VOLKSWAGEN

AKTIENGESELLSCHAFT

Group Standard

TL 82166

Issue 2011-01

Class. No.: 8MD00

Descriptors: EMC, electromagnetic compatibility, interference immunity

Electromagnetic Compatibility of Automotive Electronic Components

Radiated Interferences

Preface

Additional tests necessary for evaluation and release of electronic assemblies beside the EMC tests are defined and specified in the drawing, Technical Supply Specifications (TL standard), or other documents.

For release purposes, the responsible EMC departments of Volkswagen AG will conduct examinations in the anechoic chamber, in the free field or in the laboratory.

Previous issues

TL 82166: 1986-04, 1993-08, 1998-02, 2003-03, 2004-10, 2009-05

Changes

The following changes have been made compared with TL 82166: 2009-05:

- Upper frequency limit changed to 3 000 MHz
- Test field strength for vehicle measurements above 30 MHz adapted
- Frequency ranges adapted

Contents

Technical responsibility			Standards Department	
EEI/Z	Frank Golisch	Tel.: +49 5361 9-17063	EKDV/4 Dirk Beinker	EKDV
I/EE-27	Dr. Ole Mende	Tel.: +49 841 89-90833	Tel.: +49 5361 9-32438	Manfred Terlinden

1 Scope

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

2 Symbols and abbreviations

AMPS	Advanced Mobile Phone System
FPSC	Functional Performance Status Classification
GSM	Global System for Mobile Communication
IBK	A collection of "off the shelf" electronic modules that are not unique to or developed for Volkswagen AG and may be used by other
IMT-2000	International Mobile Telephone 2000
TETRA	Terrestrial Trunked Radio
TLS	Transmission Line System
UMTS	Universal Mobile Telephone System

3 General test conditions

Deviations from the following test conditions must always be documented in the test report.

Operating temperature	acc. to drawing, Performance Specifications or Technical Supply Specification (TL)
Test temperature	(23 ± 5) °C; operating temperature in special cases
Operating voltage	acc. to drawing, Performance Specifications or TL standard

4 Functional performance status classification (FPSC)

This standard uses the functional performance status classification (FPSC) as defined in ISO 11452-1 AMD 1.

The following status definitions as specified in ISO 11452-1 AMD 1 are used:

Status I: The function behaves as specified prior to, during and after the test.

Status II: The function does not behave as specified during the test, but returns to normal operation automatically after completion of the test.

The following definitions from ISO 11452-1 AMD 1 are used to determine which status (I or II) must be complied with up to which level (field strength, amperage or voltage).

L1: Field strength (or amperage/voltage) up to which status I must be complied with.

L2: Field strength (or amperage/voltage) up to which at least status II must be complied with (status I is also permissible).

Deviating from the examples given in ISO 11452-1 AMD 1, it is not the different functions of a DUT that are categorized, but the effects or functional deviations of a DUT occurring during an interference immunity test. Based on the effect on the customer, a differentiation is made between three categories of effects:

Category 1: Minor effects or negligible malfunctions of the DUT.

Category 2: Effects or malfunctions of the DUT which impair comfort.

Category 3: All significant and all other effects and malfunctions of the DUT that do not fall into category 1 or category 2.

The vehicle manufacturer alone is responsible for the categorization of the effects that ocurred during testing. If a malfunction has not been assigned a category, that particular malfunction must always be assigned to category 3.

The functional performance status classification is represented graphically as shown in Figure 1.

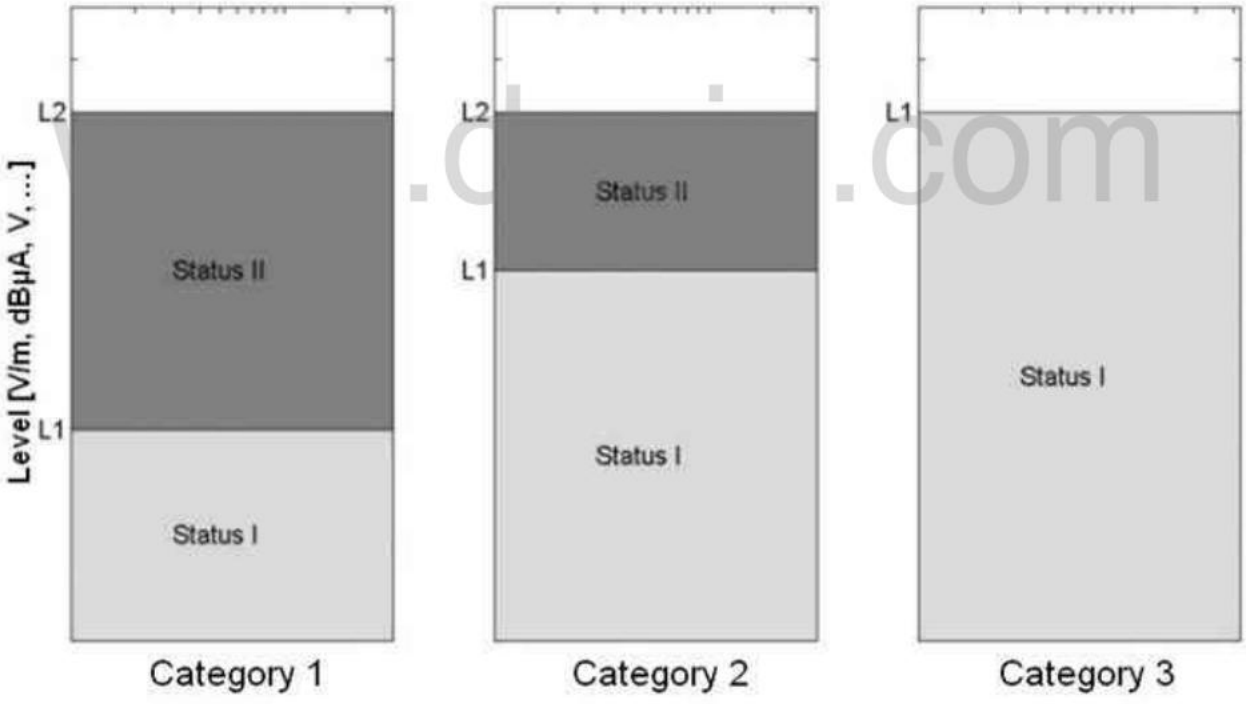

Figure 1 – Graphical representation of the functional performance status classification

5 Test documentation

The following information must be provided to the EMC department when samples for EMC tests are delivered:

1. system designation and description,
2. Hardware version, component location drawings and layout plans as well as bills of materials, circuit diagram and description of the EMC measures (e.g., filter and protection circuits for inputs/outputs as well as supply lines and screening measures),
3. Software version with description of the EMC measures (e.g., filtering of signals implemented in software, temporary deactivation of individual circuit components, limp-home features),
4. Deviations from TL specifications as agreed upon between Volkswagen AG and supplier,
5. EMC qualification report of the relevant sample status.

