gain for each rotation angle at each measurement frequency and show the directivity in the polar coordinates or the orthogonal coordinates (see **Figure 9 or 10**).

The specific calculation method and the graphing method shall be in accordance with **Annex A**.

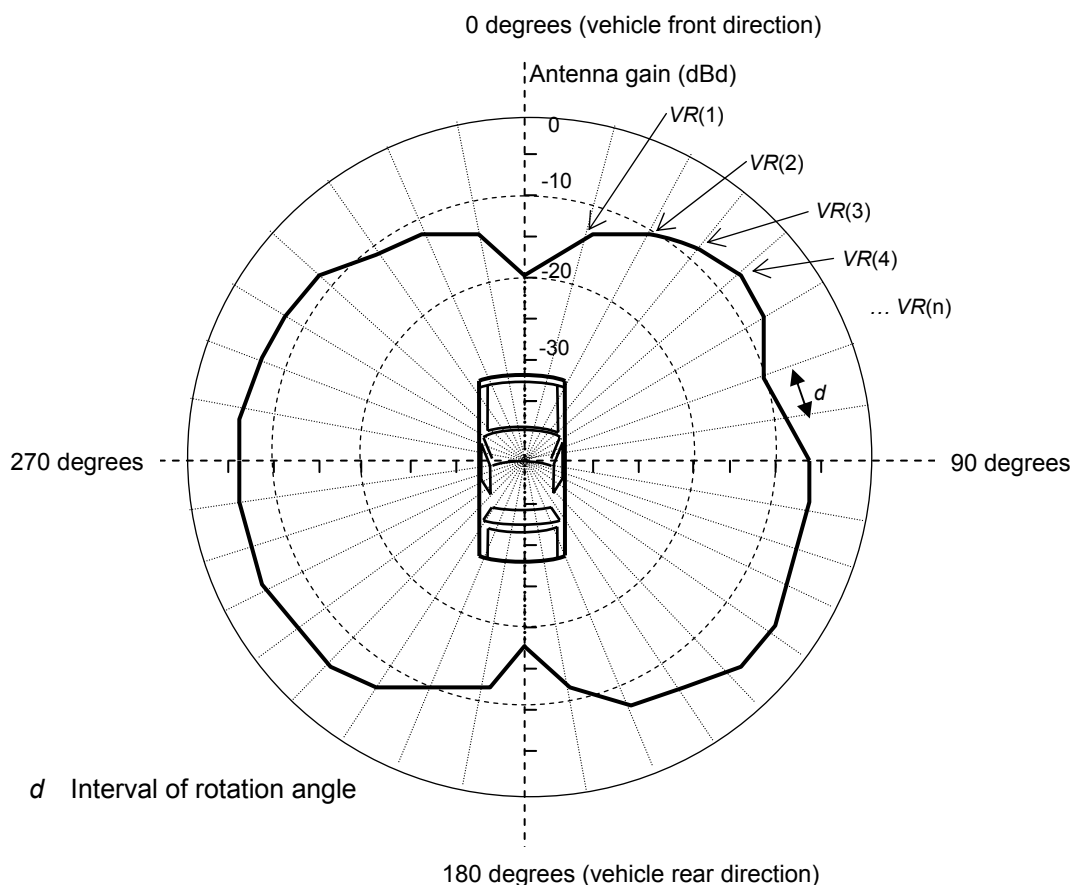


Figure 9 Example of directivity diagram in polar coordinate chart

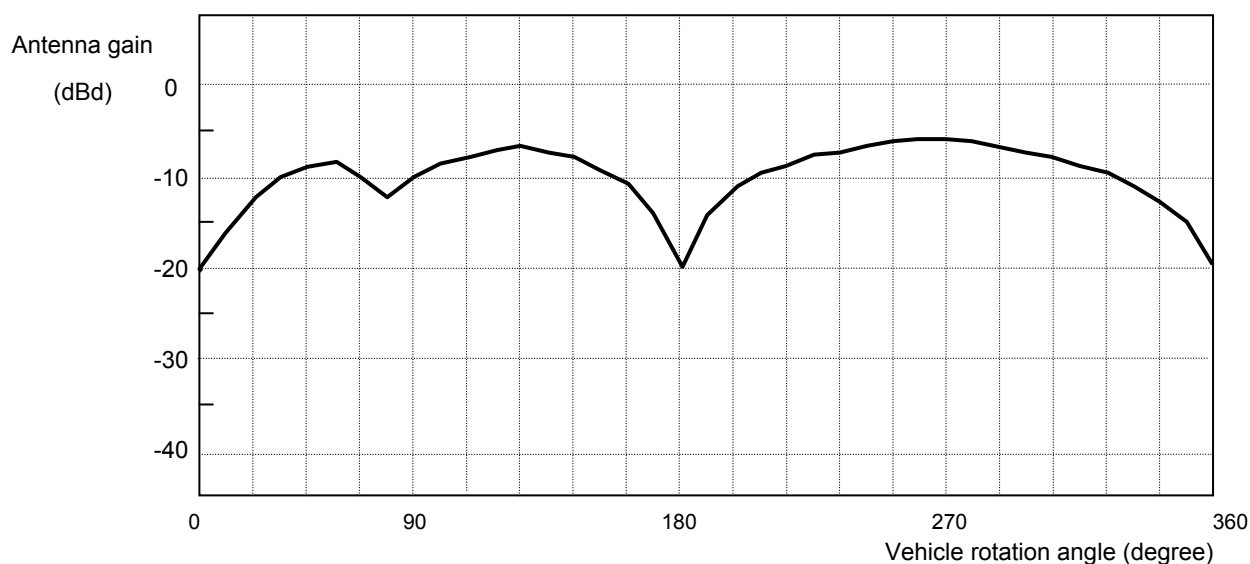


Figure 10 Example of directivity diagram in orthogonal coordinate chart

b) Calculation of overall gain

