| VOLKSWAGEN AG | **Reference Point System - RPS -**<br>Drawings | **VW 010 55** |
|---|---|---|
| **Konzernnorm** | | |

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## 1 Scope and Aim

This standard applies to dimensioning and to manufacturing and inspecting single parts or assemblies (ASSY) in all product creation phases for

- uniform positioning throughout the manufacturing and inspection areas
- assurance of identical dimensional references

Fortsetzung Seite 2 bis 14


| Fachverantwortung/Responsibility | | | Normung/Standards (EZTN, 1733) | | |
|---|---|---|---|---|---|
| AK "RPS-Systematik" | Lüer | Vonau | Lüer | Tel: +49-5361-929063 | Sobanski |

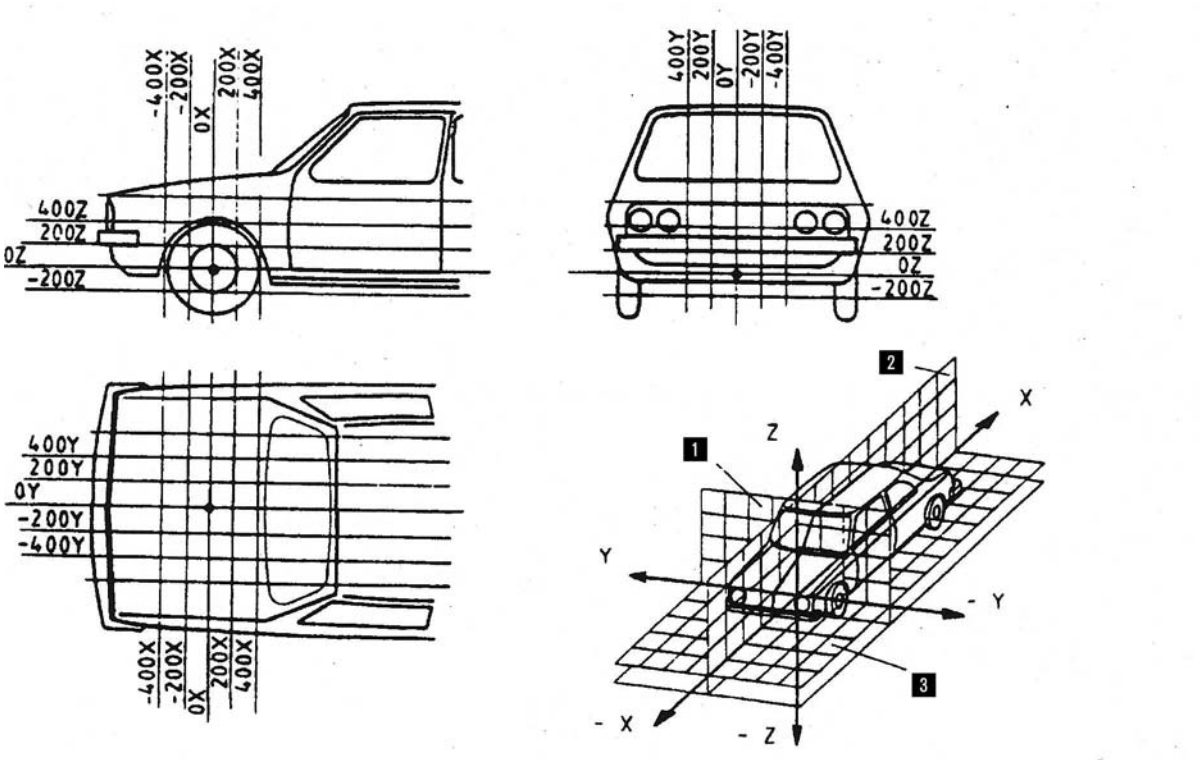

Form FE 41 - 12.00

## 2 Theoretical Principles

### 2.1 Component-Oriented Reference System

One of the basic ideas forming the basis for the reference point system is the component-oriented coordinate system according to VW 010 52.

A vehicle is dimensioned by means of a global coordinate system (mathematical vehicle coordinate system), the origin of which is defined to be in the center at the level of the front axle of a vehicle (see VW 010 59 Part 1; VW 010 52 is the binding reference for the vehicle coordinate system), Figure 1.




A Vertical plane S Longitudinal center plane D Horizontal plane

Figure 1. Global coordinate system for vehicles

Starting from the axes of this coordinate system, grid lines are spread out parallel to the axes. These grid lines, spaced 100 mm apart, theoretically penetrate the vehicle. These grid lines serve to find all points on the vehicle. In other words, they help to determine the position of each vehicle component. Dimensioning is also performed with the aid of these grid lines.