6 Component testing

All component tests are to be conducted by the supplier, as agreed upon in the testing concept. The frequency range between 0,1 and 3 000 MHz must be tested.

For components belonging to the Industrial Assembly (IBK - German abbreviation), the use of the following test methods is mandatory: BCI method (acc. to ISO 11452-4) and antenna method (acc. to ISO 11452-2).

Components not belonging to the Industrial Assembly (IBK - German abbreviation) may also be tested using the stripline (acc. to ISO 11452-5) instead of the BCI method. However, the stripline may only be used if approved by the responsible Volkswagen Group EMC department.

The operating state of the DUT must be chosen such that all of its relevant functions can be tested. If it is impossible to test all functions in one single operating state, the test must be performed in several test runs.

The specifications listed in Table 1 apply.

Table 1 – Component testing

<table>
<tr><td></td><td>ISO 11452-2
Antenna method</td><td>ISO 11452-4
BCI</td><td>ISO 11452-5
Stripline</td></tr>
<tr><td>Frequency range</td><td>200 to 3 000 MHz</td><td>0,1 to 400 MHz</td><td>0,1 to 400 MHz</td></tr>
<tr><td>Increment Δf</td><td colspan="3">The test is to performed using a linear increment. A logarithmic increment may also be used as an alternative. The following maximum increments apply:

0,1 to 1 MHz : 0,03 MHz
1 to 200 MHz : 1 MHz
200 to 400 MHz : 2 MHz
400 to 1 000 MHz : 5 MHz
1 000 to 3 000 MHz : 10 MHz
linear increment

0,1 to 1 MHz : 10 %
1 to 10 MHz : 4 %
10 to 100 MHz : 2 %
100 to 1 000 MHz : 1 %
1 000 to 3 000 MHz : 0,5 %
logarithmic increment

If the DUT responds to frequencies within a band that is narrower than the one covered by the maximum frequency increments, the frequency increments must be reduced accordingly.</td></tr>
<tr><td>Dwell time per Δf</td><td colspan="3">The minimum dwell time is two seconds (2 s). If the DUT exhibits a slower response to interferences, the dwell time must be extended accordingly.</td></tr>
<tr><td>Test modulation</td><td colspan="3">The following modulations must be applied:
continuous wave (CW), amplitude modulation (AM) and pulse modulation (PM).
Amplitude modulation is to be carried out with 1 kHz, 80%, as specified in ISO 11452-1. The EMC department may specify deviating modulation frequencies.
Pulse modulations are to be carried out with a) a repetition rate of 217 Hz and a duration of 577 µs and with b) a repetition rate of 300 Hz and a duration of 3 µs.
The following specifications apply.

Frequency in MHz — Modulation type
0,1 to 806 — CW and AM
806 to 915 — CW and PM (217 Hz, 577 µs)
915 to 1 200 — CW
1 200 to 1 400 — CW and PM (300 Hz, 3 µs)
1 400 to 1 710 — CW
1 710 to 1 910 — CW and PM (217 Hz, 577 µs)
1 910 to 2 700 — CW
2 700 to 3 000 — CW and PM (300 Hz, 3 µs)</td></tr>
<tr><td>Procedure/ note</td><td>Polarization:
vertical, and also horizontal for frequencies above 400 MHz</td><td></td><td></td></tr>
</table>

Effects observed on the DUT when reaching the required test level must be examined with regard to their failure threshold. Effects, frequency, interference threshold and the status of the function must be documented in the test report.

6.1 BCI test

Only the substitution method must be used for the BCI test. Deviating from ISO 11452-4, the test harness must have a length between 1 700 mm and 2 000 mm.

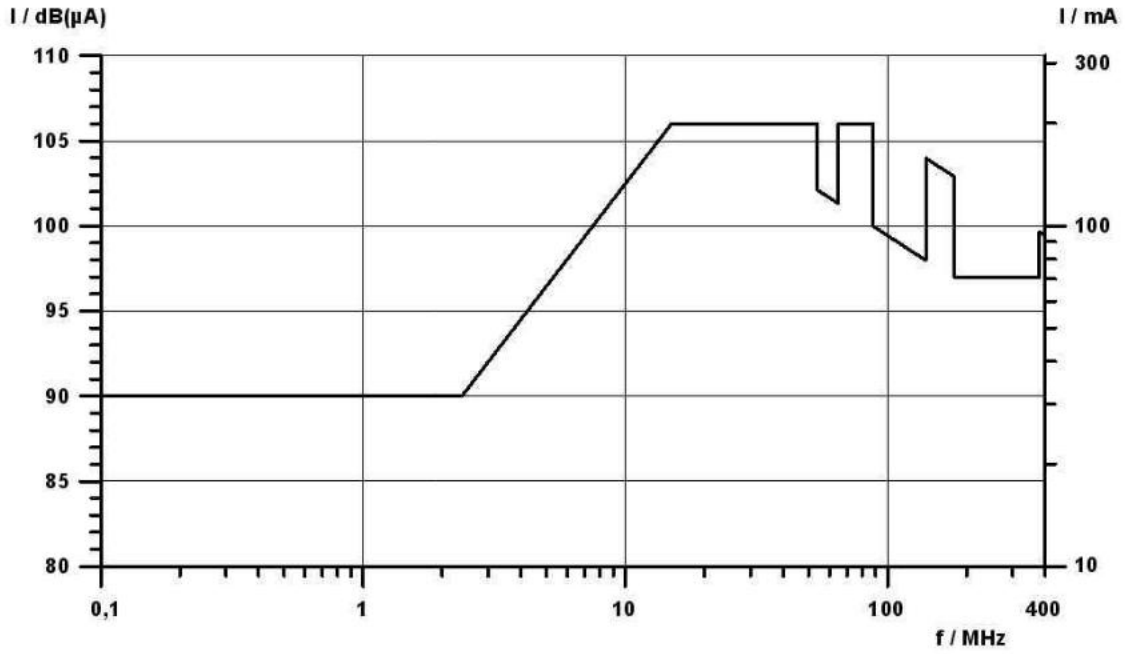

Figure 2 – Test current depending on frequency (BCI test)

