

VOLKSWAGEN AG		Car Radio	VW
		General Functional Requirements	809 72
Konzernnorm			
Descriptors: car radio, radio, radio equipment			
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Fachverantwortung/Responsibility		Normung/Standards (E2TC, 1733)	
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Norm vor Anwendung auf Aktualität prüfen / Check standard for current issue prior to usage.

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

Numerical notation according to ISO practice (see VW 01000).

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## Changes

The following changes have been made as compared to Volkswagen standard VW 80972, 2001-10:

- General: various titles adapted to VW 80101
- Scope reference to validity of corresponding standards
- General requirements deviations and priority regulation
- EMC acceptance Technical Supply Specification TL 82288 deleted, omitted
- General test conditions supplemented
- Test temperatures supplemented to include tolerance
- Equipment marking updated, supplemented
- Test frames sketches removed, text supplemented
- Temperature requirements adapted to VW 80101
- Temperature cycle 30 cycles, adapted to VW 80101
- Resistance to environmental factors, humid heat replacement for resistance to environmental cycle test
- Control elements paintwork added
- Resistance to chemical agents skin creams added
- Test sequence adapted, supplemented
- Operating noise new
- Noise limit value new
- Actuation endurance test load definition, temperature and extension to encoder
- Vibration excitation adapted to VW 80101, playback medium
- Continuous operation adapted
- Strength of front panel buttons Test Specification PV 3602 invalid, supplemented
- Shocks omitted
- Pull-off strength for buttons new
- Control lines, antenna stabilized antenna operating voltage, new definition
- Interferences new limits
- Power supply system interference limit value added
- Interference caused by alternator measuring conditions, requirement
- Frequency ranges that can be selected AM Europe corrected
- Voltages adapted to VW 80101, operating state supplemented
- Operating voltages deleted, contained in Section 6.2
- Reverse-polarity protection added
- Max. permissible closed-circuit current/power consumption test range, unit state, limit TA memory
- Control lines antenna remote supply
- Control inputs high and low definitions adapted to VW 80101
- Frequency drift temperature range expanded
- Interference caused by alternator new limits
- Protection against electrostatic discharges adapted to TL 82466, 2004 issue, functional state
- Audio restructured

– Audio level diagram	new reference point, supplemented for new media
– Audio outputs	restructured, supplemented to include BOSE®
– Passive speaker outputs	capacity, measuring conditions
– Audio outputs, full level	new
– Background noise	updated
– Audio frequency response	expanded
– Frequency response for digital data carriers	new
– Frequency response for DAB and SDARS	new
– Frequency response for telephone	new
– Frequency response for traffic memory	new
– Vehicle-specific sound curves	new
– Fader control capacity	supplemented to include bass equalization
– Control capacity of center control	new
– Speed-sensitive volume control	deleted
– GADK	deleted
– Audio inputs	supplemented
– Stereo input for external media	new
– MD unweighted signal-to-noise ratio (S/N)	reference point
– MD volume range	measurement conditions, reference point
– CD, DVD audio operation	auto reload time
– CD unweighted signal-to-noise ratio	replaced with signal-to-noise ratio
– CD volume range	reference point
– Vibration behavior	requirements, measuring conditions
– Volume range	measuring conditions
– SD cards	new
– Hard disk drives	new
– Reverse-polarity protection	requirements
– Closed-circuit current	requirements
– Antenna remote supply	new DAB
– Frequency drift	new RF level
– Continuous power/system cooling	new
– Resistance to chemical agents	PV 3964 added

### Previous issues

TL 972: 1995-07; VW 809 72: 2000-07; 2001-10

## 1 Scope

VW 80972 specifies requirements and tests for all the radios used in the Volkswagen Group.

The relevant version valid at the time the order is placed shall apply to corresponding standards and regulations.

## 2 General requirements

All individual parts of the standard production units shall conform to the released samples. Release reference samples shall be confirmed by the manufacturer and the releasing department. For the usage period, plus the duration of the warranty period, one of each radio shall be stored by the manufacturer and the releasing department.

If changes are necessary in a current series production, the modification shall be documented and all reference samples shall be replaced. All changes require a new release.

**Requirements called out in drawings and performance specifications shall have precedence over component-specific Technical Supply Specifications and Volkswagen standards.**

**Requirements specified in component-specific Technical Supply Specifications and Volkswagen standards take precedence over VW 80101.**

**Requirements called out in drawings, performance specifications and component-specific Technical Supply Specifications and Volkswagen standards refer on principle to conditioned components!**

Deviations from this Volkswagen standard shall be specified on the component drawing with appropriate substantiation. If this should prove impossible, other forms of documentation shall be provided in the manufacturer's project development record.

Deviations are only permissible if a special application makes this necessary or if new concepts not yet considered in this specification produce better overall performance.

**Damage that is visible when in use is not permissible. Squeaking or rattling of installed and/or add-on parts in all the operating conditions specified in this standard is not permissible.**

### 2.1 Release trial (in-vehicle test)

Balanced and satisfactory behavior on the country-specific evaluation routes is a necessary prerequisite for a release. Values developed here that deviate from this specification take priority and are documented.

For the release, at least 7 out of 10 points according to the Volkswagen evaluation scale (see Table 1) must be achieved for subjective reception evaluations in all practical disciplines; the goal is "Best in Class".

**Table 1**

<b>Points</b>	<b>Reception verbatim</b>	<b>KAF <sup>1)</sup> weighting</b>
<b>1</b>	<b>No reception,</b> no station available, random noise	<b>n o R E L E A S E S</b>
<b>2</b>	<b>A station can be vaguely perceived,</b> random noise and interference predominate	
<b>3</b>	A station is available; information cannot be clearly recognized, <b>unusable however</b>	
<b>4</b>	Station audible, Information recognizable, but annoying, <b>still not usable</b>	
<b>5</b>	Station clearly recognizable, definite degree of interference, but not annoying, <b>“I would listen to it if important”</b>	System still to be improved
<b>6</b>	Station has continuous slight interference, <b>usable</b>	
<b>7</b>	Strong signal, interference from time to time, interference mostly concealed in driving operation, <b>still good</b>	<b>R E L E A S E</b>
<b>8</b>	Good signal, interference during driving only audible if concentrated on, <b>good</b>	
<b>9</b>	No interference audible during driving operation, signal without interference, <b>very good</b>	
<b>10</b> (goal)	Signal absolutely free of interference, suitable for stereo even with vehicle standing still, free of random noise, <b>excellent</b>	<b>Best in Class</b>
1) KAF = Corporate group acceptance test drive		

## 2.2 Definitions

General descriptions:

AU-S	Function description <b>A</b> udio <b>S</b> ound
CRIN	Description in ISO for <b>C</b> ar <b>R</b> adio <b>I</b> dentification <b>N</b> umber
HW	Hardware
LCD	<b>L</b> iquid <b>C</b> rystal <b>D</b> isplay (type of display device)
LSM	<b>L</b> ast <b>S</b> ituation <b>M</b> emory
RT	Description for room temperature
SW	Software

Calibration value = Measured value in as-delivered condition before carrying out any test that may have an influence.

Head impact = Simulation of a collision in which front seat passengers hit their heads on the dashboard according to specification according to EC 74/60 EEC.

Radio engineering descriptions:

Descriptions of radio wave ranges depending on wave length

Limitation	= Compensation of audio level fluctuations depending on the reception level
dB	= Unit of measure for the logarithmic relationship of levels
dB $\mu$ V	= Logarithmic level relationship with the reference value 1 $\mu$ V
E'	= RF level at antenna input behind the antenna simulation
E' <sub>R</sub>	= RF level for the actual noise-limited sensitivity
f <sub>N</sub>	= Frequency of the desired station
f <sub>S</sub>	= Frequency of the interfering station
f <sub>n</sub>	= nth sender in multiple-transmitter measuring methods
FM	= <b>F</b> requency <b>M</b> odulation, also VHF = <b>V</b> ery <b>H</b> igh <b>F</b> requency
FS	= "Full scale" reference full level, CD 0 dB (full modulation amplitude)

Functional states A to E according to definitions as per VW 80101

RF	= <b>R</b> adio frequency, frequencies > 100 kHz
KAF	= Corporate group acceptance test drive (German abbreviation)
k <sub>max</sub>	= Maximum nonlinear distortion factor

Nonlinear distortion factor = Degree of nonlinear audio distortions, indicated in %

HF	= <b>H</b> igh <b>F</b> requency
L	= Left stereo channel
m	= Modulation level for AM modulations in %
MF	= <b>M</b> edium <b>F</b> requency, also AM = <b>A</b> mplitude modulation
LF	= <b>L</b> ow frequency, audio frequency range, 20 Hz to 20 kHz

Desired station = Station tuned in to listen to

P <sub>LF</sub>	= Audio output power
R	= Right stereo channel

Stereo	= 2-channel sound playback
Interfering station	= The station influencing the desired station
$U_B$	= Battery voltage/operating voltage at the control unit's connection block
$U_{Ant}$	= Antenna operating voltage at the antenna jack
$U_A$	= RF output level at signal generator ahead of antenna simulation
$\Delta f$	= Modulation shift for FM modulations in kHz

### 3 Higher-level regulations and guidelines

#### 3.1 Regulations

Unless other requirements exist, the standard production units must comply with the specifications of the respective national governmental approval agency.

The manufacturer is responsible for proof.

#### 3.2 Applicable laws and regulations

ECE	R 21	Cab (interior trim)
EC	74/60 EEC	Cab (head impact)
(EC	78/632	contained in the revision EC 74/60 EEC)
ECE	R10 <sup>2)</sup>	Electromagnetic compatibility
EC	95/54/EC <sup>2)</sup>	Radio interference suppression

Presentation for type approval for the passenger compartment specifications to the releasing government authority is carried out by the responsible department of the respective corporate brand in the scope of the vehicle model release.

#### 3.3 EMC acceptance

For original use, an EMC acceptance is carried out by the Volkswagen AG technical department in the scope of the vehicle model release.

Compliance with the applicable EMC Technical Supply Specifications (TL standards) according to the list is absolutely necessary for this:

TL 965	Interference Emission; Requirements
TL 82066	EMC of Electronic Components, Conducted Interference
TL 82166	EMC of Electronic Components, Radiated Interference
TL 82366	EMC of Electronic Components, Coupled Interference on Sensor Cables
TL 82466	Immunity to Electrostatic Discharges (ESD)

To carry out the EMC release, three sample devices that represent the series production status have to be presented. After successful testing, these devices shall be stored as confirmed reference samples, one of each device at the type testing department, development release department and at the manufacturer's location.

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<sup>2)</sup> This is covered by Volkswagen AG in the EMC type approval. For the original equipment, use in the vehicle manufacturing plant, neither an e nor an E nor a CE marking is required.



### 3.4 Environmental requirements

The “General Environmental Performance Specifications for VW Vehicles and Assembly Groups” and VW 91101 have to be considered for manufacture of the units and selection of materials.

Compliance must be documented by the manufacturer with a hazardous-substance documentation list with quantity data for the hazardous substances contained in the product.

## 4 General test conditions

All specimens must comply with the requirements specified in VW 80101. All parts must completely fulfill their specified function both during and after the tests, unless these are destructive tests. The requirements apply to the entire operating voltage and operating temperature ranges.

During the tests, the specimens must be continuously monitored.

For test sequence, number and sequence, see Section 5.8.

### 4.1 Voltage source

Test voltage	(14 ± 0,1) V, terminal voltage at the device
Internal resistance	< 0,1 Ω
Reference output power	0,5 W at load simulation of 4 Ω

## 4.2 Test temperature

All limits and parameters according to the valid specifications must be adhered to within the test temperature range.

Temperature range -30 °C to +70 °C

Further “special” temperatures are indicated in the relevant sections and must be taken into consideration.

A tolerance of  $\pm 2\text{ }^{\circ}\text{C}$  shall apply to all temperatures.

Measurements for which no temperature is specified shall be performed at RT = (23 ± 5) °C according to DIN.

### 4.3 Preferred measuring frequencies

LF	153	207	252		kHz	
MF	531	1053	1395		kHz	EUROPE
AM	600	1050	1400		kHz	North America
HF					MHz	
FM	89,1	94,1	99,1	106,1	MHz	
FM	79,5	82,5	86,5	89,5	MHz	Japan
DAB	174,928	216,928	223,936	239,200	BAND III	
DAB	1452.960	1471.792	1490.624		L-BAND	EUROPE
DAB	1452.816	1472.000	1491.184		L-BAND	CANADA
SDARS all reception paths (terrestrial and SAT)						North America
DRM/HD radio analogous to AM and FM						

#### 4.4 Modulation

AM:	1000 30	Hz %	Modulation Modulation level	signal
FM:	1000 $\pm 40$	Hz kHz	Modulation Frequency shift	signal
Additionally for stereo	19 $\pm 7,5$	kHz kHz	Pilot Frequency shift	tone
Additionally for RDS	57 $\pm 2$	kHz kHz	Pilot Frequency shift	tone
DAB/SDARS	Analogous to FM			
DRM/HD radio	Analogous to AM and FM			

#### 4.5 Note

As much as possible, the test procedures conform to the recommendations of DIN EN 60315-4.

