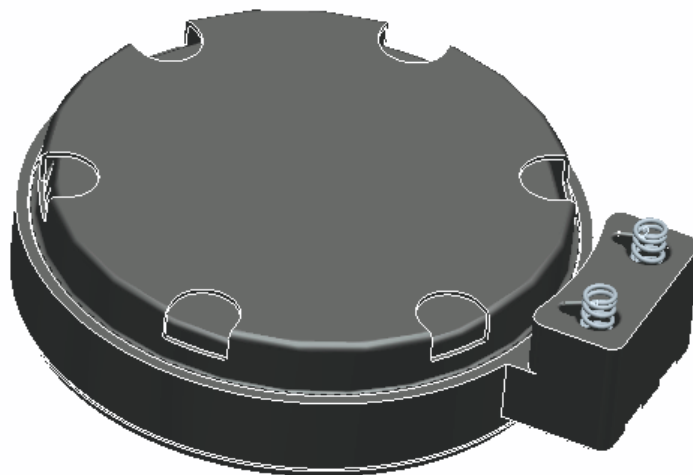
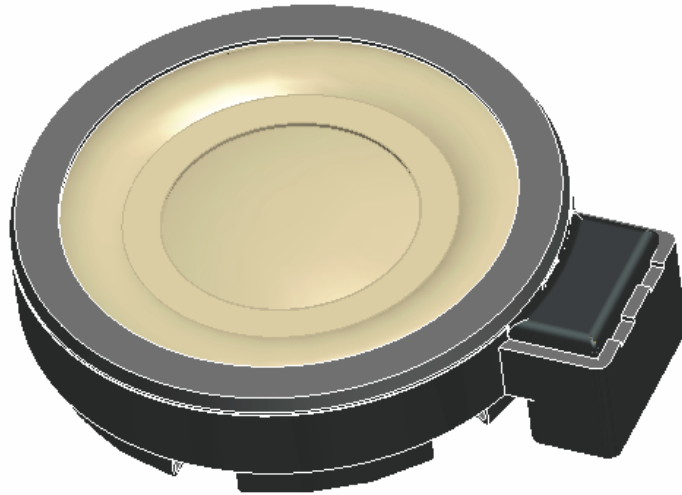




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SPEAKER-16-4.7-MFD

Change History

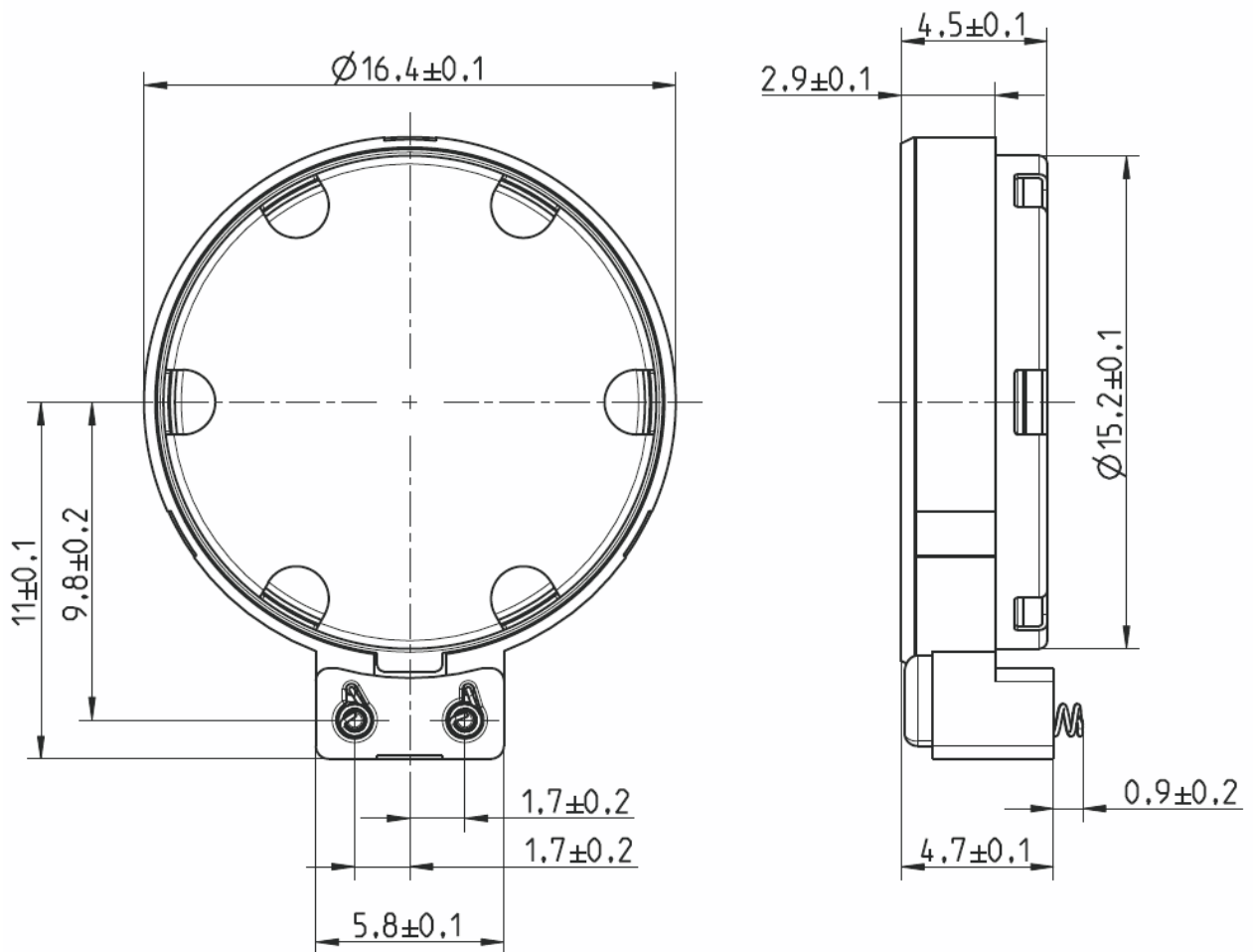
| Status | Version | Date | ECR | Comment / Changes | Initials of owner |
|---------|---------|----------|------|--|-------------------|
| Draft | A1 | 18.02.08 | | Draft specification for first samples | MW |
| Draft | A2 | 02.03.09 | | Draft specification for first samples | HW |
| Draft | A3 | 15.05.09 | | Draft specification for samples | HW |
| Release | A | 15.10.09 | | First released Version | HW/AH |
| Release | B | 07.12.09 | | Dimension update | HW/AH |
| Release | C | 27.01.10 | | Spring Force added | HW |
| Release | D | 15.02.10 | 2818 | Main tolerance and Handling Force update | HW |

