

The English translation is believed to be accurate. In case of discrepancies the German version shall govern.

Norm vor Anwendung auf Aktualität prüfen / Check standard for current issue prior to usage.

VOLKSWAGEN AG	Electromagnetic Compatibility of Automotive Electronic Components Radiated Interference Radiated Interference	TL 821 66
Konzernnorm		
Descriptors: electromagnetic compatibility, EMC, interference immunity		
<b>Preface</b> <p>Additional tests necessary for evaluation and release of electronic components beside the EMC test are defined and specified in the drawing, Technical Supply Specification (TL) or other documents.</p> <p>For release procedure, measurements in the anechoic chamber, in the free field or in the laboratory are conducted by the responsible EMC departments of VOLKSWAGEN AG.</p>		
<b>Contents</b>		
		Page
1	Scope .....	2
2	Abbreviations .....	2
3	General test conditions.....	2
4	Functional states .....	2
5	Test documentation .....	3
6	Component testing .....	3
7	Vehicle testing .....	4
8	Referenced standards .....	8
<b>Changes</b> <p>The following changes have been made as compared to TL 821 66: 1998-02 issue:</p> <ul style="list-style-type: none"><li>- Approved component test procedures extended</li><li>- Frequency range to be tested with component test procedures extended</li><li>- Maximum amplitude field</li><li>- Field strength values adapted to new field control method</li><li>- Mobile radio test scope extended</li><li>- References to international standards</li></ul>		
<b>Previous issues</b> <p>1986-04; 1993-08; 1998-02</p>		
		Page 1 of 8
Fachverantwortung/Responsibility		Normung/Standards (EZTD, 1733)
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Form FE 41 - 01.03

## 1 Scope

This standard contains requirements and tests for determining the electromagnetic compatibility (EMC) of electronic components with respect to radiated electromagnetic interferences coupled into the vehicle's supply and signal circuits and/or into electronic components.

## 2 Abbreviations

AMPS	-	Advanced Mobile Phone System
TETRA	-	Trans European Trunked Radio
UMTS	-	Universal Mobile Telephone System
GSM	-	Global System for Mobile Communication
IMT-2000	-	International Mobile Telephone 2000

## 3 General test conditions

Deviations from the following test conditions shall be noted in the test report in any case.

Operating temperatures	according to drawing, performance specifications or TL standard
Test temperature	$(23 \pm 5) ^\circ\text{C}$ ; operating temperature in special cases
Operating voltages	according to drawing, performance specifications or TL standard

## 4 Functional states

In the case of disturbance of function the interference threshold shall be determined. Here, acc. to the respective assembly specifications, the following states are possible:

Functional state A:	The assembly / system operates during and after exposure as designed and within the permissible tolerances.
Functional state B:	Individual functions of the assembly / system work beyond the prescribed tolerances, but independently return to normal operation after the disturbance has been removed. Requirements acc. to functional state A apply to memory functions.
Functional state C:	Individual functions of the assembly / system fail but independently return to normal operating state after removal of interference.
Functional state D:	Individual functions or the complete assembly / system fail. Function can be returned to normal after the exposure has been removed by simple operations like e.g. fuse replacement without the aid of customer service shops.
Functional state E:	Individual functions or the complete assembly / system fail. Function cannot be returned to normal without repair or replacement in a customer service shop.

## 5 Test documentation

The following information shall be given for the EMC engineering department when delivering samples for EMC tests:

- System designation and description
- State of hardware, mounting lists and layout schematics as well as parts lists, circuit diagram and description of the EMC measures (e.g. filter and screening circuits for in/outputs and supply lines, screening measures)
- State of software with description of the essential EMC measures (e.g. filtering of signals implemented in software, temporary deactivation of selected circuit components, limp-home features)
- Deviations from TL standard specifications as agreed upon between VOLKSWAGEN AG and supplier
- EMC qualification report for each sample status

## 6 Component testing

Component tests shall be conducted by the supplier completely, as agreed upon in the testing concept.

Any combination of the test methods specified in the standards ISO 11452-2, -3, -4 and -5 as well as ISO 11452-1 shall be applied to test interference immunity from 1 MHz to 1 000 MHz. The deviations listed in table 1 shall apply.

**Table 1**

	ISO 11452-2 Anechoic chamber	ISO 11452-3 TEM cell	ISO 11452-4 BCI	ISO 11452-5 Stripline
Frequency range	(80 to 1,000) MHz	(1 to 400) MHz	(1 to 1,000) MHz	(1 to 400) MHz
Increment	1 to 200 MHz: 200 to 400 MHz: 400 to 1,000 MHz:	1 MHz 2 MHz 5 MHz		
Stay time per $\Delta f$	$\geq 1$ s (depending on the response time of the system under test)			
Test modulation	AM modulation 1 kHz (sinusoidal), $m = 80$ % acc. to ISO 11452-1 (different modulations may be chosen to achieve maximum interference in the system under test)			
Testing field strength and current (functional state)				
- Standard requirement	80 V/m (A)	200 V/m (A)	200 mA (A)	200 V/m (A)
- Systems with reduced requirements	80 V/m (C) 40 V/m (A)	200 V/m (C) 100 V/m (A)	200 mA (C) 100 mA (A)	200 V/m (C) 100 V/m (A)
Procedure/ Note	Vertical polarization; from 400 MHz on additional horizontal polarization	Acc. to ISO 11452-3, section 4.3.1		

Assignment of certain systems that are not relevant for safety to the group of systems with reduced requirements can only be made in individual cases upon agreement with the responsible engineering department. Nevertheless, there shall be no damage up to the standard limit value even in this case.