#### 4.6 Identification of units

**Unambiguity: Each ID number may only be used once.**

Identification plate:

Type: according to drawing

Contents: according to drawing

Identification number structure based on CRIN Acc. to DIN ISO 10486

**Table 2**

V	W	Z	1	Z	1	P	1	2	3	4	5	6	7
1	2	3	4	5	6	7	8	9	10	11	12	13	14

1. and 2.	Vehicle manufacturer <sup>3)</sup>	
3.	Space	
4.	Unit manufacturer <sup>3)</sup>	
5.	Space	
6.	Unit type <sup>3)</sup>	
7.	Manufacturing year	Acc. to DIN ISO 10486
	starting	2001 A
	continuing	2002 B
		2003 C
		2004 D
		Deviating from ISO, only letters and <u>no</u> figures are used.
8. – 14.	Unit number including manufacturer-specific sorting characteristics, such as production plant, etc..	

<sup>3)</sup> Positions 1, 2, 4 and 6 are coded as per individual assignment by the Volkswagen Group, Engineering Information Systems.

#### **4.7 Test frames** (schematic description)

The test frames shall be bolted firmly and without stress (no rubber mounting).

They are to be reinforced in such a way that no resonance points due to the test frame occur, particularly during vibration tests.

### **5 General requirements**

Specific to mounting location according to VW 80101 or performance specifications.

For systems which are used in the dashboard or center console without particular instructions, all the requirements of VW 80101 "Interior Parts, Normal Requirements, Requirements Range 5" shall be fulfilled.

#### **5.1 Temperature requirements**

According to VW 80101, interior parts, normal requirements.

Components with deviating use, specific to mounting location according to the performance specifications.

##### **5.1.1 Operating temperatures**

Temperature range: (-30 to +70) °C

Full functionality and data retention.

The dew point is considered part of the operating range and must be considered accordingly.

Restricted function is permissible for player equipment of audio recording devices with rotating parts (CC, CD, DVD, MD and HDD) in the range (-40 to -30) °C. Initial operation in this temperature range must not cause any damage to the player equipment or the playback medium.

For CC tests  $\geq +60$  °C, special suitable tape material is required.

Test procedure:

1. Device is capable of operation under operating conditions with all external components.

The specimen shall be switched off until the lower limit temperature is reached.

The function shall be tested starting with the lower operating temperature and then increasing in 5 °C steps until the upper limit temperature is reached. The air conditioning system-specific dew point has to be determined and taken into consideration.

2. Low-temperature operation: 24 h according to VW 80101
3. High-temperature operation: 96 h according to VW 80101

Conditions:

RF level E' at onset of limitation (-3 dB LF drop).

Continuous monitoring of LF signal.

Visual monitoring of the display elements (in particular LCD), requirement according to **TL 82189** (instrument clusters).

## 5.2 Temperature resistance

### 5.2.1 Conditioning (aging in mechanically circulated air, without load)

No disturbance of function, damage or color changes shall occur after conditioning.

To be conditioned at maximum storage limit temperature for 24 h according to Section 5.2.2 plus 24 h at +90 °C (aging, specimen not ready for operation)

### 5.2.2 Temperature cycle (no load)

No residual disturbance of function or damage shall occur after aging.

Specimen ready to operate with power supply, but not switched on

Maximum storage temperature +85 °C

Minimum storage temperature      -40 °C

Test procedure according to VW 80101

Number of cycles 30

### 5.2.3 Rapid temperature cycle with specified transfer duration (thermal shock test)

No residual disturbance of function or damage shall occur after testing.

Normal requirements according to VW 80101

Number of cycles 100

Specimen ready to operate with power supply, but not switched on.

### 5.3 Resistance to environmental factors: humid heat, cyclic

Test procedure according to VW 80101.

Operating modes: 3.2 at maximum operating temperature

2.1 in all other ranges

Directly after the humid heat test, the drop in sensitivity shall not exceed max. 6 dB relative to the initial condition. The mechanical system shall be fully functional.

The measurement must be completed within 10 minutes of the end of the test.

After aging at RT ( $\geq 24$  h), there shall be no further drop in sensitivity with respect to the initial condition. (2 dB measuring accuracy, reproducibility of results)

Aging at RT                      24 h aging in as-installed position

Perform immediately after the humid heat test.

## 5.4 Illumination/nighttime design

Requirement according to VW 80104.

Illuminated uniformly, glare-free.

No light shall escape around sides.

Color: Light intensity and dimming characteristics are brand-specific according to the drawing.

### **5.5 Control elements (keys and trim)**

Symbol lettering (symbols)	according to VW 80660
Paint coating	according to TL 226

### **5.6 Chemical requirements (resistance to chemical agents)**

Procedure according to VW 80101 (only wet, do not immerse)

- a) Diesel fuel
  - m) Interior cleaner
  - o) Diesel fuel (FAME)
  - q) Windshield washer fluid
  - r) Refreshment containing caffeine and sugar
  - s) Commercial glass cleaner
  - u) Sweat
- Skin creams & cosmetics according to PV 3964

### **5.7 Lightfastness**

No color shift is permissible, evaluation scale according to drawing and/or maximum deviation samples.

Procedure	according to PV 1303
Exposure periods	3

### **5.8 Test sequence**

The test sequence and the number of specimens shall be agreed upon beforehand with the releasing department.

All parts must still fulfill their required function during and after the tests below. The requirements apply to the entire operating voltage and operating temperature range. The relevant functional requirements must be continuously monitored. The test sequence according to Table 3 shall be adhered to unless otherwise agreed.

The reliability random sample in the release department can be omitted if the following requirements are present and carried out by the manufacturer in its own responsibility.

- known standard production supplier,
- test equipment recognized by Volkswagen,
- the test sequence plan is coordinated with the release department and Quality Assurance,
- random samples by release department at the manufacturer's location during reliability testing,
- mutual final evaluation of the reliability tests by the manufacturer with the participation of the engineering department and Quality Assurance.

**Table 3 – Test sequence** (without special agreement)

Visual inspection <u>during</u> the sample transfer (all specimens) (in the presence of the supplier)				
Device conditioning (all specimens)				
Function testing and calibration (all specimens)				
<b>Test series 1 General (2)</b>	<b>Test series 2 Mechanical sys- tem (4)</b>	<b>Test series 3 Electrical system (3)</b>	<b>Test series 4 Drives (4)</b>	<b>Test series 5 EMC (3)</b>
Operating temperature Low temperature High temperature Behavior at dew point	Rattling noise	Operating voltage	Endurance test 10 000 cycles RT Play >>-<<- Play	Interference emission according to TL 965
Rest ≥ 24 h RT	Button forces load/displacement Buttons/encoder torques	Undervoltage	Endurance test 3 000 cycles +60 °C 1 000 cycles -10 °C	Coupled inter- ferences TL 82366
Temperature cycle	Shaking 8 h/spatial axis Severity 2/3 3 for function 2 without destruc- tion	ON-OFF continuous opera- tion 10 000 mechanical 20 000 electrical	Inspection	Conducted interference TL 82066
Rest > 24 h RT	Continuous button and key operation	Continuous opera- tion radio 200 h	Endurance test Insert Eject Insert	Radiated inter- ference TL 82166
Humid heat, cyclic according to VW 80101	Button forces load/displacement Buttons/encoder torques	Overvoltage - short - long	Endurance test 1 500 h with TA intervals 1 000 × 10 s	ESD TL 82466
Rest > 24 h RT	Thermal shock	Voltage dips	Drive performance	EMC type re- lease
<b>Test series 6, destructive tests</b> new sample parts (2) in each case, parallel to test series 1 to 5				
<ul style="list-style-type: none"> <li>- Flammability</li> <li>- Head impact</li> <li>- Mechanical shocks</li> <li>- Colorfastness</li> <li>- Abrasion resistance</li> <li>- Resistance to creams &amp; chemical agents</li> </ul>				
Function testing and repeat measurement, test series 1 to 6 (all specimens)				
Evaluation				
<b>Development release</b>				
<p>(Specification in brackets = number of specimens for random samples at Volkswagen).</p> <p>The number of units for the reliability test at the manufacturer's premises shall be sufficient to ensure a well-founded statement on the result and varies with the level of equipment and the functional scope of the units. The number of specimens to be specified for each test series is part of the test sequence plan between the manufacturer and the releasing department.</p>				

## 5.9 Flammability

According to TL 1010

(mandatory for USA, Canada, China and Japan)

## 5.10 Operating noise

Noise limit values for all part components of a radio/radio navigation unit with electro-mechanical drive: audio drives (CC, CD, MD and HDD) and cooling fans in "normal operation".

(In preparation)

## 5.11 Noise limit values during excitation (rattling and squeaking)

Noise limit value for the radio/radio navigation component subject to defined excitation.

This test shall confirm that there is no rattling, as required in the performance specifications.

The term "rattle-free" is hereby defined by a limit value curve at a specified excitation.

The specimen shall be secured in the test frame in accordance with Section 4.7.

All intended as-installed positions according to vehicle type shall be taken into consideration.

For units with playback drives, the test shall be conducted with and without the playback medium. For several playback media (type and number), combinations and partial complements must also be taken into consideration.

Excitation is in the vertical direction.

Evaluation:

Noise evaluation                      SPL in dB(A),

Analysis range                      25 Hz to 20 kHz, 1/3 octave

Duration                              linear mean over 30 s

Distance to microphone              (75 ± 1) cm from the geometric center of the specimen

The environment is to be recorded by means of pre- and post-measurements, but without the assembled specimen.

The limit curve includes the noise spectrum emitted by the specimen including the environment.

Limit curve                              in preparation

## 6 Mechanical requirements

### 6.1 Torque of control knobs

Torques and character concept-specific according to drawing or performance specifications.

Over-tightening torque              ≥ 100 Ncm      no mechanical damage permissible

Release forces for  
flush rotary knobs                      ≤ 10 N

## 6.2 Control forces for keys

Switching points must be clearly perceptible (haptic feedback).

Load/displacement behavior concept-specific according to drawing or performance specifications.

Max. permissible force difference of adjacent buttons	$\leq 25 \%$
Push-through force	$\geq 150 \text{ N}$

## 6.3 Plug connection forces

All connectors must be latchable and coded so that they are not interchangeable.

Multiple connector	according to VW 80106
Antenna jacks	according to DIN ISO 10599-1
Plug resilience:	$\geq 150 \text{ N}$

## 6.4 Endurance test

During and after testing, the units shall function properly; there shall be no mechanical or electrical damage. Operating state A.

### 6.4.1 Actuation endurance test (under load)

The load/displacement curve shall be recorded before and after the actuation endurance test. The drop in force must be max. 50%. The actuation character, the haptic feedback must not be lost.

During the actuation endurance test, the radio shall be subject to the following load.

- Control connection for external components  $I_{\text{Control}} = 80 \text{ mA/control output}$
- Antenna feed current with  $I_{\text{Antenna}} = 60 \text{ mA/antenna input}$
- Actuation under load with audio signal  $1\text{W}/4 \Omega$  per channel

Load cycles: (unless otherwise specified in the performance specifications)

Buttons	20 000 actuations
Flush controls (locking/unlocking)	5 000 actuations
On/off rotary switch	10 000 actuations <sup>4)</sup>
On/off switch via S contact	20 000 actuations
Rotary controls	20 000 actuations <sup>4)</sup>
Encoder for volume	50 000 actuations <sup>4)</sup>
Encoder for normal selection and input functions	100 000 actuations <sup>4)</sup>
Multifunction encoder with increased requirements	1 000 000 actuations <sup>4)</sup>

---

<sup>4)</sup> Actuation in the case of rotary controls with stop:

One actuation = left stop - right stop - left stop - press

Actuation in the case of rotary controls without stop (encoder):

One actuation = right- and left-turning with a random angle each time and a total of  $720^\circ$  (e.g.:  $420^\circ$  right +  $300^\circ$  left) and press

On/off rotary switch: One actuation = from position OFF to ON and back to OFF



Procedure:

Proportional at the maximum, minimum operating temperatures and RT.

Unless otherwise agreed, the following applies:

- minimum operating temperature: 10 %
- maximum operating temperature: 20 %
- RT 70 %

During the tests, the correct functionality must be monitored and verified.