The overall gain shall be expressed in the mean directivity value and the overall mean value. The individual specific calculation methods shall be in accordance with **Annex A**.

c) Creation of frequency characteristics

Create a frequency characteristics chart based on the mean directivity value at each frequency (see **Figure 11**).

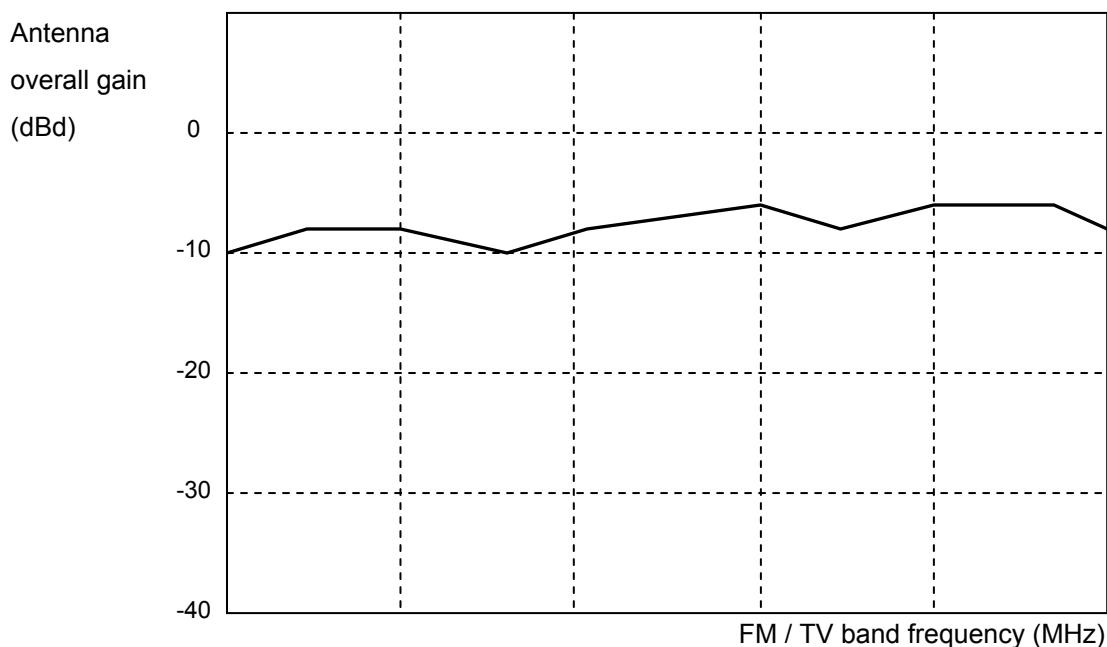


Figure 11 Example of frequency characteristics

5.1.2.2 Output VSWR**5.1.2.2.1 General**

The measurement environment of the output VSWR shall be in accordance with **5.1.1.2.1**.