## 7 Vehicle testing

Normally, vehicle testing is only carried out by the responsible EMC engineering department of VOLKSWAGEN AG after successful completion of the component tests stated in the EMC qualification report.

In case there are modifications of systems and components in current production initiated by the supplier, vehicle tests may also be carried out by external laboratories after preliminary agreements and critical review.

### 7.1 Interference immunity test (far field)

The overall vehicle's strength shall be tested acc. to ISO 11451-2 inside an anechoic chamber with conductive floor.

The deviations listed in table 2 shall apply.

**Table 2**

Frequency range	6 MHz to 1,000 MHz		
Increment $\Delta f$ and field polarization	0.1 MHz	6 to 30 MHz	horizontal polarization
	1.0 MHz	30 to 220 MHz	horizontal and vertical polarization
	2.0 MHz	220 to 400 MHz	horizontal and vertical polarization
	5.0 MHz	400 to 1,000 MHz	horizontal and vertical polarization
Stay time per $\Delta f$	$\geq 1$ s (depending on the response time of the system under test)		
Test modulation	AM modulation 1 kHz (sinusoidal), $m = 80$ % acc. to ISO 11451-1 (different modulations may be chosen to achieve maximum interference in the system under test)		
Testing field strength and functional state			
- Standard requirement	6 to 30 MHz:	200 V/m	(functional state A)
	30 to 1,300 MHz:	140 V/m	(functional state A)
	1,300 to 3,000 MHz:	70 V/m	(functional state A)
- Systems with reduced requirements	6 to 3,000 MHz:	70 V/m	(functional state A)
	6 to 30 MHz:	200 V/m	(functional state C)
	30 to 1,300 MHz:	140 V/m	(functional state C)
Field generation	4-step substitution method acc. to ISO 11451-2 Reference point = test bed center = vehicle center Exception: between 6 and 30 MHz averaging of field strength values over two points at a height of 1 m and 2 m on the left and on the right of test bed center		
Radiation direction	The vehicle shall be subjected to radiation from at least 2 directions acc. to the specifications by VOLKSWAGEN AG's EMC engineering department, depending on the installed positions of the interference sink and the harness. Specified directions: - onto the vehicle's front - onto the driver's side		

Assignment of certain systems that are not relevant for safety to the group of systems with reduced requirements can only be made in individual cases upon agreement with the responsible engineering department. Nevertheless, there shall be no damage up to the standard limit value even in this case.

## 7.2 Mobile radio measurement with exterior antenna

The standard production antennas installed in the vehicle (if present), or magnetically mounted rod antennas shall be used for testing (see ISO 11451-3). The use of a combination is permissible.

At least 2 antenna positions shall be tested for each of the frequency bands listed in table 4, if not specified otherwise by VOLKSWAGEN AG's responsible EMC engineering department:

Minimum range of the antenna positions to be tested (see table 3).

**Table 3 - Minimum range of the antenna positions to be tested**

Frequency band	Antenna position							
	Fender, front	Roof trim	Roof center, front	Roof center	Roof center, rear	Fender, rear	Trunk lid, center	Bumper, rear
SW				x				x
4 m					x	x		
2 m					x	x		
70 cm		x				x		
TETRA/TETRAPOL			x			x		
AMPS		x			x			
GSM 850/900		x			x			
23 cm		x			x			
GSM 1800/1900		x			x			
UMTS		x			x			

A test signal that is representative for the frequency band under test shall be fed via an external power amplifier (parameters acc. to fig. 4). The cable should be provided with e.g. ferrite rings in order to suppress eddies on the cable leading from the power amplifier to the vehicle antenna.

**Table 4 - Frequency bands, test signal parameters and forward power at the antenna base for mobile radio testing with exterior antenna**