#### 6.4.2 Vibration excitation

Procedure and requirements according to VW 80101, body-mounted parts in the as-installed position in an appropriate test frame, free of resonance according to Section 4.7.

Note:

If a device is used in different as-installed positions, both extreme positions with minimum and maximum installation angle must be tested.

50% of devices shall be tested with and 50% without playback medium (CC, CD, MD, DVD, SD etc.).

#### 6.5 Continuous operation (radio)

Continuous operation at RT and  $P_{LF} = 1 \text{ W}/4 \Omega$  per final stage = 200 h

After the test, there shall be **no** change with respect to the initial condition.

(2 dB measuring accuracy, reproducibility of results)

#### 6.6 Fastening system (mounting spring function)

Tight fit free of rattling in the dashboard, over all permissible dimensional tolerances of the dashboard cutout.

Horizontal position – center centering.

Guaranteed tight fit during rear crash and head impact according to EC 74/60 EEC.

Suitability and fulfillment have to be proven by Vehicle Safety.

Type and design concept-specific according to drawing.

Spring unlocking for disassembly must be possible with specific special tool.

#### 6.7 Strength of face trim, control keys, buttons

##### 6.7.1 Face trim

No damage or fracture after strength testing.

Pressure resistance perpendicular to the trim contact surface

Head impact

$F_{D\perp} \geq 300 \text{ N}$

according to EC 74/60 EEC

##### 6.7.2 Control keys

No damage or disturbance of function after strength testing.

Push-through force of key

Head impact

$F_{DT} \geq 150 \text{ N}$

according to EC 74/60 EEC

### 6.7.3 Display

No splintering after head impact

according to EC 74/60 EEC

### 6.7.4 Buttons

Pull-off torque of buttons  
and/or drawing

according to performance specifications

unless otherwise defined:

≥ 50 N

## 7 Requirements for electrical system

### 7.1 Frequency range that can be selected

See Table 4.

**Table 4 – Overview of the frequency ranges**

Range	Lowest frequency that can be set	Highest frequency that can be set	Unit	Region	Manual tuning detent
LF	153	279	kHz	Europe	9 kHz
MF	531	1 602	kHz	Europe	9 kHz
MF	522	1 629	kHz	Japan	9 kHz
AM	530	1 710	kHz	NAR	10 kHz
HF	5,95	6,2	MHz	All	
FM	87,5	108,0	MHz	Europe	100 kHz
FM	87,75	107,9	MHz	America	200 kHz <sup>5)</sup>
FM	76,0	90,0	MHz	Japan	100 kHz
DAB (Volume III)	174	240	MHz	All	
DAB (L-band)	1452	1492	MHz	All	
SDARS (Sirius)	2320,0	2332,5	MHz	NAR	
SDARS (XM)	2332,5	2345,0	MHz	NAR	

DRM/HD radio corresponding to the AM and FM frequencies

5) The first frequency that can be tuned at the beginning of the band is used to set the TV sound broadcast channel 6, at 87,75 MHz; the next frequency that can be tuned again is in the standard grid 87,9 kHz and is continued with 200-kHz steps.

The special radio requirements are described in the country-specific attachments since the requirements are not uniform and vary depending on the country.

VW 80972-1 = Europe AM, FM, stereo, RDS, traffic announcement program, DAB, TMC

VW 80972-2 = Japan AM, FM, stereo, TI, VICS, DARC

VW 80972-3 = America AM, FM, stereo, SDARS (XM/SIRIUS), HD radio

## 7.2 Voltages

- a) Ranges of the voltage supply, see VW 80101, "Overview of voltage definitions for networked systems", with the following deviation:

Full functionality and data retention: Terminal voltage: 10,8 V to 15,5 V

Full function Terminal voltage: 9,0 V to 15,5 V

(LF restricted according to specification in drawing or performance specifications).

Safe range = theft protection response  $\leq 3,5$  V to 0 V for  $t \geq 0,5$  s.

- b) Behavior in the various voltage ranges

The supply voltage is defined as the voltage applied to the radio terminals.

Functional states A to E according to VW 80101

Only permissible radio-specific deviations and special features are described below.

Functional state A: 15,5V to 10,8 V

Full functionality including diagnosis

Functional state B: 10,8 V to 9,0 V

Subjective functional performance ensured, data specification may be restricted, mute durations potentially longer

After end of B:

Full functionality and data retention.

Functional state C:  $\leq 9,0$ V/ $15,5$ - $17,0$ V

- No undefined states permissible
- LF mute permissible, if required
- CC and CD in "stand by" above reset threshold permissible
- Manual switch-off of unit possible
- No further key functions permissible
- No external data communication below the reset threshold permissible
- Display OFF permissible, if required
- No data communication permissible (does not apply to ring networks, e.g. MOST)
- Switch-off of all control outputs and inputs permissible
- Theft protection must respond if terminal voltage  $< 3,5$  V for  $t > 0,5$  s

After end of C:

Continuation of operating state as before, if required cancel LF mute

When theft protection responds, behavior according to performance specifications

Reset behavior according to VW 80101

Functional state D:  $\leq$ Reset value/ $\geq 17,0$ V

Protective shut-off, all functions OFF

After end of D:

Unit may remain in OFF state, after manual ON last situation memory (LSM) or initial connection default state according to the battery disconnection state.

## 7.3 Overvoltage protection

According to VW 80101

LF output power

0,5 W per final stage

### 7.3.1 Testing at 10,8 V

During testing, there shall be no increase in the nonlinear distortion factor of the LF output signal.

Test procedure:

Resistance of power supply line increased by 0,5  $\Omega$ .

### 7.3.2 Voltage dip, brief period (starting pulse)

Starting pulse 12 V power supply system according to VW 80101, "Operating voltage dips".

The test described below comprises two parts

- 1) the component test in the laboratory with artificial network according to DIN
- 2) the system test in the reference vehicle with real power supply system

Below the operating voltage, there shall be no interferences over LF caused by the undervoltage (mute is permissible, functional state C).

After the operating voltage has been reached again, the unit shall be in the operating state it was in before the voltage drop (reset).

Reset behavior according to VW 80101.

Response of theft protection is not permissible.

- 1) Component test

In addition to the diagram of the level/voltages/duration of the voltage curve in Table 5, all of the following variations must be tested in each operating state.

(Detailed description currently in preparation (Mr. Warnecke))

- 2) Vehicle reference test

The component tests in the laboratory shall be backed up by the reference vehicle test with the real power supply system.

For the details and procedure, see: "Test specifications for Audi reference vehicles"

### 7.3.3 Interruption

Procedure according to VW 801 01.

Interruption time                      10 s

Functional state                          D

### 7.3.4 Reverse-polarity protection

Procedure according to VW 80101, case 1 and case 2

Functional state: D

Actuation of the fuse is not permissible. <sup>6)</sup>

Max. permissible blocking current:  $I_S \leq 1 \text{ mA}^*$

---

<sup>6)</sup> This applies to units with development start as of 2006

## 7.4 Current

#### 7.4.1 Maximum permissible closed-circuit current/power consumption

The specified limit values are to be tested in the voltage interval 6 V to 15,5 V.

In idle state:  $I_0 \leq 300 \mu A$  (mean value)

TA speech memory readiness	$I_0 \leq 50 \text{ mA}$ (mean value, without antenna remote supply)
----------------------------	--

Automatic deactivation of the TA speech memory readiness if not used after 1 000 h.

(Operation and notification according to the relevant device-specific HMI description.)

Unit condition during measurement:

## Bus sleep

Theft protection active

Unit initialized

The mean value over 15 minutes is to be determined as the current limit value.

When determining the mean value, higher peak currents for an anti-theft LED shall be considered.

This does not include recordings in the TA memory during this period.

To determine the closed-circuit current, any type of device afterrun, like TA readiness, station memory update, etc., is to be switched off in as-delivered condition (code by-pass).

### 7.4.2 Control lines (capacity)

All control outputs must be safe at idle and short-circuit-proof.

Device damage and overheating are **not** permitted.

An increase in the closed-circuit current with radio OFF is **not** permitted.

#### 7.4.2.1 Radio ON

**Radio ON** via control line  $\geq 100\text{ mA}$ : short-circuit-proof

For time curve, see switching behavior, ON/OFF (for sound systems).

## Radio ON via speaker output

typically  $\frac{1}{2} U_B$ , but at  $U_B = 9 \text{ V}$  must be  $\geq 4,0 \text{ V}$

#### 7.4.2.2 CD changer

CD changer control line  $\geq 100$  mA; short-circuit-proof

Max. permissible voltage drop related to U (terminal)  $\leq 1 \text{ V}$ .

The CD and radio ON control outputs are to be decoupled from each other.

CD changer, continuously positive  $\geq 1$  A; short-circuit-proof

≥ 5 A;      peak load for 1 minute duration

### 7.4.2.3 Antenna supply

Antenna remote supply (via RF neutral wire).

Short-circuit or idling is detected.

A short circuit may lead to the antenna remote supply being switched off, the unit will remain functional.

Note:

For operating current range and diagnosis thresholds, see antenna diagnosis in the relevant valid diagnosis performance specifications.

Interference suppression (residual ripple):  $U_B/U_{Ant} \geq 90 \text{ dB}$

In the relevant frequency range used by the receiver.

Measurement

Power supply and injection of interference signal with artificial network according to TL 82066.

The modulation of the useful signal shall be switched off.

Mechanical design and coding, see relevant unit performance specifications.

#### 7.4.2.3.1 Antenna remote supply, normal requirements

For AM/FM systems with normal requirements and simple diagnostic scope.

Rated voltage at antenna jack	$U_{Ant} = (10,5 \text{ to } 13,0) \text{ V}$ , load-dependent
at an input voltage	$U_B = 14,0 \text{ V}$
and load of	$I_A = (25 \text{ to } 100) \text{ mA}$
max. load capacity:	$I_A \geq 100 \text{ mA}$

For DAB systems with normal requirements and simple diagnostic scope.

Rated voltage at antenna jack	$7,0 \text{ V} \leq U_{Ant} \leq 15,0 \text{ V}$ , load-dependent
at an input voltage	$U_B = 9,0 \text{ V to } 16,0 \text{ V}$
and load of	$I_A = (20 \text{ to } 110) \text{ mA}$
max. load capacity:	$I_A \geq 130 \text{ mA}$

#### 7.4.2.3.2 Antenna remote supply with stabilized supply voltage

For AM/FM systems with expanded requirements, additional diagnostic scopes.

Stabilized rated voltage at the antenna jack	$U_{Ant} = (8,5 \pm 0,2) \text{ V}$
--	-------------------------------------

at an input voltage  $U_B = 10,8 \text{ V to } 17,0 \text{ V}$

Load capacity:	AM/FM main antenna	$\geq 100 \text{ mA}$
	FM ancillary antenna	$\geq 60 \text{ mA}$

### 7.4.3 Overcurrent resistance

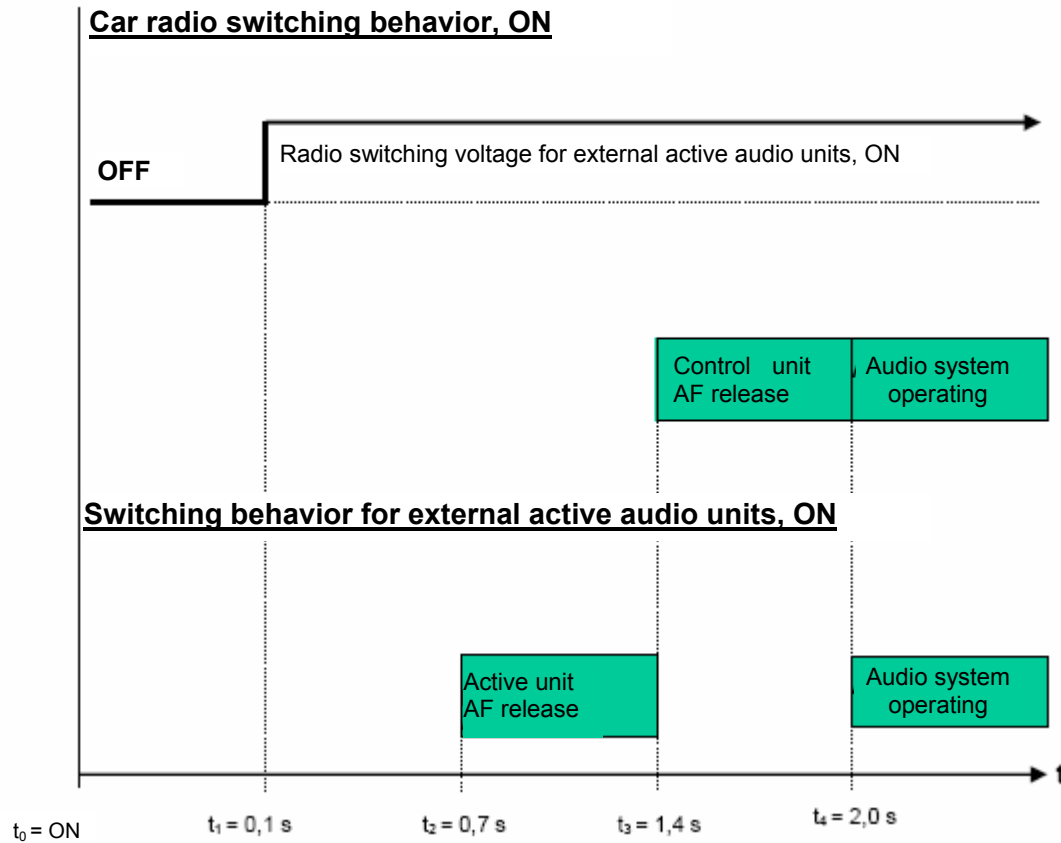
Procedure and requirements according to VW 80101.