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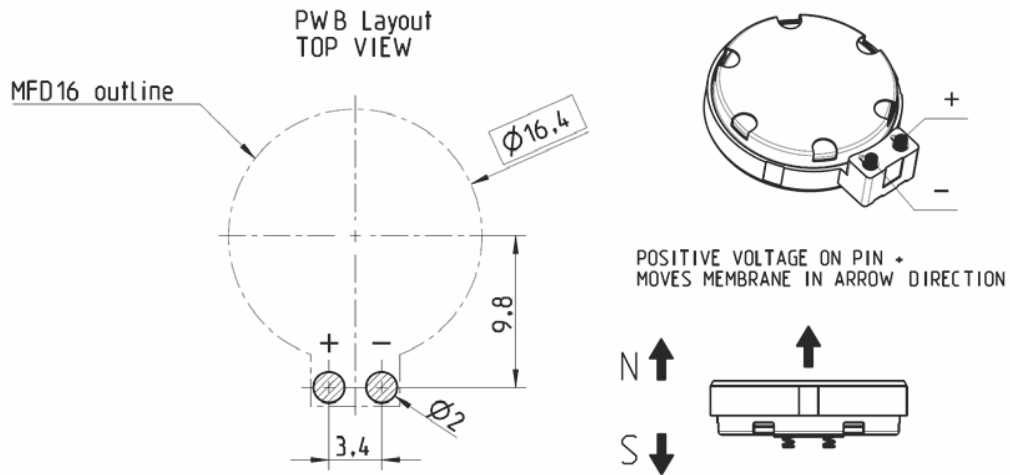
1. Mechanical Characteristics