5.1.2.2.2 Measuring method

Use a network analyzer, etc. as shown in **Figure 12** to measure VSWR at the connecting terminal of the coaxial cable to the receiver. The measurement frequency range shall include the required frequency band of the receiving antenna.

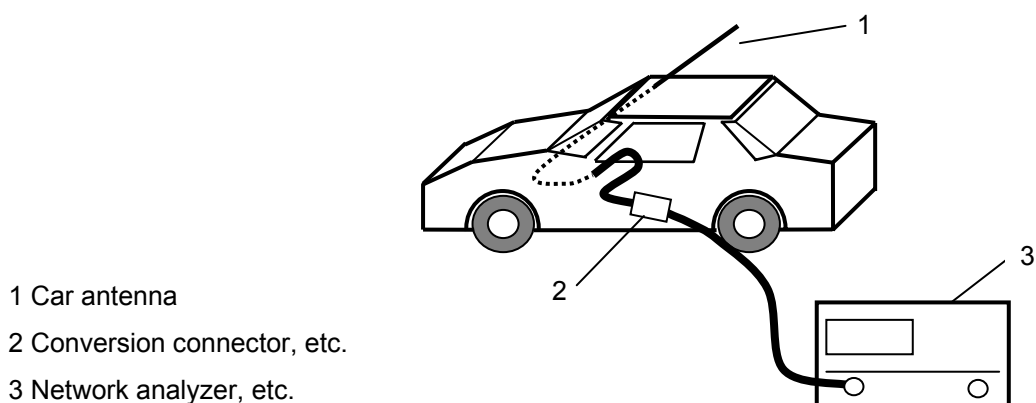


Figure 12 Example of car antenna VSWR measurement system

5.1.2.2.3 Processing measurement results

The measurement results shall be shown in the output VSWR characteristics chart as shown in **Figure 13**.

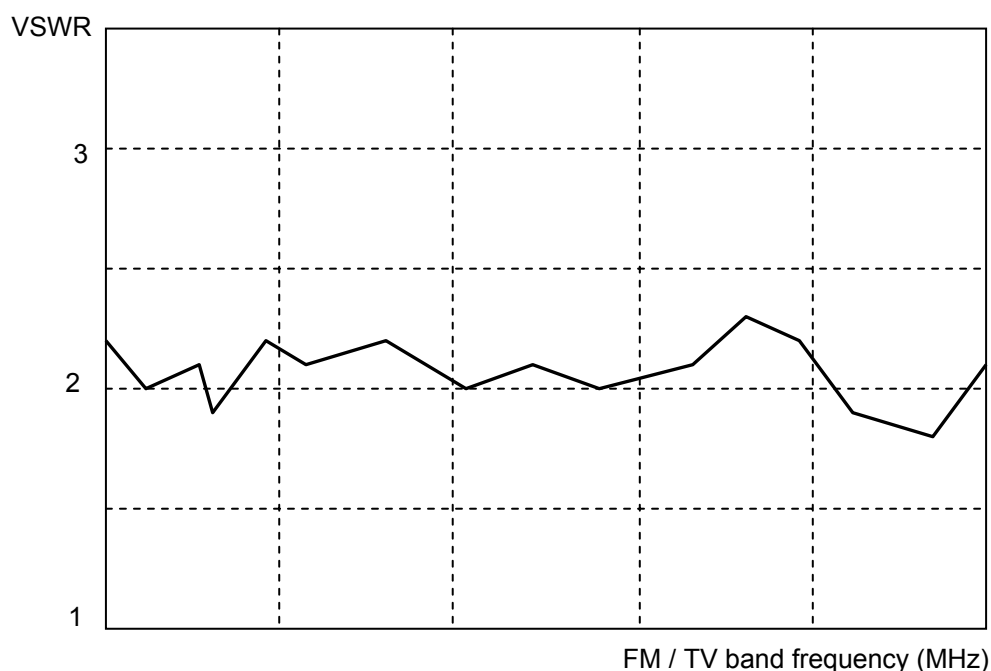


Figure 13 Example of output VSWR characteristics

5.1.3 Antenna receiving telephone

On-board performance of an antenna receiving telephone shall be expressed by the overall gain, the directivity and the output VSWR.

