VOLKSWAGEN AG	**Electromagnetic Compatibility of Automotive Electronic Components** Interference Immunity with Respect to Magnetic Fields	**TL 82566**
Konzernnorm		

Descriptors: electromagnetic compatibility, EMC, interference immunity, magnetic field

Preface

Besides the EMC tests, the evaluation and release of electronic assemblies requires additional tests, which are defined and required in the drawing, in Technical Supply Specifications (TL) or other documents.

In the release procedure, tests conducted in the anechoic chamber, in the free field or in the laboratory are taken into consideration by the responsible VW Group EMC departments.

Contents

1 Scope

The TL 82566 specifies requirements and test methods which are to ensure interference immunity of electronic components, assemblies or systems with respect to magnetic fields, which can couple into the component, assembly or system as well as into their respective supply and signal lines.

2 Terms and definitions

Component	general term used to designate an electronic component, assembly or system (e.g. control unit, sensor, actuator)
DUT	electronic component, assembly or system to be tested (Device Under Test)

3 General test conditions

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

Operating temperatures	acc. to drawing, Performance Specifications or Technical Supply Specification
Test temperature	(23 ± 5) ℃, operating temperature in special cases
Operating voltages	acc. to drawing, Performance Specifications or Technical Supply Specification

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4 Description of functional states

In the case of malfunctions, the interference threshold shall be determined. Depending on the respective assembly specifications, the following states are possible:

Functional status A

All device/system functions perform as specified during and after exposure to the transient.

Functional status B

All device/system functions perform as specified during exposure. However, one or more functions may be outside the specified limit deviation. All functions automatically return to the specified limits once exposure has ended. Memory functions must remain in functional status A.

Functional status C

One or more device/system functions do not perform as specified during exposure, but return to normal operation once exposure has ended.

Functional status D

One or more device/system functions do not perform as specified during exposure, only returning to normal operation once exposure has ended and the device/system was restarted ("reset") by user intervention.

Functional status E

One or more device/system functions do not perform as specified during and after exposure and cannot be returned to normal operation without repairing or replacing the respective device/system.

5 Test documentation

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

a) system designation and description,
b) 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),
c) 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),
d) deviations from TL specifications as agreed upon between Volkswagen Group and supplier,
e) EMC qualification report of the relevant sample status.

6 Component testing

As agreed upon in the testing concept, the supplier shall carry out all component tests required in TL 82566. Unless otherwise provided in the following pargraphs, the requirements acc. to Military Standard MIL-STD-461E (issue: August 1999) apply.

The **frequency range** to be tested with this TL standard is 15 Hz to 30 kHz. Unless provided otherwise herein, the frequency increment can be found in Table 1. Irrespective of this, the following frequencies shall be tested in any case: 15 Hz, 16 ⅔ Hz, 50 Hz, 60 Hz. All test frequencies shall be specified in the test report. The DUT shall be exposed to each frequency for at least 2 s. The test shall be performed without modulation, i.e. a pure sinusiodal signal shall be used in all cases.

Table 1 – Frequency increment

Frequency range			Frequency increment
15	–	100 Hz	10 Hz
100	–	1 000 Hz	20 Hz
1 000	–	10 000 Hz	200 Hz
10 000	–	30 000 Hz	500 Hz

All of the DUT's functions shall be tested in switched-on state. To this effect, the DUT shall be connected to a supply voltage as well as to any peripheral components necessary for proper function. The wiring harness used in this test shall be designed such that as few interferences as possible are coupled into the DUT by the applied magnetic field. This can, for instance, be achieved by twisting the cables.
The **test field strengths** according to Table 2 and Figure 1 apply. Unless otherwise provided herein, test field strength 2 shall be complied with. The magnetic field strength is defined acc. to ISO 11452-1.

Table 2 – Test field strengths for standard DUTs

Frequency range / Hz			Test field strength 1 H / (A/m)	Test field strength 2 H / (A/m)	Test field strength 3 H / (A/m)	Test field strength 4 H / (A/m)
15	–	60	30	100	300	1 000
60	–	180	30 / (f/60)	100 / (f/60)	300 / (f/60)	1 000 / (f/60)
180	–	600	10	100 / (f/60)	300 / (f/60)	1 000 / (f/60)
600	–	1800	10	10	300 / (f/60)	1 000 / (f/60)
1 800	–	6 000	10	10	10	1 000 / (f/60)
6 000	–	30 000	10	10	10	10