The BCI test must be performed using the maximum test current as specified in Figure 2. The recessed portions of the graph shown in Figure 2 are 6 dB each (corresponding to factor 2). According to Table A.1 (in Section A.1) containing the overview of services, an increased test severity is only used for mobile radio services. The functional performance status classification must be performed in accordance with Table 2 or Figure 3.

Table 2 – Functional performance status classification (BCI test)

Test severity	Frequency range in MHz	Category 1 I / dB(µA)	Category 2 I / dB(µA)	Category 3 I / dB(µA)
L2	0,1 to 2,38	90	90	not specified
	2,38 to 15	106 - 20 lg (15/f)	106 - 20 lg (15/f)	
	15 to 54	106	106	
	54 to 65	100 - 10 lg (f/88)	100 - 10 lg (f/88)	
	65 to 88	106	106	
	88 to 140	100 - 10 lg (f/88)	100 - 10 lg (f/88)	
	140 to 174	106 - 10 lg (f/88)	106 - 10 lg (f/88)	
	174 to 380	97	97	
	380 to 400	106 - 10 lg (f/88)	106 - 10 lg (f/88)	
L1	0,1 to 2,38	82	86	90
	2,38 to 15	98 - 20 lg (15/f)	102 - 20 lg (15/f)	106 - 20 lg (15/f)
	15 to 54	98	102	106
	54 to 65	98	100 - 10 lg (f/88)	100 - 10 lg (f/88)
	65 to 88	98	102	106
	88 to 140	98 - 10 lg (f/88)	100 - 10 lg (f/88)	100 - 10 lg (f/88)
	140 to 174	98 - 10 lg (f/88)	102 - 10 lg (f/88)	106 - 10 lg (f/88)
	174 to 278,28	98 - 10 lg (f/88)	97	97
	278,28 to 380	98 - 10 lg (f/88)	102 - 10 lg (f/88)	97
	380 to 400	98 - 10 lg (f/88)	102 - 10 lg (f/88)	106 - 10 lg (f/88)

NOTE 1 In the formulae, the frequency f must be entered in MHz; "lg" denominates the logarithm to the base 10.

The specified numerical values are maximum values. The test is performed until reaching the maximum test level.

Table A.2 (see Section A.2) specifies the test severity levels for the 3 different categories (BCI test).

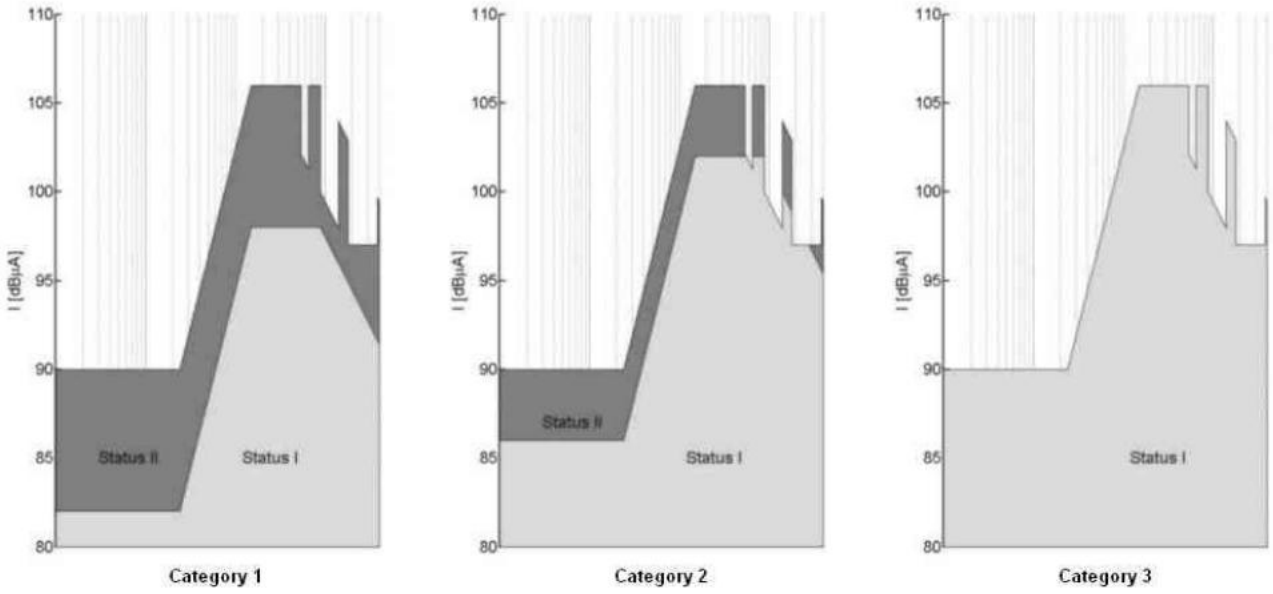

Figure 3 – Functional performance status classification (BCI test)