Load holding time	10 min
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Load	$1,5 \times I_{rated}$
------	------------------------

## 7.5 Switching behavior, ON/OFF

Diagram with description of the graduated ON-time of the control output for external audio amplifiers up to LF release to prevent switching noises.



**Figure 1 – Switching behavior, ON**

### Description of switching behavior, ON

t<sub>0</sub> = Point in time when car radio is switched on.

All other time information on switching behavior, ON, is relative to this point in time.

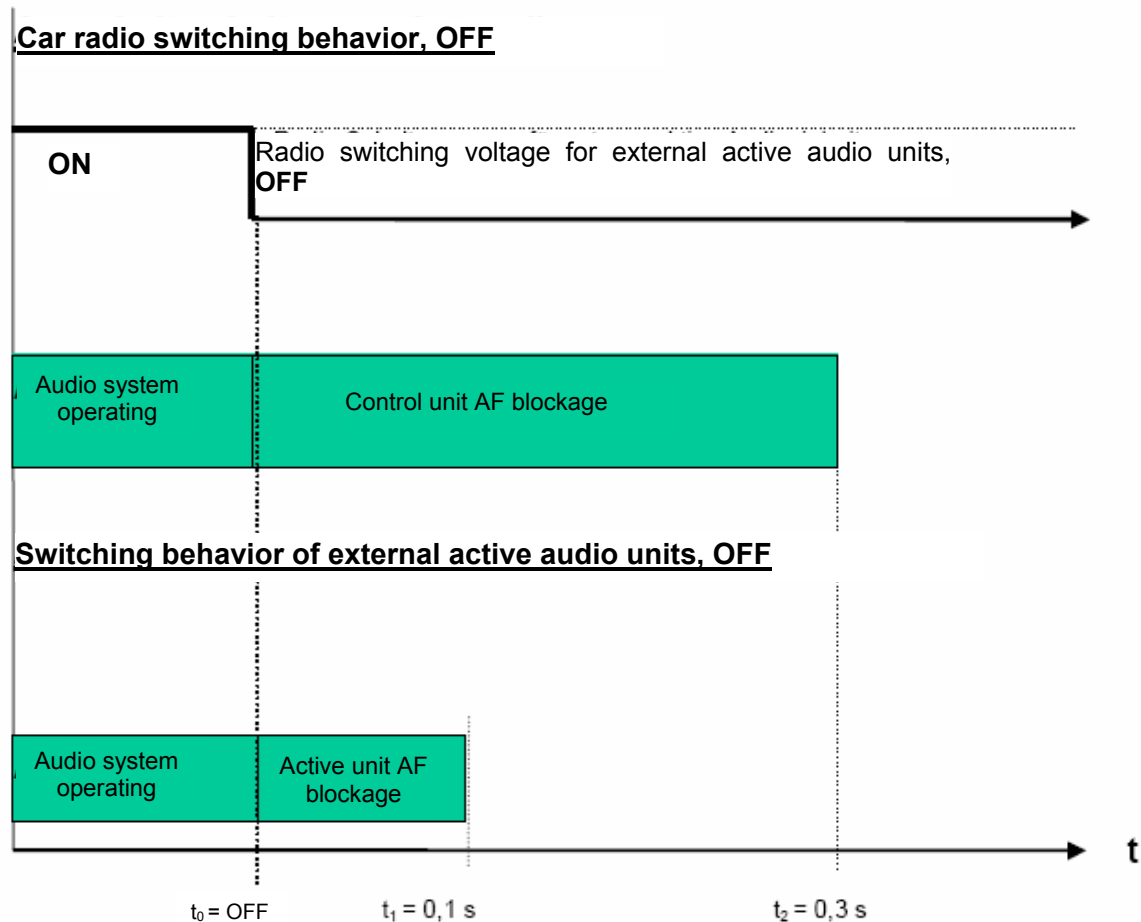
The switching voltage for external active units shall be available at the designated contact after max. 0,1 s (t<sub>1</sub>).

Up to the point in time 0,7 s (t<sub>2</sub>), the switch-on/transient noises of the car radio shall be avoided for all existing LF outputs. As of the point in time 0,7 s (t<sub>2</sub>), switch-on/transient noises at the LF outputs are not permissible.

Between the points in time 0,7 s (t<sub>2</sub>) and 1,4 s (t<sub>3</sub>), the LF outputs of external active units shall be released. Observe the variable switching point t<sub>1</sub> (0 to 0,1 s) for the circuit design of external active units.

Between the points in time 1,4 s (t<sub>3</sub>) and 2 s (t<sub>4</sub>), the LF outputs of the car radio shall be released. In this process, all existing LF outputs must be released simultaneously with a “**soft demute**” (guaranteed “free of clicking”, see also switch-on curve in radio performance specifications).

The LF release of the radio has to take place after the release in the external audio amplifier; a radio demute before t ≤ t<sub>3</sub> is not permissible.



**Figure 2 – Switching behavior, OFF**

Description of switching behavior, OFF

$t_0$  = Point in time when car radio is switched off.

The switching point, OFF, is defined as the time at which the switching voltage for the external active units is interrupted or switched off. All other time information on switching behavior, OFF, is relative to this point in time ( $t_0$ ).

As of point in time 0,1 s ( $t_1$ ), the LF blockage of the external active unit shall have taken place. Mutes of the car radio to ground are not permitted.

Up to point in time 0,3 s ( $t_2$ ), no interferences (e.g. caused by decreasing supply voltage levels) shall reach the LF output that triggers the external active unit.

After point in time 0,3 s ( $t_2$ ) switch-off/transient noises of the car radio and the external active unit shall be avoided.

Behavior during voltage dip:

A voltage dip lower than the reset threshold shall be handled like switching off and back on again. No superimposing of the sequences is permitted. LF interference pulses in the switching behavior, OFF, must be suppressed. The procedure for switching back on must not start (at  $t_0$  ON) until the switch-off process is complete, i.e.  $\geq 0,3 \text{ s} + t_{\text{voltage dip}}$  after control line low ( $t_0$  OFF).



## 7.6 Control inputs

All inputs (sensor inputs, digital inputs, A/D channels) must be continuously short-circuit-proof to  $U_B$  and ground.

Functions that depend on control inputs shall not react to interference pulses (contact bouncing, spikes, etc.).

As the analog inputs are being replaced by digital control signals via the CAN, each device no longer has to be equipped with an analog input. For type and scope of the control inputs, see the relevant valid device-specific performance specifications.

### 7.6.1 PHONE (analog input)

External mute (LOW=active=mute)

Level: according to VW 80101

Switched to ground ("open collector").

Input with pull-up resistor, decoupled with diode  $I_C = 1 \text{ mA}$  (nominal value)

For digital input, see CAN performance specifications.

For dimensioning of interface box, see performance specifications: Specification of the audio/mute interface.

### 7.6.2 S contact (analog input)

S contact (HIGH=active=ON)

Level according to VW 80101

Load  $I_{\max} \leq 1 \text{ mA}$

For digital input, see CAN performance specifications.

### 7.6.3 Illumination

Only digital input, see CAN performance specifications.

### 7.6.4 Speed-sensitive volume control

Only digital input, see CAN performance specifications.

## 7.7 Frequency constancy

### 7.7.1 Station frequency repeatability

No deviation permitted.

### 7.7.2 Frequency drift upon change in ambient temperature

#### FM range

Permissible deviation over the entire operating temperature range  $\leq 5,0$  kHz.

Measuring method	according to DIN EN 60315-4:
FM tuning criteria	nonlinear distortion factor minimum
Shift	75 kHz
Measuring frequency	94,1 MHz
Input level	$E' = E'_R + 6$ dB

Run three preliminary cycles over the total temperature range without performing measurements.

For the test procedure:

Tuning and reference point at RT.

Then cool the unit to minimum operating temperature.

Warm unit in 20-°C steps up to the maximum operating temperature and measure drift at each 20-°C step.

Wait until no further frequency drift occurs to adjust to the next temperature step – **stabilization!**

Then cool to room temperature, measure, and compare this value with the value determined initially.

The climate chamber shall be closed during the entire measurement. If necessary, required retuning measures shall be carried out on the signal generator.

#### AM range

The deviation over the total temperature range shall not exceed 0,5 kHz.

Modulation level	80 %
Measuring frequency	1 053 kHz or 1 050 kHz
Input level	$E' = E'_R + 6$ dB

#### Digital reception media:

For DRM and HD radio according to AM/FM range.

For DAB according to the DAB guidelines.

For SDARS according to the SDARS (XM/Sirius) guidelines.

### 7.7.3 Frequency drift upon changes in operating voltage

No deviation permitted.

## 7.8 Interferences

### 7.8.1 Interferences caused by controls

Tuning criteria: AM:  $f_1 = 207$  kHz Europe  
 $f_2 = 1053$  kHz Europe  
 $f_2 = 1050$  kHz North America  
 $m = 30\%$ ; 1 kHz  
 FM:  $f = 94,1$  MHz  
 $\Delta f = 40$  kHz; 1 kHz

Reference output power: 0,5 W

Test frequencies: AM: complete AM band, in 9-kHz or 10-kHz steps  
 FM: complete FM band, in 100-kHz or 200-kHz steps

**Table 5 – Signal-to-noise ratio**

	E'	S/N
AM	40 dB $\mu$ V	$\geq 38$ dB
	> 60 dB $\mu$ V	$\geq 48$ dB
FM	20 dB $\mu$ V	$\geq 44$ dB
	40 dB $\mu$ V	$\geq 55$ dB mono $\geq 50$ dB stereo
Effective value measurement with filter according to CCIR 468		

The receiver shall be adjusted according to the tuning criteria. Modulation shall be turned off, and any interference signal that is present shall be evaluated.

The signal generator and receiver are to be adjusted one step further, the interference signal is to be evaluated and the process is to be continued until a complete band sequence has been completed.

For DRM, HD radio, DAB and SDARS, the relevant reception-specific guidelines shall be taken into consideration.

### 7.8.2 Interference due to internal drives (CC, CD, MD, SD and HDD)

An integrated or connected media playing device must not cause interference in the radio band, either in radio monitor operation or in traffic information background operation.

## 7.9 Interference immunity

### 7.9.1 Ignition interference

Limit value of signal-to-noise ratio voltage in the presence of interference pulses:

for FM  $\geq 32$  dB for AM  $\geq 20$  dB

Actuation shall be prevented.

#### Noise evaluation:

Measurement of signal-to-noise ratio according to DIN 45405; (67) evaluated with CCIR 468 quasi peak value.

Interference generator:      Pulse frequency      100 Hz  
    Output level            32 mV at 50  $\Omega$

Desired station:                FM:  $f_N = 94,1$  MHz,  
    Modulation:  $\pm 22,5$  kHz/1 kHz

   AM:  $f_N = 1\,053/1\,050$  kHz  
    Modulation: 30%/1 kHz

$E' = 40$  dB $\mu$ V  
     $P_{LF} = 0,5$  W

#### Test procedure:

Tune receiver to desired frequency, set reference output power (tone control flat), set interference signal, turn off desired-station modulation and measure signal-to-noise ratio voltage.

For DRM, HD radio, DAB and SDARS, the relevant reception-specific guidelines shall be taken into consideration.

### 7.9.2 Power supply system interference

According to TL 82066, pulses 1 to 4, operating state after load: A.

A mute is permitted during pulse 1 (state C); return to operating state A after pulse 1.

See also voltages in Section 7.2. and voltage diagram in VW 80101.

Audible interferences via LF are not permissible.

### 7.9.3 Interference caused by alternator

Test according to VW 80101, Section "Superimposed alternating voltage".