1.1. Main Dimensions

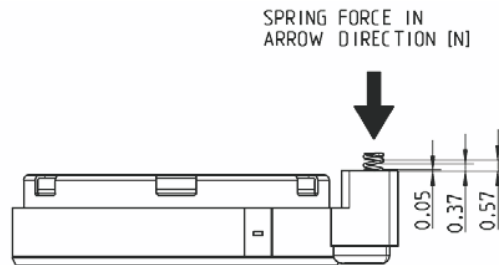


This product is non-automotive qualified

1.2. Contact Layout



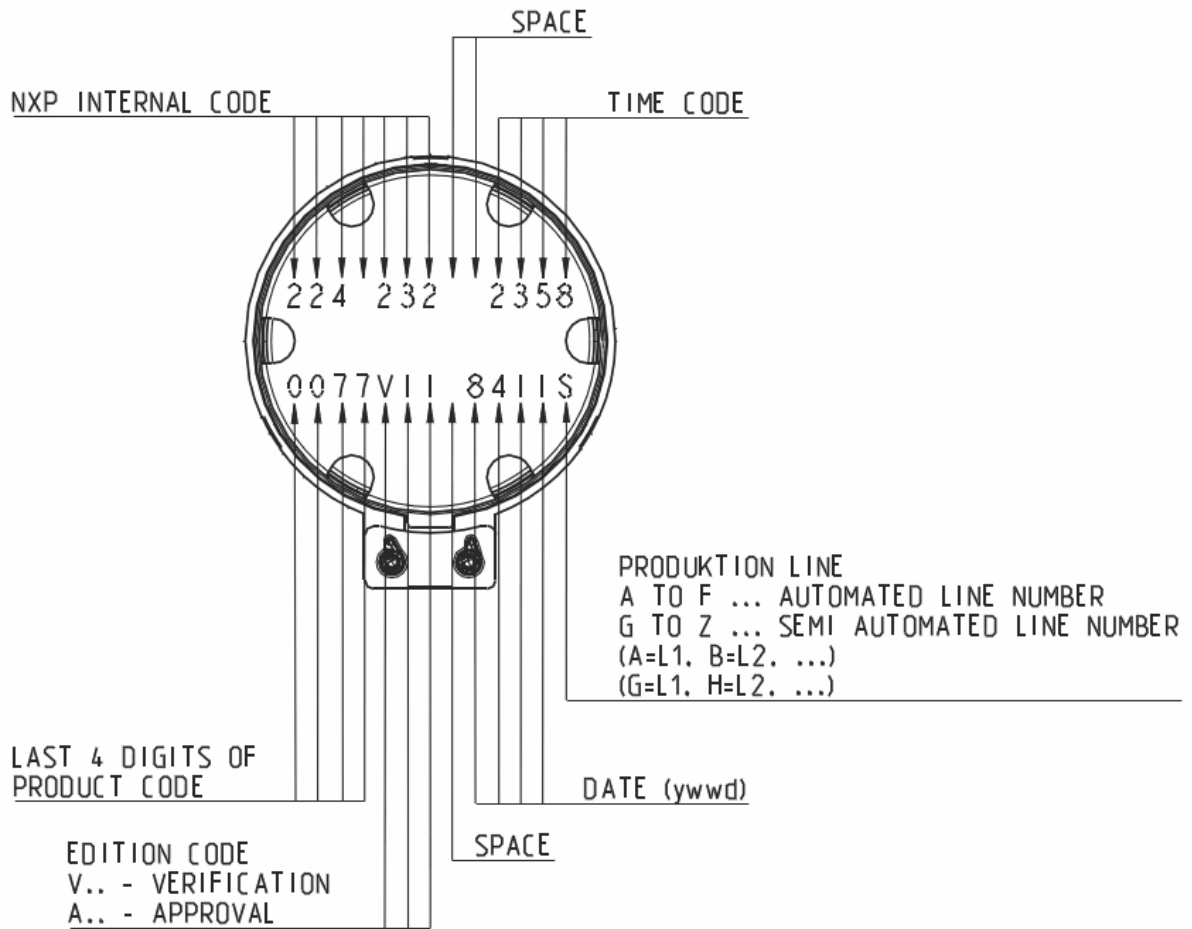
1.3. Contact Force



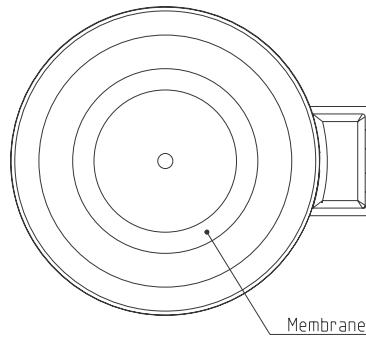
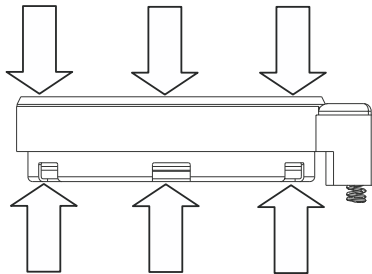
| SPRING FORCE TABLE | |
|----------------------|-----------|
| | FORCE [N] |
| SPRING FORCE AT 0.57 | 0.3 ±0.1 |
| SPRING FORCE AT 0.37 | MIN 0.35 |
| SPRING FORCE AT 0.05 | MAX 1.8 |

1.4. Print Code

PRINT CODE FOR SEMI/AUTOMATED LINE



1.5. Forces on Component



| STATE | MAX PERMANENT FORCE [N] | MAX HANDLING FORCE [N] |
|--------------------|-------------------------|------------------------|
| FROM FRONT TO BACK | 10 | 20 |
| MEMBRANE | 0 | 0 |