6.2 Antenna method

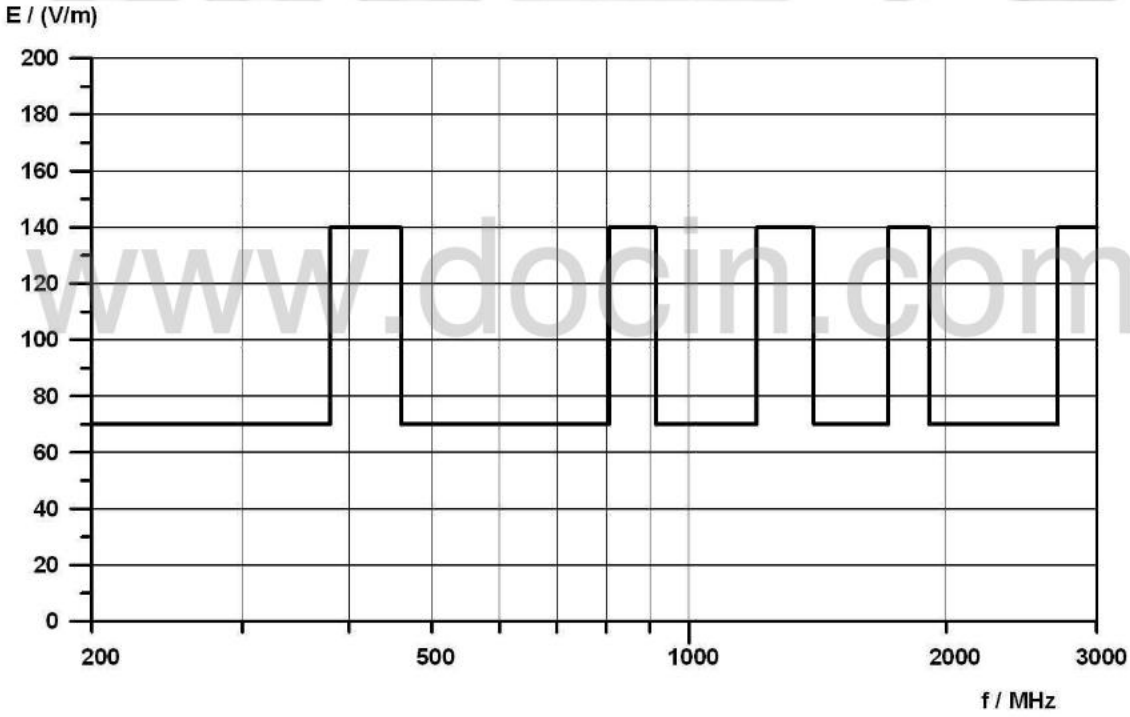

Figure 4 – Test field strength depending on frequency (antenna method)

The test using the antenna method must be performed with the maximum field strength as specified in Figure 4. The recessed portions of the graph shown in Figure 4 are 6 dB each (corresponding to factor 2). According to Table A.1 (in Section A.1) containing the overview of services, an increased test severity is only used for mobile radio services. The functional performance status classification must be performed in accordance with Table 3 or Figure 5.

Table 3 – Functional performance status classification (antenna method)

Test severity	Category 1 E / (V/m)	Category 2 E / (V/m)	Category 3 E / (V/m)
L2	140[a)]	140[a)]	not specified
L1	60	100[a)]	140[a)]

a) The specified numerical values are maximum values. The test is performed until reaching the maximum test level.

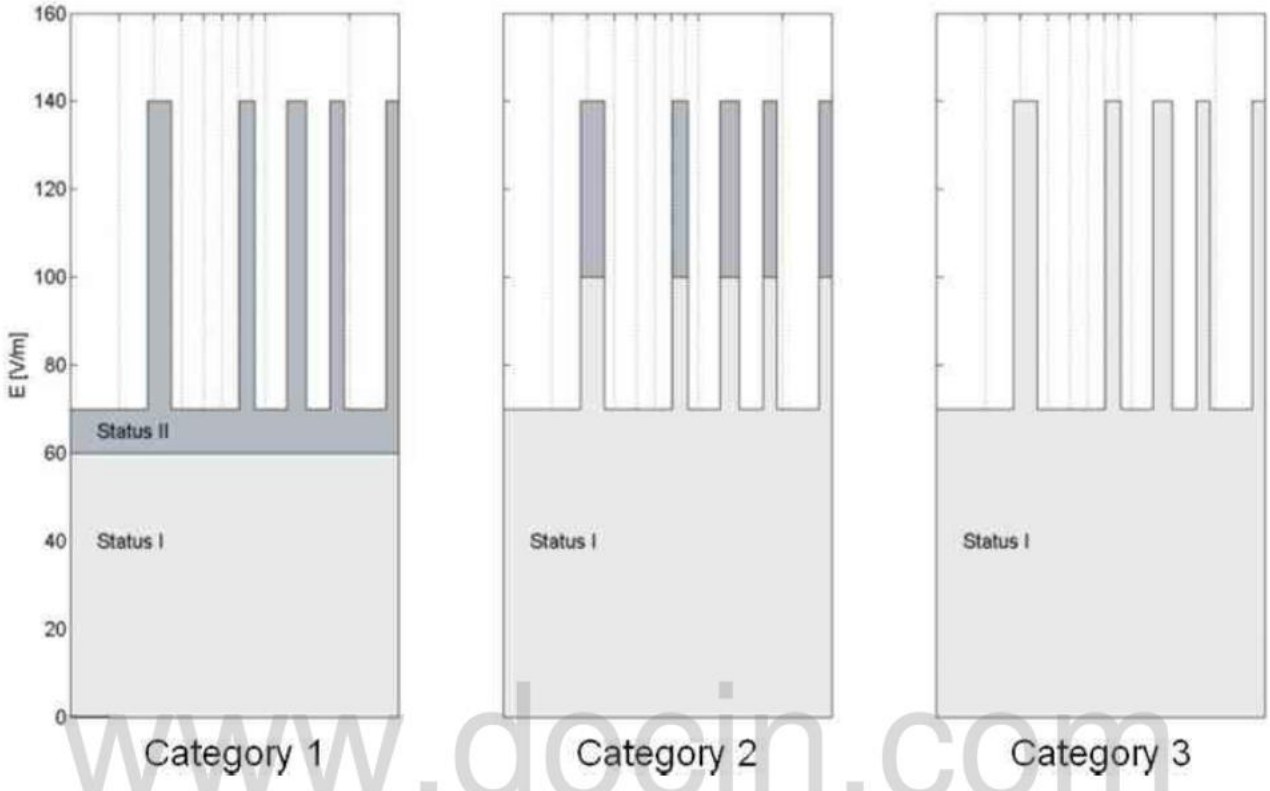

Figure 5 – Functional performance status classification (antenna method)

6.3 Stripline

Components not belonging to the Industrial Assembly (IBK - German abbreviation) may also be tested using the stripline (acc. to ISO 11452-5). However, the stripline may only be used if approved by the responsible EMC department.