No interferences shall be audible through LF ( $U_{\text{interf. out}}$ ) with a sinusoidal ripple and a frequency of 0,1 kHz to 20 kHz in the supply voltage of  $U_{\text{interf. in}} = 4$  V<sub>pp</sub>

**Table 6**

Limit values of interference voltage	0,5 kHz to 20 kHz	0,1 kHz to 0,5 kHz
Speaker outputs and symmetrical line outputs	$U_{\text{interf. out}} \leq 0,45$ mV ( $\geq 70$ dB)	$U_{\text{interf. out}} \leq 14$ mV ( $\geq 40$ dB)
Asymmetrical line outputs	$U_{\text{interf. out}} \leq 140$ $\mu$ V ( $\geq 80$ dB)	$U_{\text{interf. out}} \leq 1,4$ mV ( $\geq 60$ dB)

Note: Limit value curve being prepared.

Measurement: RMS evaluated with filter according to CCIR selectively with tracking filter (BP: 1/12 octave) at maximum usable output level according to Section 8.2.1.

Definition: Signal-to-noise ratio =  $20 \times \log (U_{\text{interf. in}} / U_{\text{interf. out}})$

## **7.10 EMC**

- |  |                       |
|--|-----------------------|
| <b>7.10.1 Interference emission</b>          | according to TL 965   |
| <b>7.10.2 Conducted interference</b>         | according to TL 82066 |
| <b>7.10.3 Radiated interference immunity</b> | according to TL 82166 |
| <b>7.10.4 Coupled interference</b>           | according to TL 82366 |

### **7.10.5 Electrostatic charging protection**

The unit shall be fully functional after capacitor discharge.

An electronic protective shut-off is permitted, functional status C.

- |                             |                      |             |                       |
|-----------------------------|----------------------|-------------|-----------------------|
| a) Direct contact discharge | 330 pF/330 $\Omega$  | $\pm$ 8 kV  | according to TL 82466 |
| b) Air discharge            | 150 pF/2000 $\Omega$ | $\pm$ 25 kV | according to TL 82466 |

## **8 Audio requirements**

All audio outputs and inputs must be safe at idle, short-circuit-proof and ESD-proof as well as short-circuit-proof to the voltage supply and ground.

These fault cases must not lead to destruction or overheating of the device.

If there is an overload, power reduction is permitted; short-term switch-off or mutes are not permitted.

High-frequency signals shall be effectively suppressed. At the outputs, interference signals in the frequency range 22 kHz to 300 kHz must not, independent of the volume setting, exceed a level of -60 dB (with respect to the max. output signal).

### **8.1 Audio requirements (subjective volume equality)**

CD is set as the reference for all tests; the standard modulation is 1 kHz.

If it is not possible to take CD as the reference, the conditions named in Table 7 shall be transferred. The level plan shall be determined with an LF reference output power of 0,5 W/4  $\Omega$ .

**Table 7 – Audio control plan**

Source	Level	Condition
<b>CD = reference</b>	<b>0 dB</b>	<b>-10 dB<sub>FS</sub></b>
FM	0 dB ( $\pm 1$ dB)	$\Delta f \pm 40$ kHz
AM	-3 dB ( $\pm 1$ dB)	m = 30%
IBOC (HD radio)	0 dB ( $\pm 1$ dB)	-10 dB <sub>FS</sub>
DRM	0 dB ( $\pm 1$ dB)	-10 dB <sub>FS</sub>
DAB	0 dB ( $\pm 1$ dB)	-10 dB <sub>FS</sub>
SDARS (Sirius/XM)	0 dB ( $\pm 1$ dB)	-10 dB <sub>FS</sub>
DVD <sub>Audio</sub>	0 dB ( $\pm 1$ dB)	-10 dB <sub>FS</sub>
MD	0 dB ( $\pm 2$ dB)	Test MD, -10 dB
Beep	Min: 0,2 V <sub>pp</sub> ( $\pm 2$ dB) Max: 1,0 V <sub>pp</sub> ( $\pm 2$ dB)	source-independent, volume-dependent
AUX in	0 dB ( $\pm 1$ dB)	Input: 1,0 V <sub>RMS</sub>
Telephone <sub>Phone</sub>	Variable, LSM	Input: 1,8 V <sub>RMS</sub>
Telephone <sub>Stereo Audio</sub>	0 dB ( $\pm 1$ dB)	-10 dB <sub>FS</sub>
TP memory	Variable, LSM	from FM source
Navigation announcement	Variable, LSM Min: tbd V <sub>RMS</sub> ( $\pm 2$ dB) Max: tbd V <sub>RMS</sub> ( $\pm 2$ dB) (must be tuned in the vehicle!)	source-dependent, in relation to volume
Test CD: e.g.: Philips No. 3, Technics CDT-002, A-Bex TCD 781 Test MD: e.g.: Sony TGYS Procedure: Measurement with bass/treble control in center position. Set LF level to reference value. Effective value measurement unevaluated. Bass/treble correction filters (EQ) have to be switched off. LSM = Last Situation Memory, variable = most recent level set individually by the user within the permissible limits in the relevant operating mode.		

## 8.2 Audio outputs

Measuring conditions:

Operating voltage	U <sub>B</sub> = 14,0 V
Reference signal	CD = -10 dB <sub>FS</sub>
RF input level, AM/FM	E' = 60 dB $\mu$ V
Standard modulation	LF = 1 kHz
Simultaneous load on all final stages	R <sub>L</sub> = 4 $\Omega$
Line Out load	R <sub>L</sub> = 100 $\Omega$

The CD signal serves as the reference for the tests described in the following.

Bass/treble controls shall be set in "center position" for testing; the geometry controls shall be set in the electrical center position (all channels = maximum level).

Any existing vehicle-specific frequency-response corrections shall be switched off for the general measurements and only switched on again for the specific frequency response measurements.

### 8.2.1 Audio outputs for passive speaker systems

Final stage capacity	$Z_N \geq 2 \Omega (\pm 20\%)$	Switch-off of the final stage is not permissible
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Note: Capacitive loads must not lead to the final stages being switched off.

System amplification:	$U_A = 4,5 V_{RMS} (\pm 1 \text{ dB})$	CD [-20 dB <sub>FS</sub> ]; $R_L = 4 \Omega$ ; volume max.
-----------------------	--	--

Nonlinear distortion factor:	THD < 0,2%;	CD [-10 dB <sub>FS</sub> ]; $U_A = 1,41 V_{RMS}$
------------------------------	-------------	--

Signal-to-noise ratio:	$S/N \geq 85 \text{ dB}$	CD [-10 dB <sub>FS</sub> ]; $U_A = 8 V_{RMS}$
------------------------	--------------------------	---

The measurement for  $U_B = 10,8 \text{ V}$  shall be performed directly after the measurement at  $U_B = 14,0 \text{ V}$  without changing the volume control and the FM shift; an increase in the nonlinear distortion factor is not permissible.

System amplification for audio sources with their own volume control:

Telephone:	$U_A = 3 V_{RMS} (\pm 1 \text{ dB})$	call 0 dB; $R_L = 4 \Omega$ ; volume max.
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SBS:(audio-response system)	$U_A = 3 V_{RMS} (\pm 1 \text{ dB})$	SBS 0 dB; $R_L = 4 \Omega$ ; volume max.
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#### 8.2.1.1 Audio continuous power, system cooling

The heat sink shall be designed with sufficient thermal capacity and radiation surface in order to guarantee a stable power output for  $t = 20 \text{ min}$  without level reduction at the max. power loss for the entire system, independent of the test signal and the audio settings.

The test is performed at a raised ambient temperature.

At raised ambient temperatures, reduction of the LF output power shall be provided for, which shall prevent the permissible outer housing temperature from being exceeded.

Measurement:

- Ambient temperature  $T = 40 \text{ }^\circ\text{C}$
- LF sinusoidal continuous power  $P_D = 4 \times 4 \text{ Watt}$  at  $R_L = 4 \Omega$ ;
- Modulation 400 Hz
- Duration 30 minutes
- No reduction in power
- No increase in the nonlinear distortion factor and
- heat sink temperature  $T_K \leq T_{Kmax}$

Max. permissible outer housing temperature ( $T_{Kmax}$ )

Heat sink at rear:	$T_{Kmax.} \leq 100 \text{ }^\circ\text{C}$
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Heat sink at side:	$T_{Kmax.} \leq 120 \text{ }^\circ\text{C}$
--------------------	---

Note: For heat sink arrangements on the back of the housing, the possibility that cables will lie directly on the heat sink cannot be excluded; therefore the permissible surface temperature is lower.

### 8.2.2 Audio outputs for sound systems (line/AUX out, rear seat entertainment)

Requirements of audio signals for further processing by sound systems with active amplifier units without active volume, sound and geometry setting options.

Layout: ground-free; symmetrical

The CD signal 1kHz, -10 dB<sub>FS</sub> serves as the reference point.

#### 8.2.2.1 General sound systems

Layout: ground-free, symmetrical

Internal resistance:  $R_i \leq 10 \Omega$

LF level:  $U_A = (2,7+0,3) V_{RMS}$ ; CD -10 dB<sub>FS</sub>;  $R_L = 100 \Omega$ ;  $U_A = \text{Volume max.}$

Nonlinear distortion factor:  $k \leq 0,3 \%$  CD -10 dB<sub>FS</sub>;  $U_A = \text{Volume max.}$

Nonlinear distortion factor:  $k \leq 1 \%$  CD 0 dB<sub>FS</sub>;  $U_A = \text{Volume max.}$

Signal-to-noise ratio:  $S/N \geq 90 \text{ dB}$  CD 0 dB<sub>FS</sub> /silence;  $U_A = 4 V_{RMS}$

Procedure:

The LF level measurement shall be performed with the volume control in its max. position.

For the S/N measurement, the CD reference signal shall be raised to 0 dB<sub>FS</sub> and an LF reference level of 4,0 V shall be set using the volume control.

Note:

On the source side, a distortion-free signal is made available. Internal overmodulation must be detected and fully stabilized. The maximum usable LF level shall be reached and the output signal shall not wobble.

Provision shall be made in the amplifier for sufficient amplification reserve for sources with lower modulation amplitude by defining the full-modulation amplitude level (< 4 V).

#### 8.2.2.2 BOSE®

System amplification:  $U_A = 4,0 V_{RMS} (\pm 1 \text{ dB})$  CD=0 dB<sub>FS</sub>;  $R_L = 100 \text{ Ohm}$ ; volume max.

Signal-to-noise ratio: see Bose® Bluebook

Nonlinear distortion factor: see Bose® Bluebook

Fulfillment of BOSE® specification:

"BOSE® OEM Music System Electrical Specifications" (Blue Book), Revision n, Date n

(n = version valid at the start of the project)

#### 8.2.2.3 Other sound systems

System-specific specification according to performance specifications or drawing.



### 8.2.3 Audio outputs for sound systems with full level input

Requirements of audio signals for further processing by sound systems with active amplifier units with active volume, sound and geometry setting options in networked sound systems.

Layout:	ground-free, symmetrical		
Internal resistance:	$R_i \leq 10 \Omega$		
LF level:	$U_A = 4,0 V_{RMS} (\pm 1 \text{ dB});$	CD 0 dB <sub>FS</sub> ;	$R_L = 100 \Omega$
Nonlinear distortion factor:	$k \leq 0,1 \%$	CD 0 dB <sub>FS</sub> ;	$R_L = 100 \Omega$
Signal-to-noise ratio:	$S/N \geq 90 \text{ dB}$	CD 0 dB <sub>FS</sub> /silent;	

### 8.2.4 LF background noise

Volume control minimum (mute + 1 increment),

Measurement evaluated, with filter according to CCIR 468

Max. permissible noise voltage for systems with final stages with analog signal input

Power output  $\leq 240 \mu V$

Line out  $\leq 65 \mu V$

(system-specific deviations possible)

Max. permissible noise voltage for systems with final stages with digital signal input

Power output  $\leq 50 \mu V$

Line out  $\leq 30 \mu V$

### 8.2.5 Clipping

Frequency independent  $k_{max}$  according to limit value curve, brand-specific according to drawing.

Measuring conditions:

- FM shift:  $\pm 75 \text{ kHz}$
- or CD:  $-7 \text{ dB}_{FS}$
- Modulation 20 Hz to 8 000 Hz
- Volume control Maximum
- Supply voltage 14,0 V
- All bass/treble controls in maximum position
- Measurement with 20-kHz low-pass filter

The specified, frequency-specific limit value must not be exceeded. The maximum usable LF level must be achieved. The output signal shall not wobble.

### 8.2.6 THD over power

The nonlinear distortion factor performance of the audio final stage shall be evaluated without clipping.