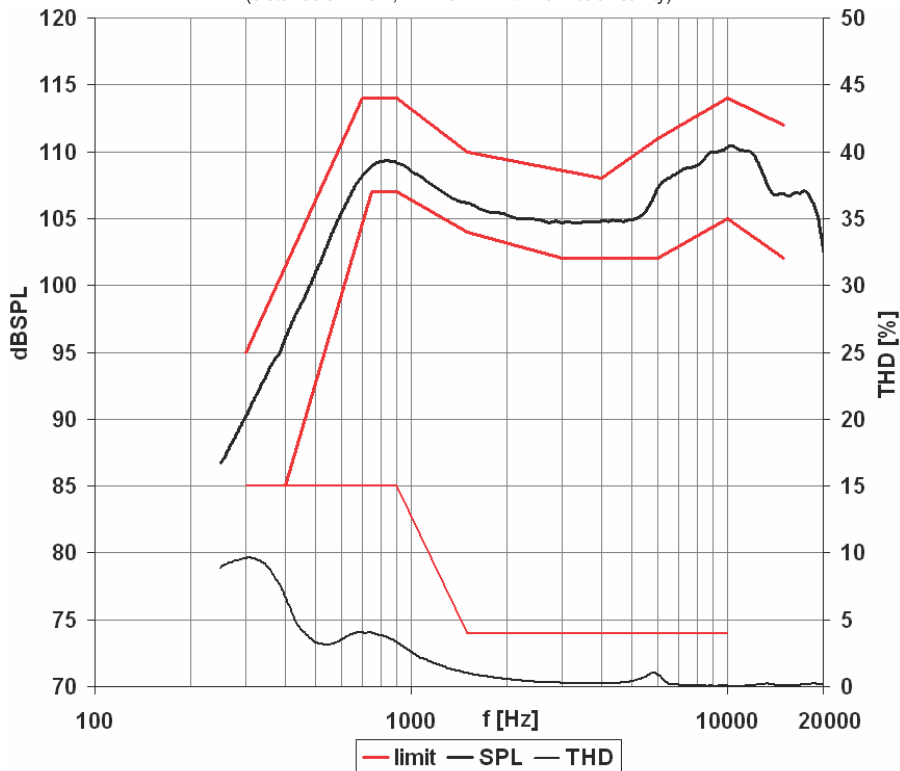
1.6. Material List

- | | |
|------------------------------|--------------------|
| 1. Material of housing: | PC |
| 2. Material of membrane: | Plastic Foil |
| 3. Material of pot: | Soft Magnetic Iron |
| 4. Material of topplate | Soft Magnetic Iron |
| 5. Material of magnet: | Nd Fe B |
| 6. Material of contact | Stainless Steel |
| 7. Material of cover: | PC |
| 8. Material of bottom: | Stainless Steel |
| 9. Material of vibra spring: | CrNi-Steel |
| 10. Dimensions [mm]: | ∅16.4 x 4.7 |
| 11. Mass: | 3.0 g |

2. Electro-Acoustic Characteristics

2.1. Frequency response

Typical frequency response measured on baffle according to 2.4.
in measurement adapter according to 2.9
(distance $d = 1\text{cm}$, $P = 125\text{mW}$ with 2cm back cavity)



| Tolerance window | | | | |
|------------------|----------------------|----------------------|--------|--------------------|
| f [Hz] | lower limit [dB SPL] | upper limit [dB SPL] | f [Hz] | upper limit [%THD] |
| 300 | | 95 | 300 | 15 |
| 400 | 85 | | 900 | 15 |
| 700 | | 114 | 1500 | 4 |
| 750 | 107 | | 10000 | 4 |
| 900 | 107 | 114 | | |
| 1500 | 104 | 110 | | |
| 3000 | 102 | | | |
| 4000 | | 108 | | |
| 6000 | 103 | 111 | | |
| 10000 | 105 | 114 | | |
| 15000 | 102 | 112 | | |

2.2. Electro-Acoustic Parameters

Loudspeaker mounted in adapter acc. to 2.9 measured on baffle according to 2.4.

| | | |
|--|------------------------|---|
| 1. Rated impedance | Z: | 8Ω |
| 2. Voice coil resistance | R: | 7.2Ω±10% |
| 3. Resonance frequency in 2ccm (measured @15mW) f ₀ : | | 740Hz±10% |
| 3.1. Resonance frequency with open back | f ₀ : | 540Hz typical |
| 4. Maximum usable excursion | X _{max p-p} : | 0.6mm p-p |
| 5. Nominal characteristic sensitivity (calculated for 1W in 1m) average from 2kHz to 5kHz | | 74±2dB |
| 5.1. Measured characteristic sensitivity (at 125mW in 1cm) average from 2kHz to 5kHz | | 105±2dB |
| 6. THD | | according chapter 2.1. |
| 7. Rub & buzz | | < 80dB SPL (300Hz -1500Hz) in 1cm at 500mW (2V _{eff}) |

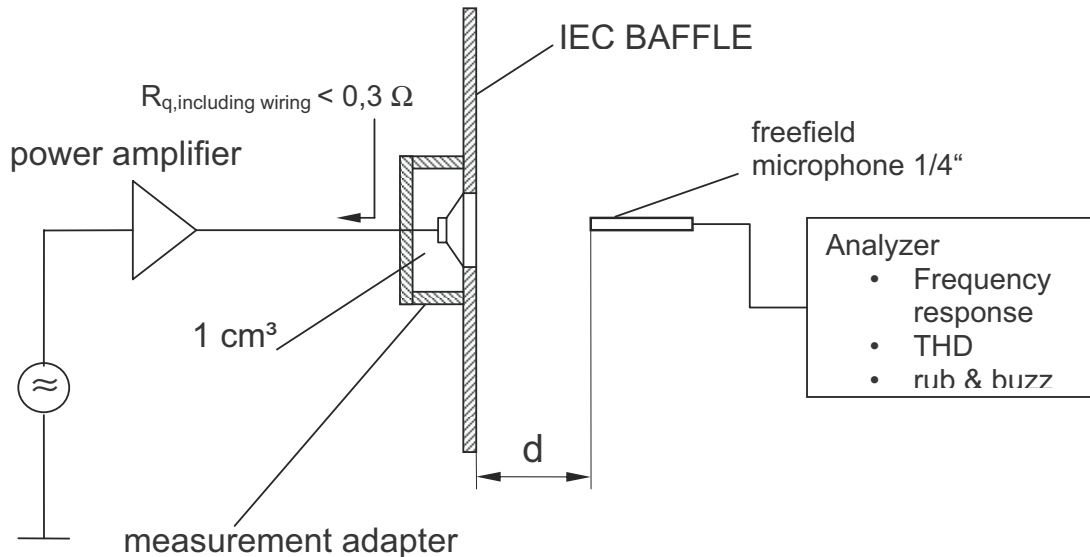
All acoustic measurements at 23±2°C

2.3. Power Handling

Loudspeaker mounted in lifetime test device (1ccm back cavity, open front)