5.1.3.1 Overall gain and directivity

5.1.3.1.1 General

For the overall gain and the directivity, measure the received levels of the reference antenna and the car antenna, using an anechoic chamber or a facility equivalent to it. Next, determine the directivity from the antenna gain for each azimuth angle of the car antenna, and subsequently calculate the overall gain.

The measurement environment and the major measurement conditions shall be in accordance with **Table 4**.

Table 4 Measurement environment and major measurement conditions

Items	Conditions
Measurement environment	Measurement shall be made in an environment in which four parameters are known: the field uniformity, the height pattern, the dynamic range, and the floor face specifications (of an equivalent-to-ground floor or a non-reflecting floor). It is desirable that the field uniformity be within ± 3 dB, and the dynamic range be 40 dB or more in the 900 MHz band and 30 dB or more in the 2 GHz band.
Measurement center of vehicle	The vehicle center shall be aligned with the measurement position of the reference antenna. However, if an offset between the vehicle center and the car antenna center would affect the antenna performance, the measurement may be made by installing the vehicle so as to reduce the effect of the offset.
Passenger load on vehicle	No load shall be applied normally.
Type of transmitting antenna	An antenna capable of transmitting a linear polarization shall be used.
Height of transmitting antenna	The height of the transmitting antenna measured from the reference antenna shall be within 0 to 10 degrees in elevation angle.
Polarization plane of transmitting antenna	Basically, a vertical polarization shall be used. Alternatively, a horizontal polarization, etc. may be added through agreement among the parties involved in transmission and reception.
Distance between transmitting and receiving antennas	The distance shall satisfy the field uniformity, and the distance shall not be changed during the measurement.
Measurement frequency	At least 3 frequencies shall be used including the upper limit, the lower limit and the median of the transmission frequency band and the reception frequency band.
Interval of whole circumference measurement angle	The interval shall be from 1 to 10 degrees that can equally divide the circumference.
Load conditions on antenna other than the measured antenna	Opening and end terminals shall be determined by the parties involved in transmission and reception.
Indication in absolute quantity	An electric power ratio dBm shall be used.
Unit	dBd or dBi shall be used.

5.1.3.1.2 Method of measuring received level of reference antenna

The reference antenna shall be a half-wave dipole antenna with a known antenna factor. The height shall be determined by the parties involved in transmission and reception and be within the range of 1.0 m to 2.5 m from the ground at the center of the reference antenna.

Install vertically the reference antenna with a length matched to a predetermined measurement frequency to the center of a turn table. Use a transmission power with the dynamic range at measurement of the car antenna being taken into consideration so as to observe the received level with a network analyzer, etc, and assume the received level as the received electric power of the reference antenna P_{ref} dBm (see **Figure 14**).

Repeat the measurements in the same procedure at other measurement frequencies.

If an attenuator is inserted at the output terminal of the antenna or in the middle of the measurement cable, compensate loss resulting from the insertion.

When additionally measuring a horizontal polarization, set the transmitting antenna and the reference antenna horizontally, and measure the received electric power of the reference antenna in the same procedure as that for a vertical polarization.