Measuring conditions:

- All bass/treble controls in linear position
- Clipping deactivated
- CD -10 dB FS
- Modulation 100 Hz, 1 kHz, 10 kHz
- Volume control Maximum
- Supply voltage 14,0 V
- Load 4  $\Omega$
- Measurement range 0,1 W to 30 W

Limit values:

Standard final stages:	100 Hz, 1 kHz:	0,1 W to 10 W	< 0,01 %
	10 kHz:	0,1 W to 10 W	< 0,2 %
High-efficiency final stages:	100 Hz, 1 kHz:	0,1 W to 2 W	< 0,02 %
		2 W to 10 W	< 0,2 %

### 8.2.7 Volume range

See Section 11.1.8. CD

## 8.3 Audio frequency response

Measuring conditions:

Using the LF control, an output power of 1 W (2 V/4  $\Omega$ ) for power outputs or 1 V for line outputs shall be set.

The further level settings shall be created without changing the volume control but by varying the input signal instead.

In the range 20 Hz to 20 000 Hz, the following frequency responses shall be recorded with the bass/treble control in the minimum/center/maximum positions and deactivated vehicle equalizing (EQ = flat).

Power outputs:

- at 1 W Frequency response brand-specific according to drawing or function description.
- at 0,5 W Frequency response brand-specific according to drawing or function description.
- at 0,1 W Frequency response brand-specific according to drawing or function description.

Line outputs:

- at 1 V Frequency response brand-specific according to drawing or function description.
- at 0,5 V Frequency response brand-specific according to drawing or function description.
- at 0,1 V Frequency response brand-specific according to drawing or function description.

Reference output powers shall be set via the FM shift with 1-kHz LF signal while the volume control setting remains unchanged. The preemphasis shall be switched ON.

Please note: The country-specific preemphasis shall be considered.

The documentation of all the sound curves in every possible setting and the loudness character are part of the sample delivery.

The frequency responses are designed so that they are different device-specifically and vehicle-specifically.

They depend on the target customer group. A specification in the standard is not possible. The following frequency responses are part of the performance specifications or the drawing.

### **8.3.1 Loudness**

With rising LF level the increases will continually decrease.

Measuring conditions:

LF control maximum; with the FM shift, the reference point for full-modulation amplitude shall be set to 1 000 Hz according to Section 8.2.1; using the volume control, the level is reduced in 10-dB steps, to -50 dB.

The frequency response with gliding modulation frequency from 20 to 20 000 Hz is to be recorded.

Loudness character: brand-specific according to drawing

For devices with multiple uses, provision shall be made for various loudness curves for:

- 2-channel operation,
- 4-channel operation,
- operation on sound systems.

### **8.3.2 Frequency response for AM**

AM reference signal:  $m = 30\%$ , 1 kHz

No loudness in AM operation.

Frequency response specification according to the project-specific stipulation in the performance specifications AU-S.

### **8.3.3 Frequency response for FM**

FM reference signal:  $\Delta f \pm 12,5$  kHz, 1 kHz, country-specific preemphasis 50  $\mu$ s or 75  $\mu$ s ON.

Frequency response specification according to the project-specific stipulation in the performance specifications AU-S.

### **8.3.4 Frequency response for digital data carriers**

Frequency response determination by means of data carrier-specific reference signal.

CD: measurement CD, e.g.: A-bex TCD-781.

Frequency response specification according to the project-specific stipulation in the performance specifications AU-S.

### **8.3.5 Frequency response for DAB and SDARS**

Frequency response determination by means of suitable test signals via signal generator.

Frequency response specification according to the project-specific stipulated performance specifications AU-S.

### **8.3.6 Frequency response for telephone**

“Linear”, like CD

For supplementary playback requirements, see: “Spezifikation der Audio/Mute – Schnittstelle zwischen Telefon/Telematik-SG und Radio-SG” [Specification of the Audio/Mute Interface between the Telephone/Telematics Control Unit and Radio Control Unit], Chapter: “Mute-Grund spez. Anforderungen an die Audiosenke” [Reason for Mute, Specific Requirements of the Audio Sink].

### 8.3.7 Frequency response for traffic audio memory

Design only speech reproduction,  
balanced frequency response,  
greatly restricted control scope.

Minimum bandwidth:  $\geq 8$  kHz

S/N  $\geq 50$  dB

Recording duration:  $\geq 8$  min

### 8.3.8 Vehicle-specific sound curve, frequency response for traffic audio memory

Measurement of all codable sound curves according to the performance specifications in the center (neutral) bass/treble control position, loudness deactivated.

Reference output power 1 W (2 V/4  $\Omega$ ).

## 8.4 Control capacity of the volume, geometry and bass/treble controls

Brand-specific data according to drawing

Source-dependent control scope.

System-specific according to the relevant system specification: e.g. BOSE®, MONSOON®, ...

### 8.4.1 Balance

The ratio of the LF output voltages of both channels (L/R and R/L) in the respective control end positions.

Limit values and profile are brand- or system-specific according to the relevant function description AU-S.

### 8.4.2 Fader

The ratio of LF output voltages front/rear and rear/front.

Limit values and profile are brand- or system-specific according to the relevant function description AU-S.

For systems with acoustically corrected "neutral positions", it must be ensured that:

- in the fader end positions, the relevant loudspeaker groups achieve their maximum output power (see Section 8.2.1).
- there is an intermediate position in which all loudspeaker groups achieve their maximum output power.

**Bass equalization:** A bass loss through fader adjustment shall be equalized smoothly via a loudness increase to +3 dB in the relevant fader end position!

### 8.4.3 Bass

Limit values and profile are brand- or system-specific according to the relevant function description AU-S.

The control scope is limited at higher volume settings.

#### **8.4.4 Middle**

Limit values and profile are brand- or system-specific according to the relevant function description AU-S.

The control scope is limited at higher volume settings.

#### **8.4.5 Treble**

Limit values and profile are brand- or system-specific according to the relevant function description AU-S.

The control scope is limited at higher volume settings.

#### **8.4.6 Volume**

The following specifications are general approximate values. Concept-specific deviations are permitted according to performance specifications or drawing.

For the volume regulation function, a logarithmic, degressive profile shall be striven for. An approximation by means of a fixed increment in various intervals is permissible.

The following applies to digital volume controls (encoders):  $1 \text{ dB} \leq \text{increment} \leq 3 \text{ dB}$

Minimum control scope  $\geq 80 \text{ dB}$  (minimum/maximum sound level setting)

Volume control center position (50% of the setting range):  $-15 \pm 6 \text{ dB}$

Volume control zero position: mute (attenuation  $\geq -86 \text{ dB}$ ).

Limit values and profile are brand- or system-specific according to the relevant function description AU-S.

### **8.5 Reception-quality-dependent sound influence for FM**

The reception-quality-dependent sound influence shall cover reception interference. Short-term interference events ( $\leq 15 \text{ ms}$ ) can be suppressed using mute. In order to maintain a balanced tone, highs and lows must be processed in the same way.

A loudness compensation shall be produced over the sound level, if required.

Effect:

Quick response during signal deterioration level dip/multipath

Slow release during continuous signal improvement -> time hysteresis; the release time constants are variable, depending on the degree and duration of the interference events; indifferent states are not permissible; the sound change shall take place in as many ( $\geq 5$ ) and as small ( $\leq 2 \text{ dB}$ ) unperceivable steps as possible.

#### **8.5.1 Hi-cut**

The FM frequency response already includes a static hi-cut. In addition, a dynamic hi-cut depending on the reception quality (RF level, multipath, ...) is required.

Reference point: 10-kHz point of the LF frequency response curve

Limit values and profile are brand- or system-specific according to the relevant function description AU-S.

The control scope and the time profile are tuned in the field trials.

### 8.5.2 Low-cut (*proposal in preparation*)

Reduction of the bass portion when the hi-cut responds, in order to compensate for a muffled sound impression. An appropriate algorithm shall be implemented.

Reference point: mid frequency of the bass curve

Response thresholds analogous to hi-cut.

The control scope and the time profile are tuned in the field trials.

## 8.6 Speed-dependent corrections of the audio signal

Digital speed signal per CAN, see CAN performance specifications.

LF evaluation: graphic profile with  $v$  = rising and  $v$  = falling

Speed range: 0 to  $n$  km/h according to performance specifications

Speed hysteresis: approx. 10 km/h

Change in level shall be only step-by-step,  $(n \pm 1)$  max. 1,25 dB/step.

Reaction to power supply system interference is not permissible.

Detailed descriptions, see function descriptions for GALA (speed-sensitive volume control)/GADK (speed-dependent dynamic compression).

## 8.7 Audio inputs

Audio inputs shall be fully symmetrical and metallically separated (at least capacitively decoupled).

For sources with quasi-symmetrical interface, the ground connections of the right and left signals shall be combined (quasi-symmetrical = 3 lines to the outside).

The ground connections of different sources shall be decoupled.

“Open inputs” must be insensitive to coupled interference.

Frequency range: linear ( $\pm 1$  dB) in the range from 20 Hz to 20 kHz

In-phase suppression for all audio inputs  $\geq 60$  dB (measured with interference signal 2 VRMS; 200 Hz to 15 kHz, LF reference output signal 1,4 V at 0 dB input)

Input impedance:  $\geq 4,7$  k $\Omega$

S/N  $\geq 80$  dB (measured at the relevant max. input level in relation to the open input)

### 8.7.1 Stereo input for external media (CD changer/player, MD changer/player)

Layout: quasi-symmetrical, two channels.

Overmodulation protection:

Max. LF input level at 0 dB<sub>FS</sub> fix,  $(1,8 + 0,3) V_{RMS}$ ,  $k \leq 0,1\%$

### 8.7.2 Stereo input for external media (AUX)

Layout: quasi-symmetrical, two channels.

Overmodulation protection: up to  $4 V_{RMS}$  with  $k \leq 0,1\%$

### 8.7.3 Audio input for telephone

Two-channel LF input: fully symmetrical and ground-free  
Terminating resistor in radio: 100  $\Omega$  (necessary for diagnosis in telephone)

The following details refer to the additional performance specifications: "Specification of the Audio/Mute Interface..."

Source change-over behavior: chapter: Temporal sequence according to Figure 3  
Audio input level: chapter: LF processing/voice signal level  
Reference input level: nominal level 1,8 Vrms (at -3 dBFS digital) (section 7.1)  
Overmodulation protection: U LF max. = (2,55 + 0,43) Vrms ( $\hat{=}$  0 dBFS digital)  
(with U LF max. = 8,4 Vpp)

## 9 Cassette operation, cassette drive requirements

General test conditions according to Section 4.

Test cassettes C 60 according to DIN EN 60094-7  
BASF <sup>7)</sup> CC-CO Item No. 47818  
TEAC MTT-211 NA, MTT 256 U, MTT 356 U

Testing shall be performed with original assembly of the cassette-radio combination.

### 9.1 Cassette running and reproduction requirements

#### 9.1.1 Operating positions

Operation without interference in as- 1) 10° to +30°  
installed positions: 2) +20° to +60°

#### 9.1.2 Cassette speeds

Play speed 4,75 cm/s  
Rewind time for C 60 cassettes  $\leq$  120 s <sup>8)</sup>  
Static = unit in rest position  
Dynamic = excitation in test frame in as-installed position

##### 9.1.2.1 Drift

Measurement: according to DIN IEC 60386 after 10 minutes of operation,  
mean value formed from 30 s measurement time  
both running directions have to be measured  
Dynamic excitation Frequency sweep 1 octave/min, logarithmic  
Frequency (10 - 200 - 10) Hz  
Acceleration 0,35 g horizontally/vertically  
Drift, static + (1 +2/-1) % at RT

<sup>7)</sup> This cassette is to be used for arbitration measurements.

<sup>8)</sup> Approximate value; deviation depending on concept according to drawing.

Drift, dynamic  $+ (1 \pm 3) \%$  at operating limit temperature  
dynamic value = static value  $\pm (\leq 0,5)\%$

Permissible deviation

between the running directions  $\leq 1,5 \%$

within the running time up to 30 min  $\leq 1,5 \%$

#### 9.1.2.2 Wow & flutter

Static  $\leq 0,3 \%$   
 $\leq 0,5 \%$  at  $-18 \text{ }^{\circ}\text{C}$

Dynamic  $\leq 0,5 \%$

Measurement as in Section 9.1.2.1, evaluated according to DIN

#### 9.1.3 LF response

Normal setting BIAS/iron oxide 120  $\mu\text{s}$  EQ

Special setting BIAS/metal and  $\text{CrO}_2$  70  $\mu\text{s}$  EQ

Frequency response according to drawing, measuring cassette in playing direction, side "A" or side "1"

#### 9.1.4 Crosstalk attenuation (channel separation) L/R and R/L (CH 1-2/3-4)

Measured with 1-kHz filter  $\geq 40 \text{ dB}$  (typically 50 dB)

#### 9.1.5 Opposite track crosstalk

Normal/reverse and reverse/normal (CH 2-3, CH 1-4)

Measured with 1-kHz filter  $\geq 50 \text{ dB}$  (typically 60 dB)

#### 9.1.6 Unweighted signal-to-noise ratio, normal/reserve and reserve/normal

Measured and evaluated with CCIR 468 filter, RMS  $\geq 46 \text{ dB}$

Setting of reference value without filter.