1. MAX.SHORT TERM POWER (1sec. ON / 60sec. OFF) 1000mW (RMS)
(pink noise, 2nd order high pass filtered, -3dB at 800Hz, crest factor 2)
2. MAX. CONTINUOUS POWER (500h) 500mW (RMS)
(pink noise, 2nd order high pass filtered, -3dB at 700Hz, crest factor 2)

2.4. Measurement Setup (acoustics)



2.5. Measured Parameters

2.5.1. Sensitivity

SPL is expressed in dB rel $20 \mu\text{Pa}$, computed according to IEC 268-5 Measurement set up according chapter 2.4 and 2.9. This test is performed for 100% of products in the production line

2.5.2. Frequency response

Frequency response is measured according test set up in chapter 2.4 and 2.9 data sheet and checked against the tolerance window defined in chapter 2.1. This Test is performed for 100% of products in the production line.

2.5.3. Total harmonic distortion (THD)

Is measured according IEC 268-5 (2nd to 5th harmonics) and test set up in chapter 2.4 and 2.9 and checked against the tolerance window defined in chapter 2.1. This test is performed for 100% of products in the production line.

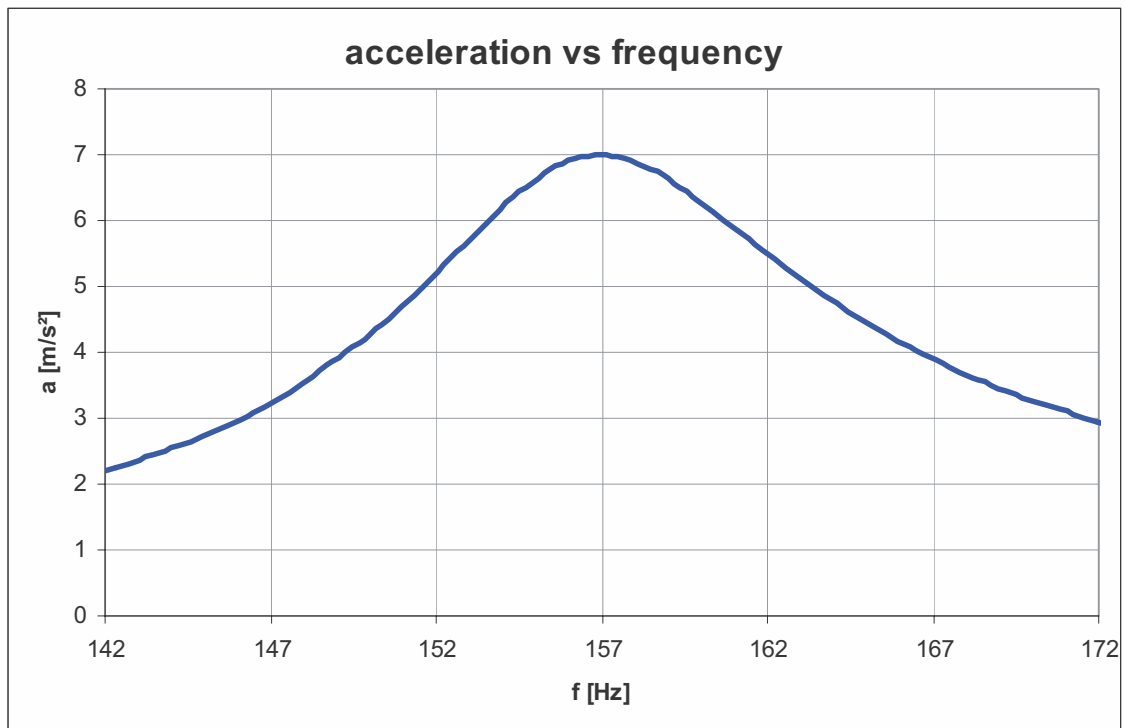
2.5.4. Rub & Buzz

Rub & Buzz will be measured in the Inline-measuring device with a sinusoidal sweep. Rub & Buzz is defined as the maximum level of no harmonic energy, expressed as signal to non-harmonic content ratio, in a certain frequency-range. Signal and evaluation criteria are according to chapter 2.2. This test is performed for 100% of products in the production line.