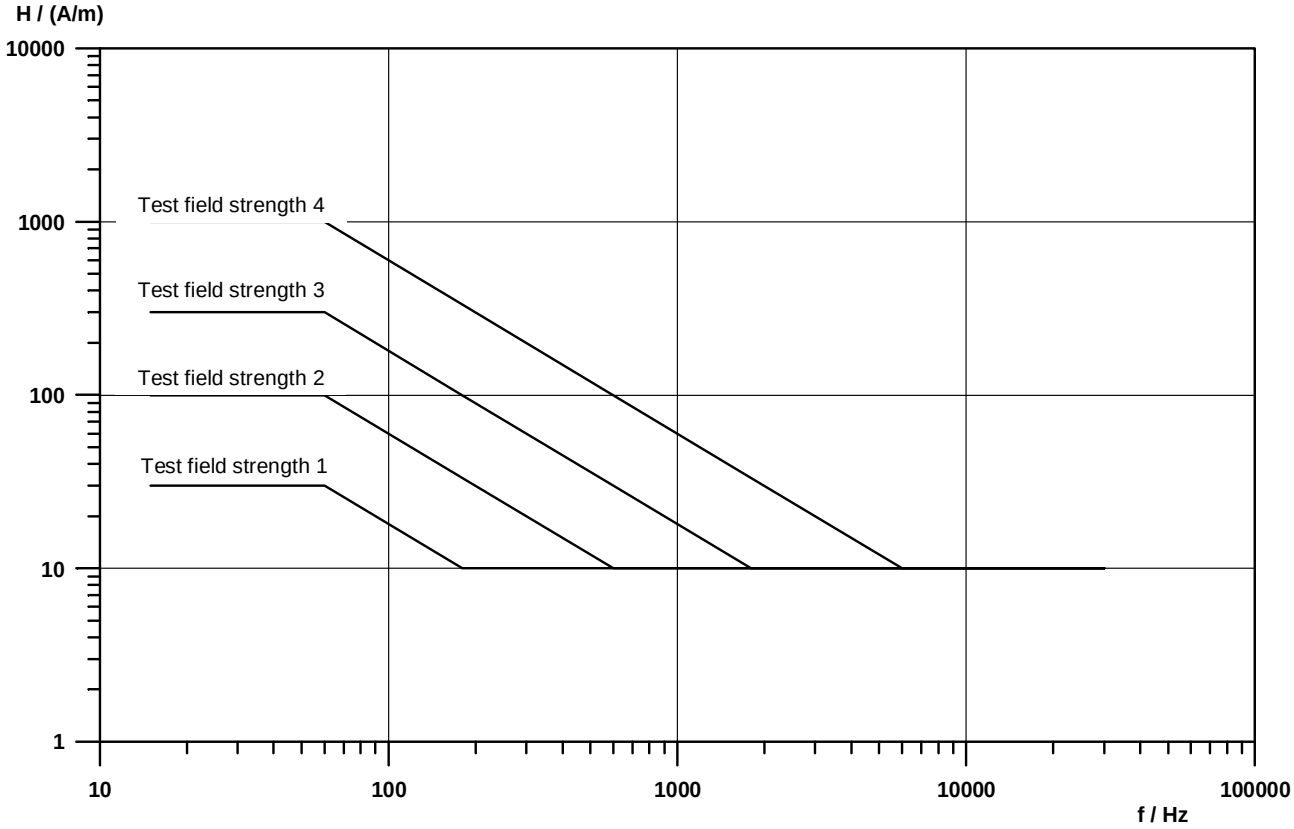

Figure 1 – Test field strengths for standard DUTs

For DUTs installed in the proximity of high amperage cables (e.g. battery cable or other cables with an amperage of more than 50 A RMS), the test field strength H = 100 A/m (Table 3) applies in the entire frequency range of 15 Hz to 30 kHz. The DUT's Performance Specifications contain information determining whether testing shall be conducted in accordance with the particular specifications of Table 3. Unless otherwise provided herein, testing shall be conducted according to Table 2 using test field strength 2.

Table 3 – Test field strength for special DUTs (proximity of high amperage cables)

Frequency range / Hz	Test field strength H / (A/m)
15 – 30 000	100

6.1 Generation of the magnetic field

Testing of interference immunity with respect to magnetic fields can be carried out using either a loop antenna or a Helmholtz coil.

6.1.1 Loop antenna

The test setup using a loop antenna is illustrated in Figure 2 (below). It consists of a signal generator, amplifier, current probe and the loop antenna. As an alternative to the current probe, a shunt may be used for current measurement.

If testing is conducted using a loop antenna, all 6 sides of the DUT shall be tested. In this case, each individual side of the DUT shall be subdivided into subareas measuring 10 cm $\times$ 10 cm each. In each test, the antenna shall be positioned in the center of the respective DUT subarea at a distance of 50 mm. Testing shall be conducted in front of each individual subarea.