#### 9.1.7 Cassette pause recognition

##### 9.1.7.1 Music search system (stop recognition by modulation pauses)

Test cassette:

Useful modulation = FF/FR sequence 315 Hz  $\geq$  full level -36 dB

Pause = stop FF/FR  $t \geq 3 \text{ s}$   $\leq$  full level -44 dB

Pauses with  $t \geq 3 \text{ s}$  shall be reliably recognized.



#### **9.1.7.2 Skip blank (FF start recognition by modulation pause)**

Conditions for an FF start:

Pause modulation  $\leq$  full level -36 dB

Pause time  $t \geq 15$  s, start FF after  $t = 10$  s

(Interference peaks in the modulation pause must not lead to counter reset).

#### **9.1.8 Noise suppression (e.g. Dolby B)**

Erased cassette 120  $\mu$ s  $\geq$  (-8) dB

Erased cassette 70  $\mu$ s  $\geq$  (-8) dB

Measured with filter acc. to CCIR 468.

#### **9.1.9 Actuating forces**

##### **9.1.9.1 Mechanical drive buttons (FF, FR, Reverse, Eject)**

Load/displacement curve continuous.

Load/displacement behavior concept-specific according to drawing or performance specifications.

The load/displacement curve has to be recorded and is part of the sample delivery.

Push-through force of keys  $\geq 100$  N shall not influence function of key mechanism

##### **9.1.9.2 Cassette insert**

Insertion force  $\leq 10$  N

The transfer point must be located outside the trim.

##### **9.1.9.3 Cassette ejection force**

Ejection of the cassettes with maximum weight = 72 g must be insured.

Test cassette: e.g. TEAC MTT-900 WT

#### **9.2 Endurance test**

##### **9.2.1 Endurance test of drive**

After the endurance test, all functions must be ensured.

Permissible deviations from the calibration values according to Section 10.1.

Before the measurement, the cassette mechanism and the sound head are to be cleaned.

Wow & flutter max. 0,4%

Drift (static)  $\pm 1,5$  %

Endurance test:

Total number of cycles	14 000
of these	10 000 at RT 3 000 at +60 °C 1 000 at -10 °C
1 cycle	consists of cycles A and B separate testing with (n times A) and (n times B) is permissible

Endurance test, two-direction drive.

**Cycle A: play – eject**

insert – play 11s – reverse – play 10 s – eject – insert – ...

**Cycle B: FF-FR**

insert – FF 5 s – play (5 to 10) s – rew 5 s – play (5 to 10) s – FF 5 s – ...

Test cassette	C 90 according to DIN EN 60094-7 Replace cassette after approx. 2 000 cycles
Test temperatures	DIN 50014 - 23/50-2 +60 °C, -10 °C

**9.2.2 Endurance test of sound head**

During the endurance test according to Section 10.2, a minimum service life of  $\geq 1\,500$  h shall be achieved with a frequency drop of  $\leq 6$  dB as compared to unused condition.

Before the measurement, the cassette mechanism and the sound head shall be cleaned.

Measuring method:

Test cassettes	C 60 and C 90 standard
Measuring cassette	8 kHz azimuth calibrated cassette
Total test duration	1 500 h
Test cassette replacement	every 100 h
Sound head cleaning	after 100 h operation with ethanol-saturated fabric tape
Device adjustment	Volume control to be set so that nonlinear distortion factor $K_{tot}$ of output voltage at speaker substitute resistor = 1%. Fix control setting and set bass/treble controls to mechanical center. Set gap angle to maximum reproduction level. After the endurance test, readjust sound head and determine reproduction level.
Minimum life	$\geq 1\,500$ h

**9.2.3 Climatic and aging tests according to radio unit**

Operating temperature (-18 to +60) °C.

**10 MiniDisc operation (MD requirements)**

General test conditions according to Section 4.

Audio signal evaluation with integrated MD player/changer at audio line output, with external MD player/changer at its line output or at control unit input with original control unit as termination or termination simulation.

Test MDs: SONY test MD

TGYS-1

TDYS-1

PATD-M01

PATD-M02

PATD-M03

MD insertion force  $\leq 5 \text{ N}$

Autoreload (automatic MD insertion if not removed)  $t = 10 \text{ s}$

Access times:	Load	$\leq 10 \text{ s}$	
	Stop – Play	$\leq 8 \text{ s}$	
	Track up/down	$\leq 3 \text{ s}$	
	Eject	$\leq 3 \text{ s}$	
	Disc change	$\leq 8 \text{ s}$	only for MD-X

## 10.1 Playback requirements

### 10.1.1 Output level

Measuring condition 1 kHz, 0 dB full level with 20-kHz low-pass filter

Level  $U_{LF} = (1,8 \pm 0,3) V_{RMS}$  (only external MDs)

Channel difference  $L/R \leq 2 \text{ dB}$

### 10.1.2 Unweighted signal-to-noise ratio (S/N)

(measured with filter according to CCIR 468)

Set LF level -10 dB<sub>FS</sub> reference point, then set zero bit in relation.

Ratio  $\geq 74 \text{ dB}$  MD drive in radio

Ratio  $\geq 80 \text{ dB}$  MD drive component

### 10.1.3 Channel separation

(measured with CCIR 468 filter)

R-CH: 1 kHz, 0 dB/L-CH: zero bit

L-CH: 1 kHz, 0 dB/R-CH: zero bit

Separation  $\geq 60 \text{ dB}$

### 10.1.4 Total nonlinear distortion factor

(20-kHz low-pass filter)

1 kHz full level,  $L = R = 0 \text{ dB}$

$k \leq 0,1 \%$

### 10.1.5 Error correction

All tracks shall be completely reproduced.

**Table 8 – Error correction**

Error type	Error dimension	Measurement MD
black band	0,3 mm	PATD-M01
red band	0,5 mm	PATD-M02
finger print	Tr. 16,17	PATD-M03

### 10.1.6 Vibration behavior, sinusoidal

10 Hz to 100 Hz 1,5 g vertically/horizontally

Anti-skip audio memory <sup>9)</sup>  $\geq 8$  s

Sound reproduction interruptions shall not be audible.

### 10.1.7 Frequency response

Max. variation of level in the 20 Hz to 16 kHz range:  $\leq 1$  dB.

### 10.1.8 Volume range

Minimum volume range  $\geq 72$  dB

Set measurement MD, track 1 kHz -10 dB<sub>FS</sub>/1 kHz -90 dB<sub>FS</sub> in relation

## 10.2 Endurance test

Tests in addition to Section 6.

After the endurance test, all functions must be available without restriction; sacrifice in reproduction performance will not be accepted. Access times may be extended by max. 25%, forces may change by max. 25%, but must be within the defined limits.

### 10.2.1 Single MD player endurance test

MD player 5 000 cycles

Insertion an MD (auto start)

1 cycle consists of:

“Start”

“Play” approx. 10 s

“Track Up” random

“Play” approx. 10 s

“Track Down” random

“Play” approx. 10 s

“Eject” approx. 20 s

(auto insert to be performed within 20 s after Eject)

<sup>9)</sup> Drives that fulfill these requirements without audio memory shall be confirmed on the Volkswagen test circuit (various poor surfaces on the Volkswagen proving grounds).

### 10.2.2 MD changer endurance test

Fill changer with n-1 MDs (1 empty slot).

Cartridge change: Eject-Insert	4 000 cycles
MD change	10 000 cycles
1 cycle consists of:	
“CD selection”	random (20 s “play”)
“Track Down”	random (10 s “play”)
“Fast Rewind”	10 s
“Play”	10 s

### 10.2.3 Continuous operation

Continuous playing operation 1 500 h  
(for MD-X maximum complement)

### 10.2.4 Operating temperature

See Section 5.1.1

Completely complying with specification in entire operating range.

(A protection shut-off is permissible starting at +65 °C.)

## 11 CD, DVD audio operation

General test conditions according to Section 4.

Audio signal evaluation with integrated CD, DVD player/changer at audio line output, with external CD, DVD player/changer at its line output or at control unit input with original control unit as termination or termination simulation.

Test CDs, e.g.:

Philips	test CD No. 3
Technics	test CD CDT-002
A-BEX	TCD-781/782
A-BEX	TCD-725 A/726

CD, DVD insertion force  $\leq 5 \text{ N}$

Autoreload (automatic CD, DVD insertion if not removed)  $t = (15 \pm 5) \text{ s}$

Access times:	Load	$\leq 10 \text{ s}$	
	Stop – Play	$\leq 8 \text{ s}$	
	Track up/down	$\leq 3 \text{ s}$	
	Eject	$\leq 3 \text{ s}$	
	Disc change	$\leq 8 \text{ s}$	only for CD, DVD-X

NOTE: For safety reasons, autoreload must work when the device is “OFF” and/or in “safe lock” mode.

## 11.1 Playback requirements

### 11.1.1 Output level

Measurement condition: 997 Hz, 0 dB full level with 30-kHz low-pass filter

Level  $U_{LF} = (1,8 \pm 0,3) V_{RMS}$  (only external CD)

Channel difference  $L/R \leq 1,0$  dB

### 11.1.2 Signal-to-noise ratio (S/N)

For CD player and changer, DVD player and changer (measured using the filter CCIR 468 unwt'd.).

Set LF level -10 dB<sub>FS</sub> reference point at  $U_{LF} = 0,5 W/4 \Omega$ , then set zero bit in relation.

Only the drive component without further downstream signal processing, measured at the CD Line Out.

Ratio  $\geq 90$  dB

Drive integrated in system, measured at the audio output of the control unit.

Limit value  $\geq 80$  dB

### 11.1.3 Channel separation

(measured using CCIR 468-3 filter)

R-CH: 1 kHz, 0 dB/L-CH: zero bit

L-CH: 1 kHz, 0 dB/R-CH: zero bit

Separation:  $\geq 60$  dB for analog input  $\geq 74$  dB for digital input

### 11.1.4 Total nonlinear distortion factor

(30-kHz/10-kHz low-pass filter and 400-Hz high-pass filter)

Track	No. 5/3	(997 Hz = L 0 dB)
	No. 9/3	(997 Hz = R 0 dB)
	$k \leq 0,02$ %	(measured at Line Out)
	$k \leq 0,3$ %	(measured at Power Out P=1 W)

### 11.1.5 Error correction

All tracks shall be completely reproduced.

**Table 9 – Error correction**

Error type	Error dimension
black band	0,8 mm
notch/scratch	0,8 mm
finger print	65 µm

### 11.1.6 Vibration behavior/playability, sinusoidal

10 Hz to 100 Hz in 1-Hz steps every 10 s                      2,0 g in as-installed position in all 3 planes  
Anti-skip audio memory    according to performance specifications  
Sound reproduction interruptions shall not be audible.

### 11.1.7 Frequency response

(Test CD: TCD 781)

Maximum variation of level in the 20 Hz to 16 kHz range  $\leq 1$  dB.

### 11.1.8 Volume range

Minimum volume range     $\geq 72$  dB  
Set measurement CD, track 1 kHz -10 dB<sub>FS</sub>/1 kHz -90 dB in relation (e.g. Abex TCD 781)  
Measured with filter A.

## 11.2 Endurance test

Tests in addition to Section 6.

After the endurance test, all functions must be available without restriction; sacrifice in reproduction performance will not be accepted. Access times may be extended by max. 25%, forces may change by max. 25%, but must be within the defined limits.

Visible wear on the CDs used for the endurance test must not influence playing quality.

Implementation of the endurance test analogous to Section 6.4.1 at various temperatures.

### 11.2.1 Single CD, DVD player endurance test

CD, DVD player    10 000 cycles  
Insertion of a CD/DVD    (auto start)  
1 cycle consists of:  
“Start”  
“Play”    approx. 10 s  
“Track Up”    random  
“Play”    approx. 10 s  
“Track Down”    random  
“Play”    approx. 10 s  
“Eject”    approx. 20 s  
(auto insert to be performed within the period after Eject)

### 11.2.2 CD, DVD changer endurance test

Fill cartridge with n-1 CDs (1 empty slot).

- |  |                      |
|--|----------------------|
| a) Cartridge change: Eject-Insert  | 4 000 cycles         |
| In changers that do not have a magazine, an eject-insert takes place after each 10 cycles with every playback medium, changing in sequence |                      |
| b) CD, DVD changer   | 10 000 cycles        |
| 1 cycle consists of:   |                      |
| “CD selection”   | random (20 s “play”) |
| “Track Down”   | random (10 s “play”) |
| “Fast Rewind”  | 10 s                 |
| “Play”   | 10 s                 |

Implementation of the endurance test analogous to Section 6.4.1 at various temperatures.