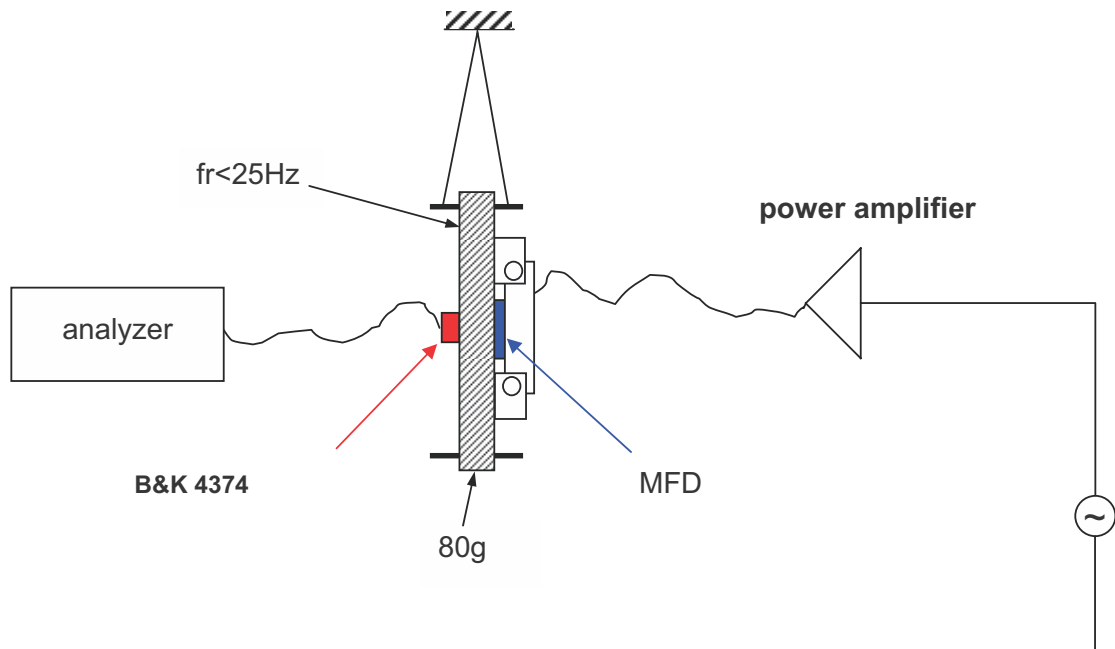
2.6. Vibra Parameters

Loudspeaker mounted in adapter acc. to 2.7

- | | | |
|---|-------------|----------------------|
| 1. Resonance frequency (measured @0.35V/15mW) | f_0 : | 157Hz±7Hz |
| 2. Max. Acceleration (measured @0.35V/15mW between 152-162Hz) | a_{max} : | >6,5m/s ² |