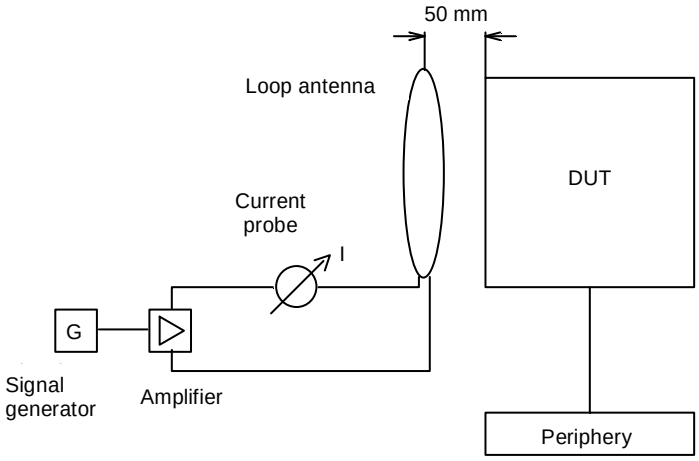

Figure 2 – Test setup using loop antenna

As regards the loop antenna, the following specifications, taken from MIL-STD-461E, shall be complied with (Table 4).

Table 4 – Loop antenna according to MIL-STD-461E

Diameter	Number of turns	Stranded wire diameter
120 mm	20	2,0 mm

For this loop antenna, the magnetic field strength *H* at a distance of 50 mm from the loop area is calculated as follows from the amperage *I*:

$H = 75{,}6 \cdot I \quad (A/m)$ Loop antenna

6.1.2 Helmholtz coil

As an alternative to the loop antenna, the magnetic field can also be generated by means of a Helmholtz coil. The respective test setup is illustrated in Figure 3. It consists of a signal generator, amplifier, current probe and the Helmholtz coil. As an alternative to the current probe, a shunt may be used for current measurement.

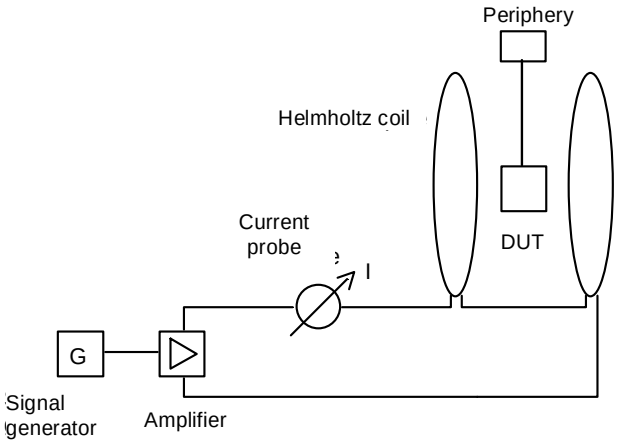

Figure 3 – Test setup using Helmholtz coil

For the Helmholtz coil, the magnetic field strength *H* in the center between both coils is calculated from the amperage *I*. *N* be the number of turns and *R* be the radius of both coils. Both individual coils must be positioned at a distance *R* from each other.

$$H = \frac{0{,}7155 \cdot N \cdot I}{R} \quad (A/m)$$ Helmholtz coil

The maximum DUT dimensions must be smaller than $2R/3$ (witch coil radius R). If testing is conducted using a Helmholtz coil, all 3 orientations of the DUT shall be tested. If the DUT dimensions exceed $2R/3$, testing shall be carried out using the loop antenna as specified in Section 6.1.1.

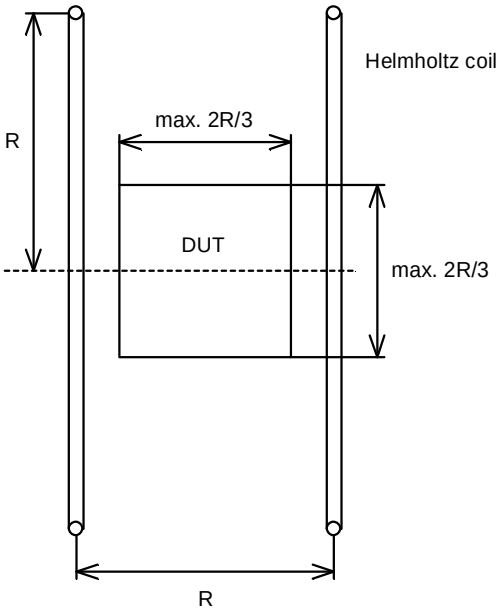

Figure 4 – Permissible dimensions of DUT inside the Helmholtz coil

7 Referenced standards[1]

MIL-STD 461 E — Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment; Issue: August 1999

ISO 11452-1 — Road vehicles - Component Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy - Part 1: General Principles and Terminology

[1] In this Section, terminological inconsistencies may occur as the original titles are used.

AppendixA (informative)

Table A.1 – Correlation between magnetic field strength H and magnetic flux density B in air

H / (dBµA/m)	H / (A/m)	B / µT	B / dBpT
180,0	1000,0	1256,0	182,0
170,0	316,2	397,1	172,0
169,5	300,0	376,8	171,5
160,0	100,0	125,6	162,0
158,0	79,6	100,0	160,0
150,0	31,6	39,7	152,0
149,5	30,0	37,7	151,5
104,1	0,16	0,2	106,1