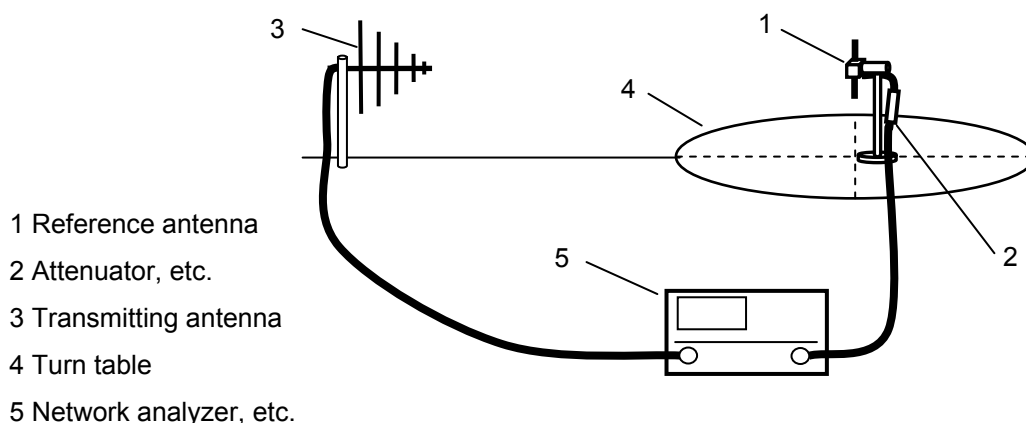


**Figure 14 Telephone band measurement system of reference antenna
(example where network analyzer is used)**

5.1.3.1.3 Method of measuring received level of car antenna

Install the vehicle on the turn table. Insert an attenuator, etc. at the output terminal of the car antenna or in the middle of the coaxial cable. Use a network analyzer, etc. to measure the received electric power P_{ant} dBm for the same conditions as those at the measurement of the reference antenna at the selected frequency (see **Figure 15**).

Repeat the measurements at other measurement frequencies.

Rotate the turn table at a predetermined interval of angle, and repeat the measurements at every rotation interval at each measurement frequency.

If an attenuator is inserted, compensate the loss resulting from the insertion.

When additionally measuring a horizontal polarization, set the transmitting antenna horizontally, and measure the received electric power of the car antenna in the same procedure as that for a vertical polarization.

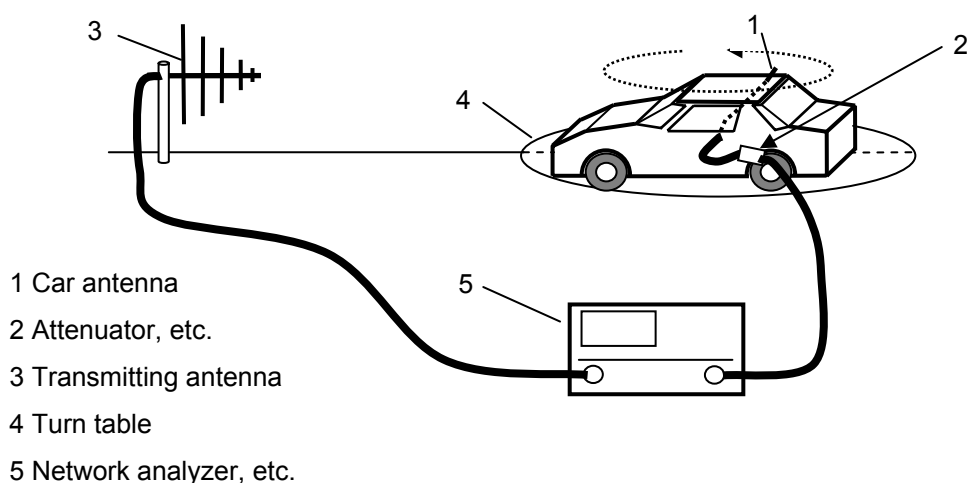


**Figure 15 Telephone band measurement system of car antenna
(example where network analyzer is used)**

5.1.3.1.4 Calculation of directivity and overall gain

The directivity and the overall gain shall be calculated as follows.

a) Calculation of directivity

Calculate the antenna gain for each rotation angle at each measurement frequency, and show the directivity in the polar coordinates or the orthogonal coordinates (see **Figures 16** and **17**).

The specific calculation method and the graphing method shall be in accordance with **Annex A**.