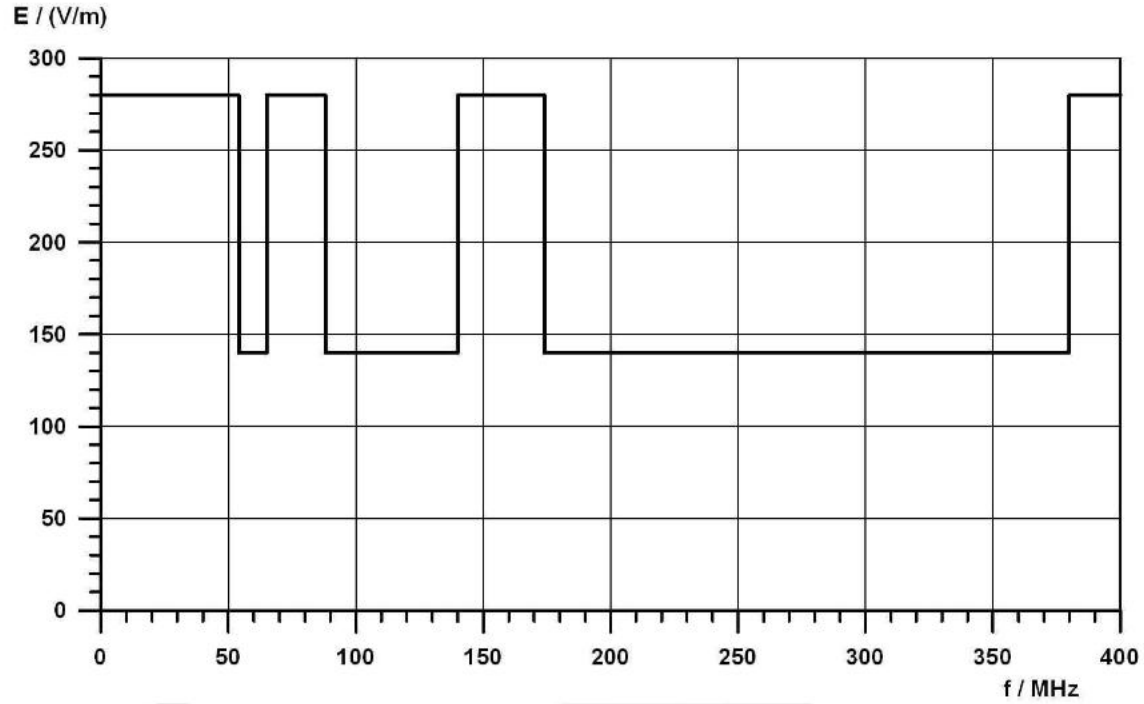

Figure 6 – Test field strength depending on frequency (stripline)

The stripline test must be performed with the maximum field strength as specified in Figure 6. The recessed portions of the graph shown in Figure 6 are 6 dB each (corresponding to factor 2). According to Table A.1 (in Section A.1) containing the overview of services, an increased test severity is only used for mobile radio services. The functional performance status classification must be performed in accordance with Table 4 or Figure 7.

Table 4 – Functional performance status classification (stripline)

Test severity	Category 1 E / (V/m)	Category 2 E / (V/m)	Category 3 E / (V/m)
L2	280[a)]	280[a)]	not specified
L1	120	200[a)]	280[a)]

a) The specified numerical values are maximum values. The test is performed until reaching the maximum test level.

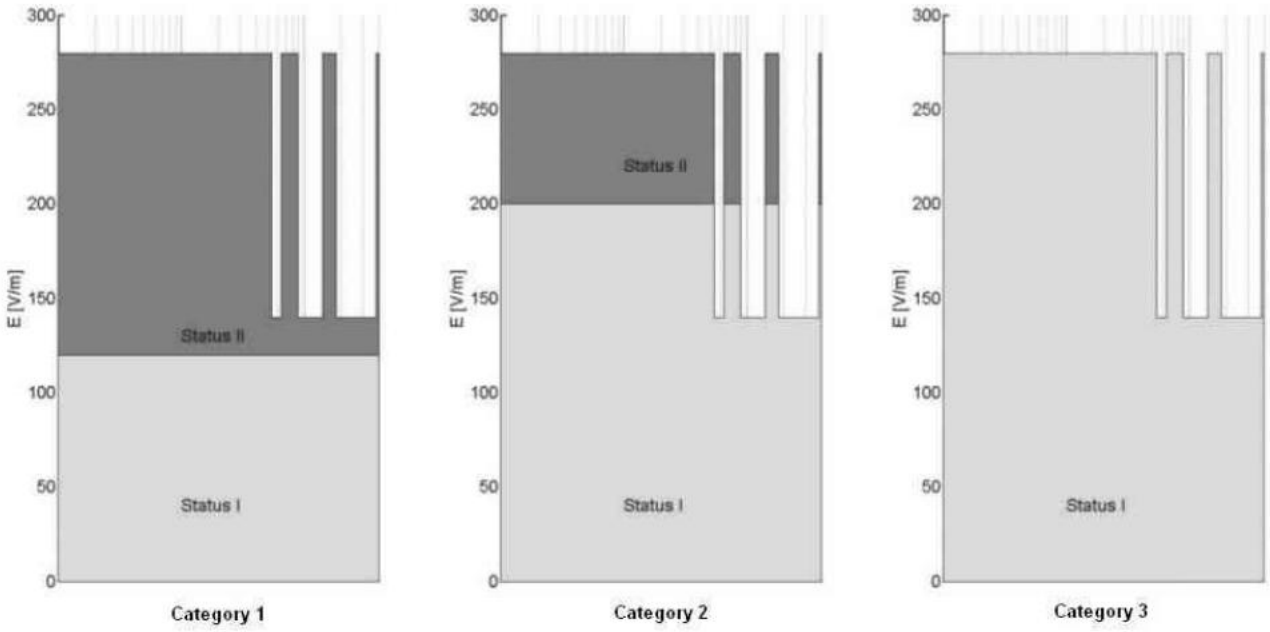

Figure 7 – Functional performance status classification (stripline)

7 Full vehicle testing

Normally, full vehicle testing is only carried out by the responsible EMC department and only after successful completion of the component tests on the EMC sample to be tested; this has to be stated in the EMC qualification report.