### 11.2.3 Continuous operation

Continuous playing operation	1 500 h
------------------------------	---------

(for CD, DVD-X maximum complement)

Monitoring of the endurance test analogous to Section 6.4.1.

### 11.2.4 Operating temperature

See Section 5.1.1.

Completely complying with specification in entire operating range.

(A protection shut-off is permissible starting at +70 °C.)

## 12 Memory cards

The SD card push-in can contain memory cards with digitally saved audio data. All files (tracks) the format of which is supported by the system shall be played in play mode. Details (supported compression formats, bit rates, play sequences, displayed track information) shall be taken from the separate function performance specifications.

The supplier must ensure that SD cards announced in the entertainment industry or normally used in the market are supported (size, timing, formats).

The test signals for audio measurements shall be taken from the listed test CDs. To this end, the test tracks shall be transferred using suitable compression procedures in digital format and saved on the SD card.



Test CDs as signal sources e.g.

Philips	test CD No. 3
Technics	test CD CDT-002
A-BEX	TCD-781/782
A-BEX	TCD-725 A/726

Access times:	Load (file display)	$\leq 2 \text{ s}$
	Load (Play)	$\leq 5 \text{ s}$
	Stop – Play	$\leq 6 \text{ s}$
	Track up/down	$\leq 3 \text{ s}$

Max. insertion force: 14 N

Max. ejection force: 14 N

Min. number of read/playback accesses: 10 000 cycles

All standard commercial storage capacities shall be supported – including cards with more than 4 GB of storage.

## 12.1 Playback requirements

The audio signal evaluation is performed on the relevant audio output of the unit.

All audio signal requirements are identical to those of a CD.

### 12.1.1 Frequency response

Max. variation of level in the 20 Hz to 16 kHz range  $\leq 1 \text{ dB}$ .

## 12.2 Operating ranges

### 12.2.1 Operating voltages

Without further information the requirements according to VW 80101 apply.

### 12.2.2 Operating temperatures

Without further information the requirements according to VW 80101 apply. The operating and storage temperature ranges are defined therein, depending on the mounting location.

For example, for use in the dashboard, the requirements range 5 shall apply, or according to Section 5.1.1.

### 12.2.3 Vibration behavior, sinusoidal

10 Hz to 100 Hz 2,0 g in as-installed position in all 3 planes

Interference due to faulty contacting, etc., is not permissible.

### 12.3 Write requirements

Write termination due to unforeseeable external events. (undervoltage)	Triggers messages as described in the relevant HMI performance specifications. Subsequently: Run independent test of system. (Check the clusters and sectors). Test the terminated write process for completeness.
Write termination due to foreseeable events (memory cards eject, actuation of ON/OFF control, terminal 15 OFF)	Triggers messages as described in the relevant HMI performance specifications.
Deletion termination due to unforeseeable external events. (undervoltage)	Triggers messages as described in the relevant HMI performance specifications. Subsequently: Run independent test of system. (Check the clusters and sectors). Test the terminated write process for completeness.
Deletion termination due to foreseeable events (actuation of ON/OFF control, terminal 15 OFF).	Triggers messages as described in the relevant HMI performance specifications.

### 12.4 Endurance test

Tests in addition to Section 6.

After the endurance test, all functions must be available without restriction; sacrifice in reproduction performance will not be accepted. Access times may be extended by max. 25%, forces may change by max. 25%.

Read access to the memory card is tested. MP3 tracks are used as play files.

Implementation of the endurance test analogous to Section 6.4.1 at various temperatures.

#### 12.4.1 Endurance test of memory cards

Playback 15 000 cycles

One cycle corresponds to:

"Start"	
"Play"	approx. 10 s
"Track Up"	random number
"Play"	approx. 10 s
"Track Down"	random number
"Play"	approx. 10 s
"Pause/Stop"	approx. 20 s
"Insert/Eject"	5 000 cycles

#### 12.4.2 Continuous operation of SD card playback

Continuous playing operation 1 500 h

### 13 Hard disks (HDD) as audio source

A hard disk drive (HDD) present in the system can contain audio data. The audio data must be stored in a separate partition. The navigation data shall be stored on the hard disk in a different partition. Simultaneous operation (reading/writing of navigational and audio data) must be possible. The specified data must be adhered to even in mixed operation

All files (tracks) the format of which is supported by the system shall be played in play mode. Details (supported compression formats, bit rates, play sequences, displayed track information etc.) shall be taken from the separate function performance specifications.

The test signals for audio measurements shall be taken from the listed test CDs. To this end, the test tracks shall be transferred using suitable compression procedures in digital format and saved on the HDD.

Test signals analogous to:

Philips	test CD No. 3
Technics	test CD CDT-002
A-BEX	TCD-781/782
A-BEX	TCD-725 A/726

Access times:	Load (display of content from Power Off Mode)	≤ 6 s
	Load (play track from Power Off Mode)	≤ 10 s
	Load (display of content from Standby Mode)	≤ 3 s
	Load (play track from Standby Mode)	≤ 6 s
	Stop – Play	≤ 6 s
	Track up/down	≤ 3 s

General information:

- Operating time – disk ready: min. 20 000 h (20% duty cycle)
- Operating time – disk reading/writing: min. 4 000 h
- Motor start/stop cycle (Pwr On, Run, St-By, Sleep, Pwr Off): min. 300 000 times
- Emergency unload after unexpected voltage switch-off: min. 20 000 times

#### 13.1 Playback requirements

The audio signal evaluation is performed on the relevant audio output of the unit.

All audio signal requirements are identical to those of a CD.

## 13.2 Operating ranges

### 13.2.1 Operating voltages

Without further information the requirements according to VW 80101 apply.

### 13.2.2 Operating temperatures

Without further information the requirements according to VW 80101 apply. The operating and storage temperature ranges are defined therein, depending on the mounting location.

For example, for use in the dashboard, the requirements range 5 shall apply.

### Notes on the temperature cycle tests according to VW 80101:

- The electrical system load for the tests shall be coordinated with the engineering department.
- The aging times for the shock test (according to VW 80101) shall be set at 60 minutes due to the increased unit weight. An agreement must be reached with the Volkswagen Group engineering department as to whether these tests shall be conducted “under load” or “without load”.
- The required temperature cycle tests can lead to condensation in the HDD. This system must safeguard against this by deactivating the HDD and triggering a corresponding error message.

### 13.2.3 Vibration behavior, sinusoidal

10 Hz to 100 Hz                      2,0 g in as-installed position in all 3 planes

Anti-skip audio memory\*) according to performance specifications

Sound reproduction interruptions shall not be audible.

\*) Drives that fulfill these requirements without audio memory shall be confirmed on the Volkswagen test circuit (various poor surfaces on the Volkswagen proving grounds).

### 13.2.4 Air pressure resistance

Operating range: min. 5 000 m above sea level.

Nondestructive up to 12 000 m above sea level.

Change in air pressure: min. 300 m/min (3,1 kPa/min)

Ensuring the non-destruction of data when the max. height is reached. A warning message must be triggered prior to switch-off. The internal navigation corridor memory shall be filled prior to switch-off with new navigation data in order to enable directions to be given for the longest possible time.

### 13.3 Write/record/deletion requirements

Write termination due to unforeseeable external events. (undervoltage)	Triggers messages as described in the relevant HMI performance specifications.  Subsequently:  Run independent test of system. (Check the clusters and sectors).  Test the terminated write process for completeness.
Write termination due to foreseeable events (CD eject, actuation of ON/OFF control, terminal 15 OFF, achieving the maximum operating altitude)	Triggers messages as described in the relevant HMI performance specifications.
Deletion termination due to unforeseeable external events. (undervoltage)	Triggers messages as described in the relevant HMI performance specifications.  Subsequently:  Run independent test of system. (Check the clusters and sectors).  Test the terminated write process for completeness.
Deletion termination due to foreseeable events (actuation of ON/OFF control, terminal 15 OFF).	Triggers messages as described in the relevant HMI performance specifications.

### 13.4 Endurance test

Tests in addition to Section 6.

After the endurance test, all functions must be available without restriction; sacrifice in reproduction performance will not be accepted. Access times may be extended by max. 25%.

Write and read access to the HDD are tested.

#### 13.4.1 Endurance test of HDD recording and playback

Test medium is an audio CD with 60 minutes playtime and 10 to 15 tracks.

The recording cycle starts with recording during which the data is digitalized by the system and stored on the HDD. This is followed by repeated playback cycles and finally by the deletion of the audio data on the HDD. This recording cycle is repeated many times.

HDD recording cycle 50 cycles

A HDD recording cycle consists of:

"Start CD playback with compression on HDD"	
"50 x HDD playback cycle"	50 cycles
"Clear the HDD"	approx. 10 s
"S contact/terminal 15 OFF and pause"	approx. 20s

Here the following applies:

A HDD playback cycle corresponds to:

"Start/Play"	approx. 10 s
"Track Up"	random number
"Play"	approx. 10 s
"Track Down"	random number
"Play"	approx. 10 s
"Pause/Stop"	approx. 20 s

#### 13.4.2 Endurance test of HDD playback with rev up

Test medium is a hard disk filled with music. The rev up cycle starts when the device is switched on (UB). Next, playback of the audio data continues from the last track, in accordance with last mode.

HDD rev up cycle	5 000 cycles
"Start from Power Off mode/terminal 30 ON"	
"Start/Play"	approx. 10 s
"2xTrack Up"	
"Play"	approx. 10 s
"2xTrack Down"	
"Play"	approx. 10 s
"Pause/Stop"	approx. 20 s
"Disconnect the HDD from terminal 30"	

#### 13.4.3 Continuous operation of HDD playback

Continuous playing operation                      3 000 h  
(for MP3 15 GB "complement")

### 14 Referenced standards\*

TL 226	Paint Coating on Materials used in the Vehicle Interior Trim; Requirements
TL 965	Interference Emission; Requirements
TL 1010	Materials for Vehicle Interiors; Flammability, Material Requirements
TL 82066	Electromagnetic Compatibility of Automotive Electronic Components; Conducted Interference
TL 82166	Electromagnetic Compatibility of Automotive Electronic Components, Radiated Interference
TL 82366	Electromagnetic Compatibility of Automotive Electronic Components, Coupled Interferences on Sensor Cables

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\* In this Section, terminological inconsistencies may occur as the original titles are used.

TL 82466	Immunity to Electrostatic Discharges (ESD)
PV 1303	Non-Metallic Materials; Exposure Test of Passenger Compartment Components
PV 3964	Surfaces in the Vehicle Interior; Test of Resistance to Creams and Lotions
VW 01155	Vehicle Supply Parts; Approval of First Supply and Changes
VW 80101	Electrical and Electronic Assemblies in Motor Vehicles; General Test Conditions
VW 80104	Color and Brightness (Illumination) of Illuminated Surfaces and Symbols
VW 80106	Push-On Connection on and in Electric and Electronic Components in Vehicles; Requirements
VW 80660	Symbols for Operating Devices, Display Units and Indicator Lights
VW 91101	Environmental Standard for Vehicles; Vehicle Parts, Materials, Operating Fluids; Avoidance of Hazardous Substances
DIN ISO 10486	Passenger Cars; Car Radio Identification Number (CRIN)
DIN ISO 10599-1	Car Radios; Coaxial Aerial Connectors; Dimensions
DIN 45405	Noise Level Measurement in Sound Systems
DIN IEC 60386	Method of Measurement of Speed Fluctuations in Sound Recording and Reproducing Equipment
DIN EN 60315-4	Methods of Measurement on Radio Receivers for Various Classes of Emission - Part 4: Receivers for Frequency-modulated Sound Broadcasting Emissions
DIN EN 60094-7	Magnetic Tape Sound Recording and Reproducing Systems - Part 7: Cassette for Commercial Tape Records and Domestic Use
EC 74/60 EEC	Interior Trim, Cab
CCIR 468	Audio Filter according to CCIR Standard
NOTE Additionally required documents (will be made available by the engineering department).	
General Environmental Specifications Document for New Vehicles and Engine Projects	
CAN performance specifications	
MOST performance specifications	
Radio self-diagnosis performance specifications	
Infotainment dimensions specifications	
DAB	Eureka 147, ETSI EN 300 401, EN 50248
DRM	ETSI TS 101 980, ETSI TS 101 968
HD radio	FCC-02-286A2, FCC-02-286A3
SDARS (XM/Sirius)	XM/Sirius guidelines
DARC/VICS	ARIB STD-B3 and all further relevant guidelines of the ARIB (Association of Radio Industries and Businesses) on this topic