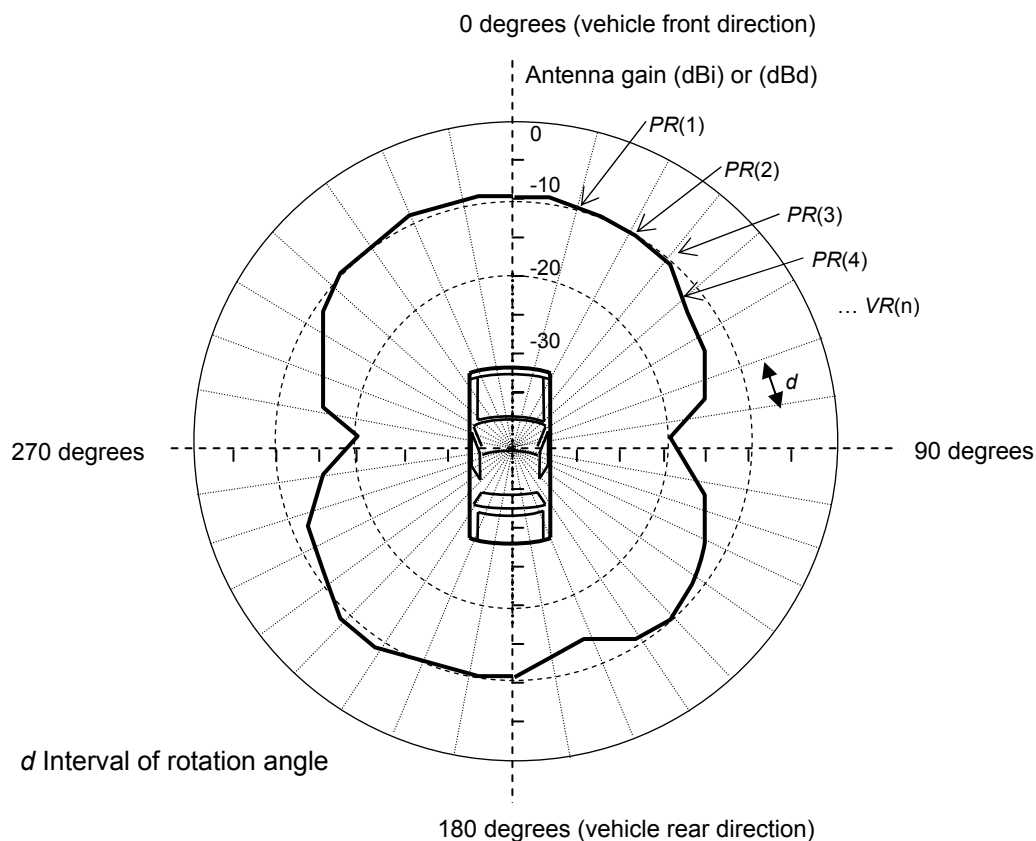


Figure 16 Example of directivity diagram in polar coordinate chart

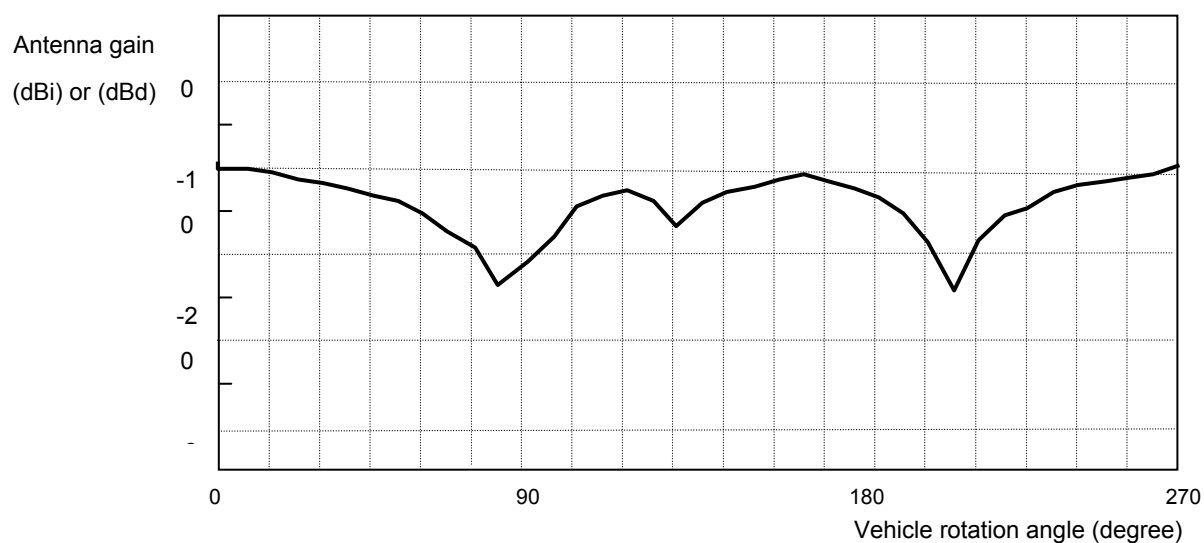


Figure 17 Example of directivity diagram in orthogonal coordinate chart

b) Calculation of overall gain

The overall gain shall be expressed in the mean directivity value and the overall mean value. The overall mean value may be omitted, if not necessary.

The individual specific calculation methods shall be in accordance with **Annex A**.

c) Creation of frequency characteristics