If there are modifications of systems and components in current production initiated by the supplier, vehicle measurements carried out by external laboratories may also by recognized after preliminary consultation and critical review.

7.1 Interference immunity test (far field)

The whole vehicle´s interference immunity must be tested according to ISO 11451-2 inside a shielded anechoic chamber with conductive floor. The deviations listed in Table 5 apply.

Table 5 – Full vehicle testing (in the far field)

Frequency range:	0,1 to 3 000 MHz		
Frequency, test field strength, modulation	Frequency in MHz	Test field strength / (V/m)	Modulation
	0,1 to 30	140	AM and/or CW
	30 to 54	100	AM and/or CW
	54 to 65	70	AM and/or CW
	65 to 88	100	AM and/or CW
	88 to 140	70	AM and/or CW
	140 to 174	100	AM and/or CW
	174 to 380	70	AM and/or CW
	380 to 460	100	AM and/or CW
	460 to 806	70	AM and/or CW
	806 to 915	100	PM (217 Hz, 577 µs) and/or CW
	915 to 1 200	70	CW
	1 200 to 1 400	100	PM (300 Hz, 3 µs) and/or CW
	1 400 to 1 710	70	CW
	1 710 to 1 910	100	PM (217 Hz, 577 µs) and/or CW
	1 910 to 2 700	70	CW
	2 700 to 3 000	100	PM (300 Hz, 3 µs) and/or CW
	Amplitude and pulse modulations must be performed; in this context, the following specifications apply: Amplitude modulation is to be carried out with 1 kHz, 80%, as specified in ISO 11452-1. The EMC department may specify deviating modulation frequencies. Pulse modulations are to be carried out with a) a repetition rate of 217 Hz and a duration of 577 µs and with b) a repetition rate of 300 Hz and a duration of 3 µs.		
Polarization	Vertical polarization: 0,1 ... 3 000 MHz and horizontal polarization: 30 ... 3 000 MHz		
Increment Δf	The following maximum increments apply. If the DUT responds to frequencies within a band that is narrower than the one covered by the maximum frequency increments, the frequency increments must be decreased accordingly.		
	0,1 to 30 MHz : 0,1 MHz 30 to 220 MHz : 1 MHz 220 to 400 MHz : 2 MHz 400 to 1 000 MHz : 5 MHz 1 000 to 3 000 MHz : 10 MHz		
	linear increment		
Dwell time per Δf	≥ 1 s (depending on the response time of the system under test)		
Radiation directions	Depending on the installation position of the interference sink and the wiring harness, the vehicle must be exposed to radiation coming from at least 2 directions in accordance with the specifications of the EMC department: Preferred direction for antenna radiation: a) onto the vehicle´s front and b) onto the driver´s side		

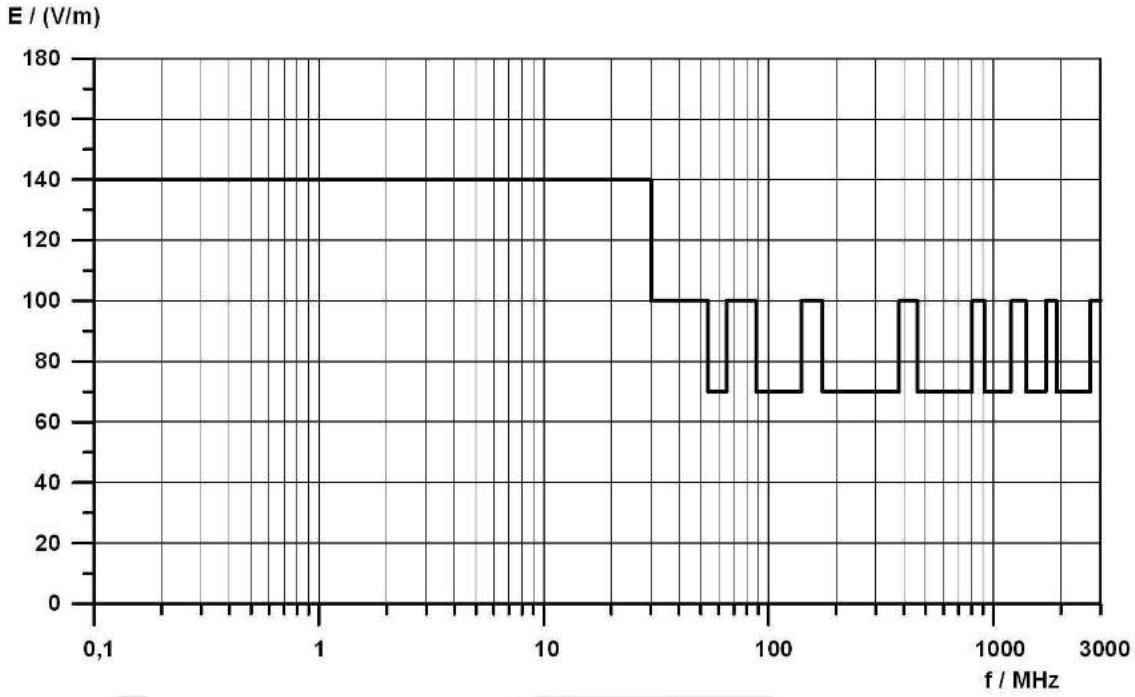

Figure 8 – Test field strength depending on frequency (vehicle measurement)

The maximum field strength for the vehicle measurement (Table 5) is represented in Figure 8. The recessed portions of the graph shown in Figure 8 are 6 dB each (corresponding to factor 2). According to Table A.1 (in Section A.1) containing the overview of services, an increased test severity is only used for mobile radio services. The functional performance status classification must be performed in accordance with Table 6 or Figure 9.

Table 6 – Functional performance status classification (vehicle measurement)

Test severity	Category 1 E / (V/m)	Category 2 E / (V/m)	Category 3 E / (V/m)
L2	140[a)]	140[a)]	not specified
L1	60	100[a)]	140[a)]

a) The specified numerical values are maximum values. The test is performed until reaching the maximum test level.