2.7. Measurement setup (Vibra Function)



2.8. Measured Parameters (Vibra Function)

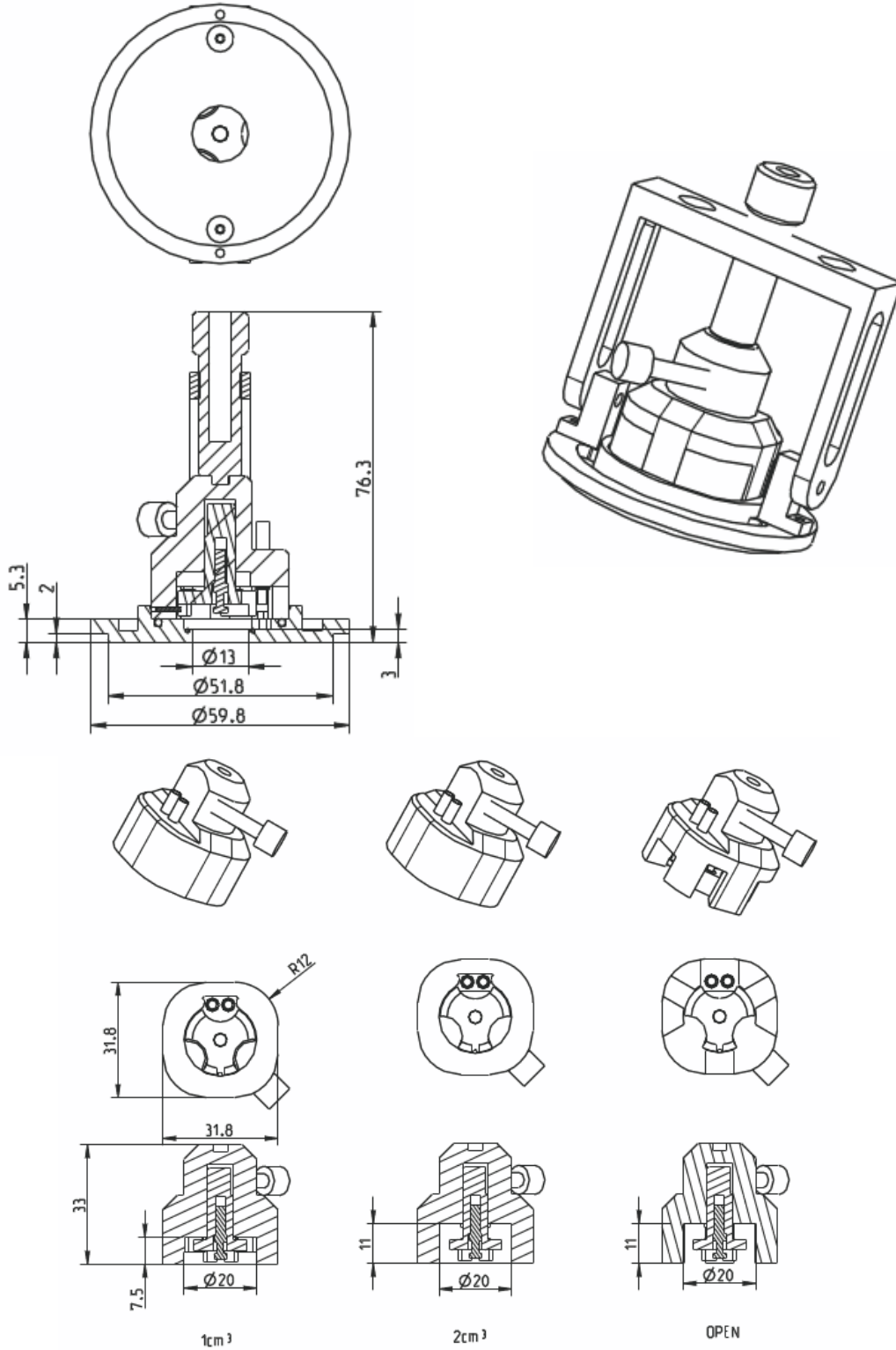
2.8.1. acceleration

Device is measured mounted on a mass of 100g in the center of gravity. This mass is mounted on a suspension with a resulting resonance frequency of less than 25Hz. An acceleration sensor (B&K 4374) is mounted in the center of gravity for measuring the acceleration. The maximum acceleration in the defined frequency range is detected by sweeping the input voltage from the minimum to the maximum frequency.

2.8.2. Vibra Resonance Frequency

The electrical impedance of the device is measured. The first maximum of the impedance (in the range of 150-162Hz) corresponds with the vibra resonance frequency.

2.9. Measurement adapter



3. Environmental Conditions

3.1. Storage

The transducer fulfils the specified data after treatment according to the conditions of

ETS 300 019-2-1 Specification of environmental test: Storage
Test spec. T 1.2: Weather protected, not temperature controlled storage locations.

3.2. Transportation

The transducer fulfils the specified data after treatment according to the conditions of

ETS 300 019-2-2 Specification of environmental test: Transportation
Test Spec. T 2.3: Public Transportation

3.3. Functionality

The transducer fulfils the specified data after treatment according to the conditions of

ETS 300 019-2-5 Specification of environmental test: Ground vehicle installations
Test spec. T 5.1: Protected installation

ETS 300 019-2-7 Specification of environmental test: Portable and non-stationary use
Test spec. T 7.3E: Partly weather protected and non-weather protected locations.

4. Environmental Tests

Qualification Tests

According to our milestone plan (Product Creation Process), a complete qualification test will be done at design validation on products, manufactured under serial conditions and 1x per year and product family. The qualification process covers all tests described under 4.5 and a complete inspection takes place.

Requalification Tests

1x per month and product family samples are taken and submitted to tests described under 0

Sample Size, Sequence

Unless otherwise stated 20 arbitrary new samples will be used to perform each test for both, qualification and requalification test as described under 0 and 0.

Period of Shelf-Life

The period of shelf-life is 12 months.

Testing Procedures

Storage Tests

Low Temperature Storage Test

| Parameter | Test Method and Conditions | Duration | Evaluation Standard |
|--|---------------------------------------|----------|--|
| Low Temperature Storage (Ref. EN 60068-2-1) | -40°C rel. humidity not controlled | 168h | Measurements after 2 hours recovery time. All samples fully operable. All acoustical parameters according specification with tolerances increased by 50 %. |

High Temperature Storage Test

| Parameter | Test Method and Conditions | Duration | Evaluation Standard |
|---|---------------------------------------|----------|--|
| Dry Heat Storage (Ref. EN 60068-2-2) | +85°C rel. humidity not controlled | 168h | Measurements after 2 hours recovery time. All samples fully operable. All acoustical parameters according specification with tolerances increased by 50 %. |

Temperature Cycle Test

| Parameter | Test Method and Conditions | Duration | Evaluation Standard |
|---|--|--------------------------------------|--|
| Change of Temperature (Ref. EN 60068-2-14) | -40°C/+85°C Transition time <3 min. See Figure 4-1 below | 5 cycles >2h for each temperature | Measurements after 2 hours recovery time. All samples fully operable. All acoustical parameters according specification with tolerances increased by 50 %. |

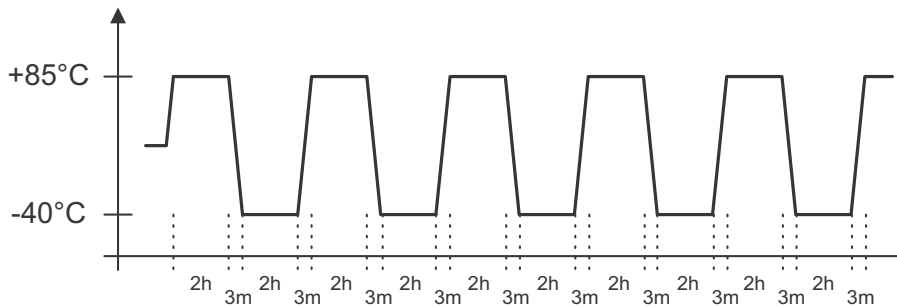


Figure 4-1: Temperature Cycle Test

Temperature / Humidity Cycle Test

| Parameter | Test Method and Conditions | Duration | Evaluation Standard |
|--|---|--------------------------------------|--|
| Damp heat, cyclic (Ref. IEC 60068-2-30) | +25°C/+55°C 90% to 95% RH. Temp. change time <3h See Figure 4-2 below Caution: no condensed water on products! | 6 cycles. 24h at each temperature | Measurements after 2 hours recovery time. All samples fully operable. All acoustical parameters according specification with tolerances increased by 50 %. |