Create a frequency characteristics chart based on the mean directivity value at each frequency (see **Figure 18**).

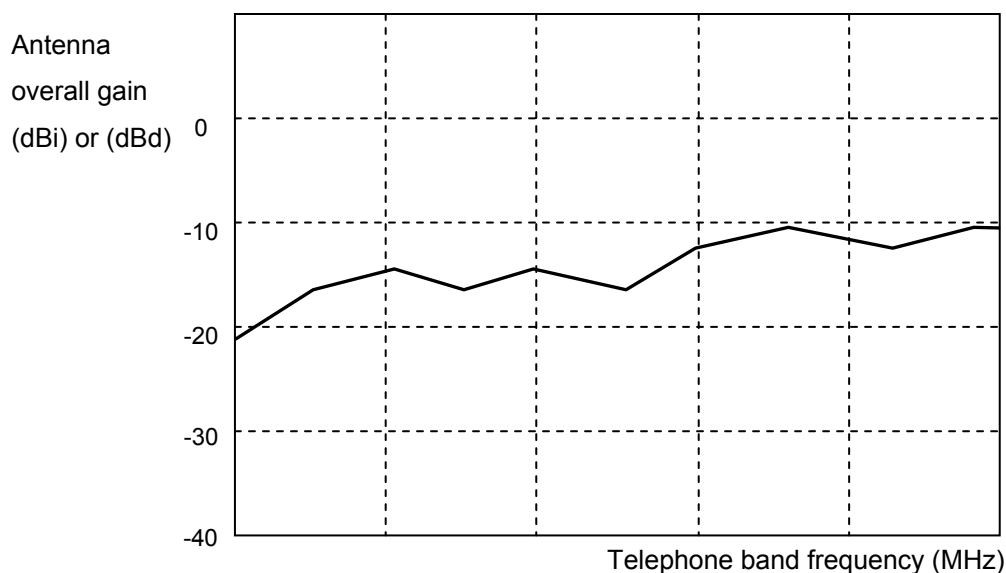


Figure 18 Example of frequency characteristics

5.1.3.2 Output VSWR**5.1.3.2.1 General**

The measurement environment of the output VSWR shall be in accordance with **5.1.1.2.1**.

5.1.3.2.2 Measuring method

Use a network analyzer, etc. as shown in **Figure 19** to measure VSWR at the connecting terminal of the coaxial cable to the transmitting and receiving device. The measurement frequency shall include the required frequency band of the transmitting and receiving antenna.