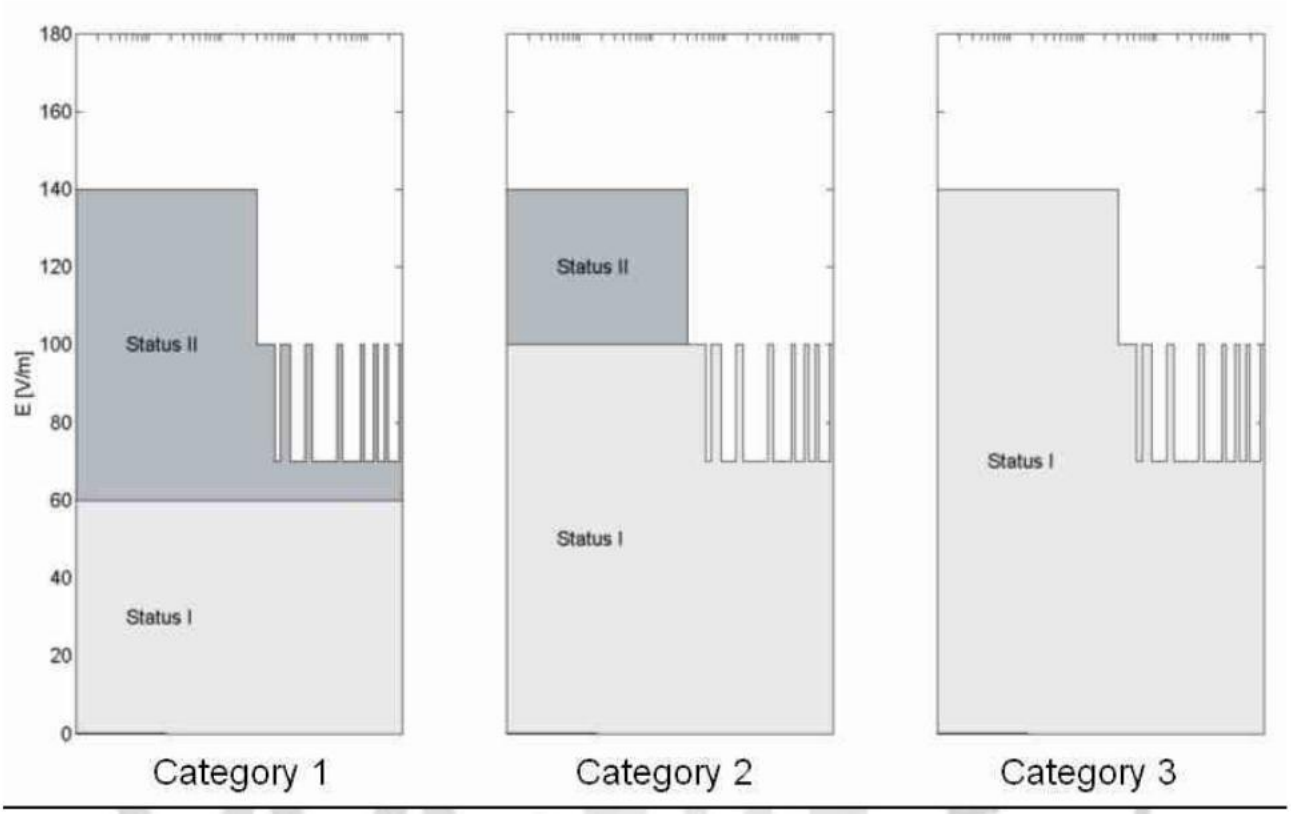

Figure 9 – Functional performance status classification (vehicle measurement)

7.2 Mobile radio testing with exterior antenna attached to the vehicle

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

Unless otherwise specified by the responsible EMC department, at least two antenna positions must be tested in each of the frequency bands listed in Table 7. The minimum scope of antenna positions to be tested is specified in Table 7.

The responsible EMC department may specify whether the mobile radio test with exterior antenna mounted on the vehicle will be restricted or whether it can be omitted completely.

Table 7 – Minimum scope of antenna positions to be tested

Frequency band	Antenna position							
	Front fender	Roof edge	Roof center, front	Roof center	Roof center, rear	Rear fender	Trunk lid, center	Trailer hitch
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 must be fed in via an external power amplifier (parameters according to Table 8). The cable should be provided with e.g. loop chokes (e.g. ferrite rings) in order to suppress propagation of interference along the screening of the cable leading from the power amplifier to the vehicle antenna.

Table 8 – Mobile radio test with exterior antenna

Frequency band or radio system	Frequency / MHz	Δf/kHz	P_{forw}/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 174	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	50 (peak)	PM 18 Hz, pulse-duty factor 50%
AMPS (mobile phone)	824 to 849	300	30 (RMS)	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_{forw}: Forward power at the antenna base peak: Nominal (RMS) power measured at maximum AM modulation or at PM during pulse				

7.3 Mobile radio testing using portable mobile radio units inside the vehicle

The test simulates the transmission operation of mobile transmitter units without exterior antennas, with the units being located inside the vehicle. The following positions must be tested:

1. Seat areas (front and rear),
2. Door pockets,
3. Tray areas in the center console (front and, if present, also in the rear),
4. Tray areas in and on the dashboard,
5. Sensor and wiring harness areas.

The mobile 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 matched transmitting antenna; the case is externally fed via a coaxial cable. The coaxial feed cable must be

provided with loop chokes (e.g. ferrite rings) in order to suppress propagation of interference along the screening. Further details can be found in Table 9.