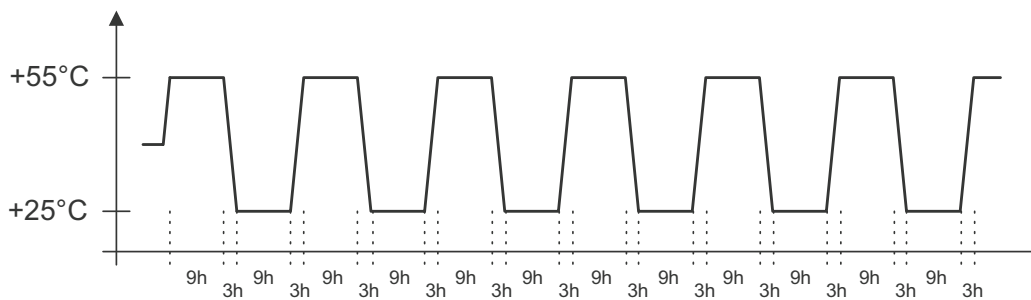


Figure 4-2: Temperature / Relative Humidity Cycle Test

Operating Tests

Cold Operation Test

| Parameter | Test Method and Conditions | Duration | Evaluation Standard |
|--|--|----------|---|
| Cold Operation Test (Ref. EN 60068-2-1) | -20°C rel. humidity not controlled signal acc. Chapter 2.3 | 72h | Measurements after 2 hours recovery time. All samples fully operable. THD may be increased after test. All other acoustical parameters according specification with tolerances increased by 50 %. |

Dry Heat Operation Test

| Parameter | Test Method and Conditions | Duration | Evaluation Standard |
|---|--|----------|--|
| Dry Heat Operation (Ref. EN 60068-2-2) | +70°C rel. humidity not controlled signal acc. Chapter 2.3 | 500h | Measurements after 2 hours recovery time. All samples fully operable. The allowable change in sensitivity shall not be greater than 3 dB. All other acoustical parameters according specification with tolerances increased by 50 %. |

Salt Mist Test

| Parameter | Test Method and Conditions | Duration | Evaluation Standard |
|---|--|----------|---|
| Salt Mist (Ref. IEC60068-2-52, Kb / Severity 2) | The part must be subjected to 2 hours spray of 5% NaCl salt mist, at 35°C then be left at 40°C and 95% RH for 22h. | 3 cycles | The samples shall be washed after the test with distilled water and dried at T < 50°C. Component may have reduced performance, but must still function properly. The allowable sensitivity difference shall not be greater than ±3dB from initial sensitivity. |

Shock Resistance Test (Free Fall Test) - unprotected product

| Parameter | Test Method and Conditions | Conditions / Sample size | Evaluation Standard |
|---|---|---|---|
| Mechanical shock (Ref. IEC60068-2-32 Ed), Procedure 1 | Drop of sample without fixation of release plane from a height of 1.5m onto concrete floor. | Each 3 shocks in both directions of the 3 axes. (18 drops in total) | Component may have reduced performance, but must still function properly. The allowable sensitivity difference shall not be greater than ± 3 dB from initial sensitivity. |

Impact Durability Test (Tumble Test) – protected product

| Parameter | Test Method and Conditions | Conditions / Sample size | Evaluation Standard |
|---|--|--|---|
| Impact durability (in a Tumble Tester) (Ref. IEC60068-2-32 Ed) (SPR a7.1.1) | Speaker <i>in drop test box</i> or representative mechanics. Random drops on steel base. | 30 units 180 drops, 1m DUT power off | Component may have reduced performance, but must still function properly. The allowable sensitivity difference shall not be greater than ± 3 dB from initial sensitivity. |

Resistance to Electrostatic Discharge

| Parameter | Test Method and Conditions | Conditions / Sample size | Evaluation Standard |
|--|---|--|---|
| Resistance to ESD IEC61000-4-2 Level 4 (SPR c 2.5.1) | One pole is grounded and the ESD pulse is applied to the other pole. The speaker must be stressed first with one polarisation and then with the other polarisation. DUT must be discharged between each ESD exposure. Level 4: contact +/- 8kV, air +/- 15kV | 10 exposures on each polarity / 5 units DUT Power off | All samples fully operable. All acoustical parameters according specification with tolerances increased by 50%. |

5. Related Documents

| | |
|------------------------|---|
| IEC 268-5 | Sound System equipment Part 5: Loudspeaker |
| IEC 68-2 | Environmental testing |
| EN 60068-2 | Environmental testing |
| ISO 2859 - 1 | Sampling procedures for inspection by attributes Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection |
| ISO 3951 | Sampling procedures and charts for inspection by variables for percent defectives. |
| ETS 300 019-2-1 | Specification of environmental test: Storage Test spec. T 1.2: Weather protected, not temperature controlled storage locations |
| ETS 300 019-2-2 | Specification of environmental test: Transportation Test spec. T 2.3: Public Transportation |
| ETS 300 019-2-5 | Specification of environmental test: Ground vehicle installations Test spec. T 5.1: Protected installation |
| ETS 300 019-2-7 | Specification of environmental test: Portable and non-stationary use Test spec. T 7.3E: Partly weather protected and non-weather protected locations |

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