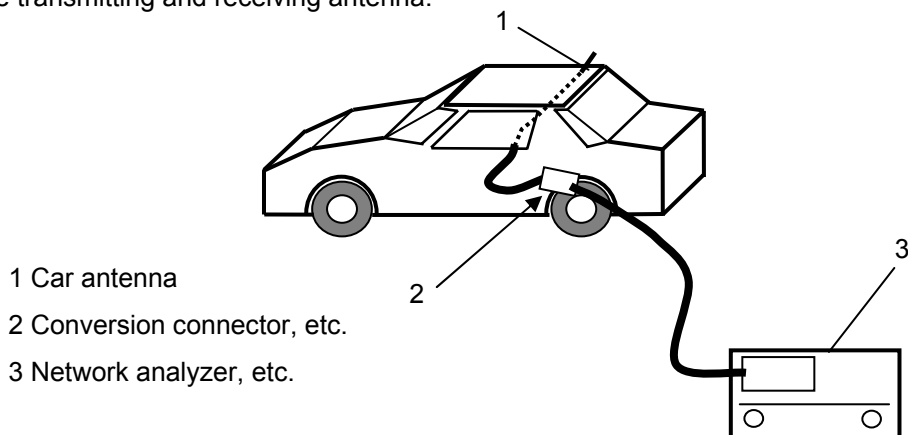


Figure 19 VSWR measurement system

5.1.3.2.3 Processing measurement results

The measurement results shall be shown in the output VSWR characteristics chart as shown in **Figure 20**.

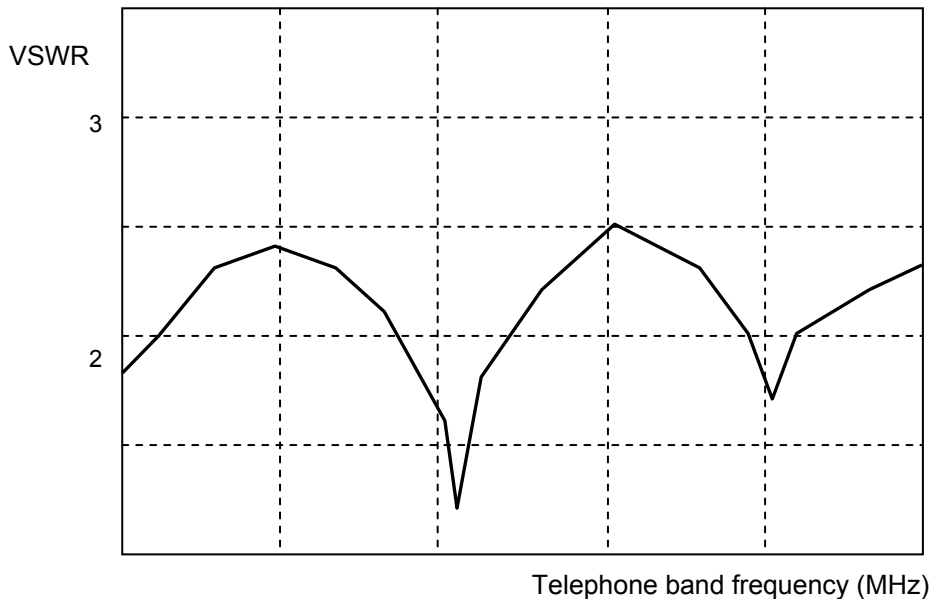


Figure 20 Example of output VSWR characteristics

5.2 Measuring method of single unit antenna

Performance of a single unit antenna shall be measured through direct connection to the antenna element or, as necessary, with the antenna connected to a certain amplifier and the coaxial cable.

If an amplifier is used, a voltage specified for the amplifier is applied using a stabilized DC power source. If an electric power source is to be superimposed on the coaxial cable, carry out this as specified.

When attaching the test antenna to a certain main plate, set the antenna with an antenna installation angle determined by the parties involved in transmission and reception. The main plate shall be a 1 m x 1 m steel plate, unless otherwise determined by the parties involved.

If a turn table is used, install the antenna to the center of the table.

Record the setting of the test antenna, the specifications and length of the coaxial cable to use, the specification of the measuring equipment, the measurement conditions, the measuring method, etc. together with the measurement results.

5.2.1 Antenna receiving AM broadcast waves

Performance of a single unit antenna receiving AM broadcast waves shall be expressed by the overall gain and the antenna system capacity.

5.2.1.1 Overall gain

5.2.1.1.1 General

Measure the received levels of the reference antenna and the test antenna using a broadcast wave. Calculate the overall gain by determining the relative value of the test antenna with respect to the reference antenna.

The measurement environment and the major measurement conditions shall be in accordance with **Table 2**. However, change the phase "measurement center of vehicle" to "position of test antenna" and the antenna position shall match the reference antenna position.