Table 9 – Mobile radio testing using portable mobile unit mock-ups inside the vehicle

Frequency band/ radio system	Frequency / MHz	Δf/kHz	P_{forw}/Watt	Modulation
10 m (CB radio, analog)	26 to 30	100	10 (peak)	AM 1 000 Hz, 80% modulation
4 m (radio, analog)	68 to 87,5	200	15 (RMS)	FM 1 000 Hz, 4 kHz deviation
2 m (radio, analog)	144 to 174	200	15 (RMS)	FM 1 000 Hz, 4 kHz deviation
70 cm (radio, analog/digital)	410 to 470	200	15 (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	10 (peak)	PM 18 Hz, modulation 50%
AMPS (mobile phone)	824 to 849	300	10 (RMS)	FM 1 000 Hz, 10 kHz deviation
GSM 850 (mobile phone) GSM 900 (mobile phone)	824 to 849 876 to 915	400	6 (peak) 15 (peak)[a)]	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
GSM1800/1900 (mobile phone)	1 710 to 1 785 1 850 to 1 910	400	3 (peak)	PM 217 Hz, pulse-duty factor 50%
UMTS (mobile phone WCDMA & TD/CDMA)	1 885 to 2 025	1 600	2 (peak)	CW and PM 1 600 Hz, pulse-duty factor 50%
Bluetooth/WLAN (data)	2 400 to 2 500	2 000	1 (peak)	PM 1 600 Hz, pulse-duty factor 50%
P_{forw}: Forward power at the antenna base peak: Nominal (RMS) power measured at maximum AM modulation or at PM during pulse				

a) The test is to be performed with a test power of 15 W at positions where a "portable" phone can be stored.

Since it is not possible to conduct tests in all conceivable positions in the vehicle interior, the transmitting power must be doubled at the start of the test to locate interference sinks.

7.4 Additional measurements in the free field

For EMC signoff, additional vehicle tests may be conducted by the responsible EMC departments of Volkswagen AG. Such tests include for example:

- 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 Other applicable documents

The following documents cited in this Standard are necessary to its application.

Some of the cited documents are translations from the German original. The translations of German terms in such documents may differ from those used in this Standard, resulting in terminological inconsistency.

Standards whose titles are given in German may be available only in German. Editions in other languages may be available from the institution issuing the standard.

ISO 11451-2	Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 2: Off-vehicle radiation sources
ISO 11451-3	Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 3: On-board transmitter simulation
ISO 11452-1	Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 1: General principles and terminology
ISO 11452-2	Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 2: Absorber-lined shielded enclosure
ISO 11452-4	Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 4: Bulk current injection (BCI)
ISO 11452-5	Road vehicles - Component test methods for electrical disturbances by narrowband radiated electromagnetic energy - Part 5: Stripline

Appendix A (normative)

A.1 Overview of services

Table A.1 – Overview of services for illustration of interference immunity requirements

Frequency / MHz	Service
0,1 to 30	AM radio transmission, mobile radio services
30 to 54	Mobile radio services
65 to 88	Mobile radio services
140 to 174	Mobile radio services
380 to 460	Mobile radio services
806 to 915	Mobile radio
1 200 to 1 400	Radar
1 710 to 1 910	Mobile radio
2 700 to 3 000	Radar

In the frequency ranges represented in Table A.1 (mobile radio services), the test severity specified for each range is used for testing. In the other frequency ranges not specified herein, the test severity is decreased by 6 db (corresponding to factor 2) in accordance with the comb pattern.

A.2 Test severity levels for BCI testing

Table A.2 – Test severity levels for BCI testing

		Category 1		Category 2		Category 3	
		Status 1		Status 1		Status 1	
i	Frequency / MHz	I / dB(µA)	I / mA	I / dB(µA)	I / mA	I / dB(µA)	I / mA
1	0,1	82	13	86	20	90	32
2	0,13	82	13	86	20	90	32
30	0,97	82	13	86	20	90	32
31	1	82	13	86	20	90	32
32	2	82	13	86	20	90	32
33	3	84,0 (1)	16	88,0 (2)	25	92,0 (3)	40
44	14	97,4 (1)	74	101,4 (2)	117	105,4 (3)	186
45	15	98	79	102	126	106	200
46	16	98	79	102	126	106	200
84	54	98	79	102	126	106	200
85	55	98	79	102,0 (4)	126	102,0 (4)	126

		Category 1		Category 2		Category 3	
		Status 1		Status 1		Status 1	
i	Frequency / MHz	I / dB(µA)	I / mA	I / dB(µA)	I / mA	I / dB(µA)	I / mA
94	64	98	79	101,4 (4)	117	101,4 (4)	117
95	65	98	79	102	126	106	200
118	88	98	79	102	126	106	200
119	89	98,0 (5)	79	100	100	100	100
169	139	96,0 (5)	63	98,0 (4)	80	98	80
170	140	96,0 (5)	63	100,0 (6)	100	104,0 (7)	158
330	400	91,4 (5)	37	95,4 (6)	59	99,4 (7)	94

The frequency increment is specified acc. to Table 1. The test current in Table A.2 is calculated using the equations (1) to (7). These are identical with the equations specified in Table 2. The frequency f must be entered in MHz. "Lg" denominates the logarithm to the base 10.

(1) I / dB(µA) = 98 - 20 lg (15 / f)

(2) I / dB(µA) = 102 - 20 lg (15 / f)

(3) I / dB(µA) = 106 - 20 lg (15 / f)

(4) I / dB(µA) = 100 - 10 lg (f / 88)

(5) I / dB(µA) = 98 - 10 lg (f / 88)

(6) I / dB(µA) = 102 - 10 lg (f / 88)

(7) I / dB(µA) = 106 - 10 lg (f / 88)

The difference in test severity between each of the three categories is 4 dB.

Table A.2 only contains the test severity levels for error status 1 (3 categories). These test severity levels only apply to the frequency ranges specified in Table A.1 (overview of services). In the frequency ranges not specified in the overview of services, the test severity level decreases by 6 dB (corresponding to factor 2).

A.3 Conversion of dB (µA) into mA

Table A.3

dB(µA)	mA	dB(µA)	mA	dB(µA)	mA	dB(µA)	mA
120	1000	110	316	100	100	90	32
119	891	109	282	99	89	89	28
118	794	108	251	98	79	88	25
117	708	107	224	97	71	87	22
116	631	106	200	96	63	86	20

dB(µA)	mA	dB(µA)	mA	dB(µA)	mA	dB(µA)	mA
115	562	105	178	95	56	85	18
114	501	104	158	94	50	84	16
113	447	103	141	93	45	83	14
112	398	102	126	92	40	82	13
111	355	101	112	91	35	81	11
						80	10