Frequency band/radio system	MHz	$\Delta f/\text{kHz}$	$P_{\text{for}}/\text{Watt}$	Modulation
SW (radio, analog)	3.5 to 54	100	150 (peak)	AM: 1,000 Hz; 80 % modulation
4 m (radio, analog)	68 to 87.5	100	100 (RMS)	FM: 1,000 Hz; 4 kHz deviation
2 m (radio, analog)	144 to 176	200	100 (RMS)	FM: 1,000 Hz; 4 kHz deviation
70 cm (radio, analog)	410 to 470	200	100 (RMS)	FM: 1,000 Hz; 4 kHz deviation
TETRA/TETRAPOL (radio, digital)	380 to 390 410 to 420 450 to 460 806 to 825 870 to 876	200	100 (peak)	PM: 18 Hz; (pulse-duty factor 50 %)
AMPS (mobile phone)	824 to 849	300	50 (peak)	FM: 1,000 Hz; 10 kHz deviation
GSM 850 (mobile phone) GSM 900 (mobile phone)	824 to 849 876 to 915	400	50 (peak)	PM: 217 Hz; (pulse-duty factor 50 %)
23 cm (radio, analog)	1,200 to 1,300	400	25 (RMS)	FM: 1,000 Hz; 4 kHz deviation
GSM 1800/1900 (mobile phone)	1,710 to 1,785 1,850 to 1,910	400	10 (peak)	PM: 217 Hz; (pulse-duty factor 50 %)
IMT-2000 (UMTS) (mobile phone WCDMA & TD/CDMA)	1,885 to 2,025	1 600	10 (peak)	CW and PM: 1,600 Hz; (pulse-duty factor 50 %)
$P_{\text{for}}$ : Forward power at the antenna base Peak Actual (RMS) power measured at maximum AM modulation or at PM during pulse				

### 7.3 Portable mobile radio measurements inside the vehicle

The test imitates the function of mobile radio units inside the vehicle without using exterior antennas. The following positions must be tested:

1. Seat areas (front and rear)
2. Door trays
3. Storage shelves in the center console (front and rear)
4. Storage shelves in the dashboard
5. Sensor and harness areas

The mobile phone unit mock-up to be used consists of a metal case (recommended dimensions approx. (20 x 7 x 3) cm for 2 m band or 70 cm-band; (11.5 x 6.5 x 3) cm for all other bands) with adapted transmitting antenna that is externally fed via a coaxial cable. The coaxial cable shall be provided with e.g. ferrite rings in order to suppress eddies. Test signal parameters see Table 5.

**Table 5 – Frequency bands and test signal parameters for mobile radio testing using portable radio unit mock-ups**

Frequency band/radio system	MHz	$\Delta f/\text{kHz}$	$P_{\text{for}}/\text{Watt}$	Modulation
10 m (CB radio, analog)	26 to 30	100	20 (peak)	AM: 1,000 Hz, modulation 80 %
2 m (radio, analog)	144 to 174	200	30 (RMS)	FM: 1,000 Hz; 4 kHz deviation
70 cm (radio, analog/digital)	410 to 470	200	30 (RMS)	FM: 1,000 Hz; 4 kHz deviation
TETRA/TETRAPOL (radio, digital)	380 to 390 410 to 420 450 to 460 806 to 825 870 to 876	200	30 (Peak)	PM: 18 Hz; (modulation 50 %)
AMPS (mobile phone)	824 to 849	300	30 (peak)	FM: 1,000 Hz; 10 kHz deviation
GSM 850 (mobile phone) GSM 900 (mobile phone)	824 to 849 876 to 915	400	15 (peak)	PM: 217 Hz; (pulse-duty factor 50 %)
23 cm (radio, analog)	1,200 to 1,300	400	10 (RMS)	FM: 1,000 Hz; 4 kHz deviation
GSM 1800/1900 (mobile phone)	1,710 to 1,785 1,850 to 1,910	400	5 (peak)	PM: 217 Hz; (pulse-duty factor 50 %)
UMTS (mobile phone WCDMA & TD/CDMA)	1,885 to 2,025	1,600	5 (peak)	CW and PM: 1,600 Hz; (pulse-duty factor 50 %)
Bluetooth/WLAN (data)	2,400 to 2,500	2,000	2 (peak)	PM: 1,600 Hz; (pulse-duty factor 65 %)
$P_{\text{for}}$ : Forward power at the antenna base				
Peak Actual (RMS) power measured at maximum AM modulation or at PM during pulse				

#### 7.4 Additional measurements in field testing

For release tests additional vehicle tests conducted by the responsible EMC engineering departments of VOLKSWAGEN AG can be necessary, such as the following:

- Measurements in front of long-wave and medium-wave transmitters in a frequency range from 0.15 to 1.65 MHz,
- Measurements in front of short-wave high-power transmitters in a frequency range from 4 to 26 MHz.

#### 8 Referenced standards<sup>1</sup>

ISO 11451-1	Electrical Disturbances from Narrowband Radiated Electromagnetic Energy – Part 1: General and Definitions
ISO 11451-2	Vehicle Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy – Part 2: Off-Vehicle Radiation Source
ISO 11451-3	Electrical Disturbances by Narrowband Radiated Electromagnetic Energy – Vehicle Test Methods - Part 3: On-Board Transmitter Simulation
ISO 11452-1	Component Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy – Part 1: General and Definitions
ISO 11452-2	Electrical Disturbances by Narrowband Radiated Electromagnetic Energy - Component Test Methods – Part 2: Absorber-Lined Chamber
ISO 11452-3	Component Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy – Part 3: Transverse Electromagnetic (TEM) Cell
ISO 11452-4	Component Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy - Part 4: Bulk Current Injection (BCI)
ISO 11452-5	Component Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy - Part 5: Stripline

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<sup>1</sup> In this section terminological inconsistencies may occur as the original titles are used.