The reference point system is based on a component-oriented reference system.

The origin of the component reference system is defined by the intersection point of three reference planes. The reference planes are formed via the RPS main mountings defined on the component.

When several parts are assembled, these parts are toleranced with respect to each other.

After the parts are joined, the ASSY is described by a combined component-oriented reference system. This is formed

by adoption of one of the existing reference systems or

by forming a new reference system using the existing reference points.

The specification of the new reference system depends on the function of the ASSY.

## 2.2 Standard Sizes/Characteristics for RPS Mountings

Multiple-use location holes with high precision requirements must be adequately strong.

In general, the standard sizes according to Table 1 and Table 2 shall be used. In case of holes in RPS surfaces, it must be ensured that the bearing surfaces are of adequate size and provide process assurance.

The specified dimensions shall be projected – parallel to the axes – onto the component.

Table 1. Recommended standard values
For further standard sizes see VW 010 77

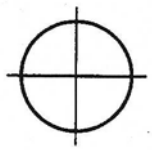
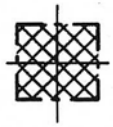
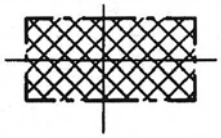
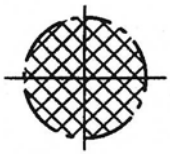
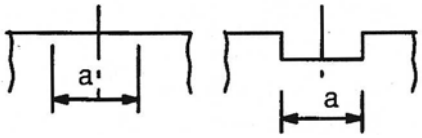
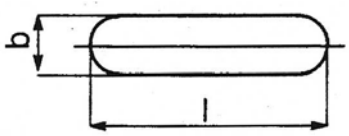
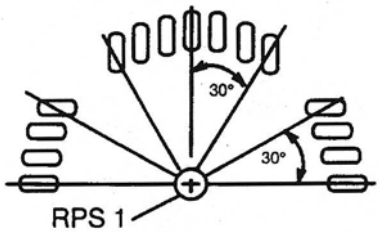
| Designation | | Nominal dimension | Tol. | Graphical representation |
|---|---|---|---|---|
| Location holes, pluggable | Round hole | see VW 01077 | |  |
| Surfaces | Square | 10 | +1 |  |
| | | 15 | | |
| | | 20 | | |
| | | 25 | | |
| | Rectangle | 6 x 20 | +1 |  |
| | | 10 x 20 | | |
| | | 15 x 20 | | |
| | Circle | Ø 15 | +1 |  |
| | | Ø 20 | | |
| | | Ø 25 | | |
| Edges | Edge length "a" | 10 | +1 |  |
| | | 20 | | |
| | | 25 | | |

Table 2. Recommended standard values
For further standard sizes see VW 010 78

| Designation | | Nominal dimension w x l | Tol. | Graphical representation |
|---|---|---|---|---|
| Location holes, pluggable | Long hole | see VW 01078 | |  |
| | Long hole in angle position | | |  |

## 3 The 3-2-1 Rule

Every rigid body possesses six degrees of freedom in three-dimensional space: three translational degrees parallel to the axes of a reference system and three rotatory degrees around the axes, Figure 2.

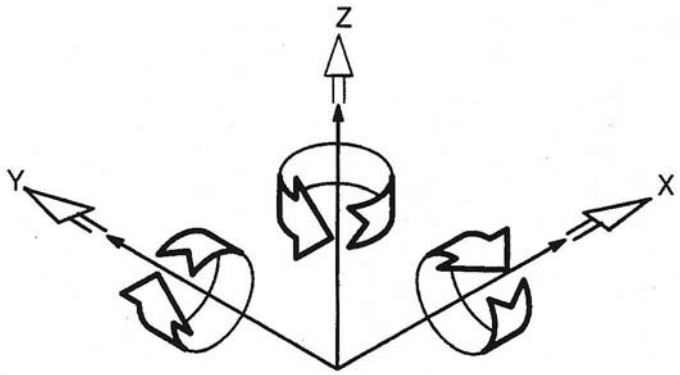



Figure 2. The degrees of freedom in three-dimensional space

In order to support a non-rotationally-symmetric body in a uniquely determinate manner, it must be fixed in all six possible directions of movement. The 3-2-1-rule provides for such unique fixing. It determines the following main-mounting distribution:

| | | |
|---|---|---|
| E.g. | 3 mountings | in z direction |
| | 2 mountings | in y direction |
| | 1 mounting | in x direction |

Implementation of this rule is shown based on the following representation, Figure 3.

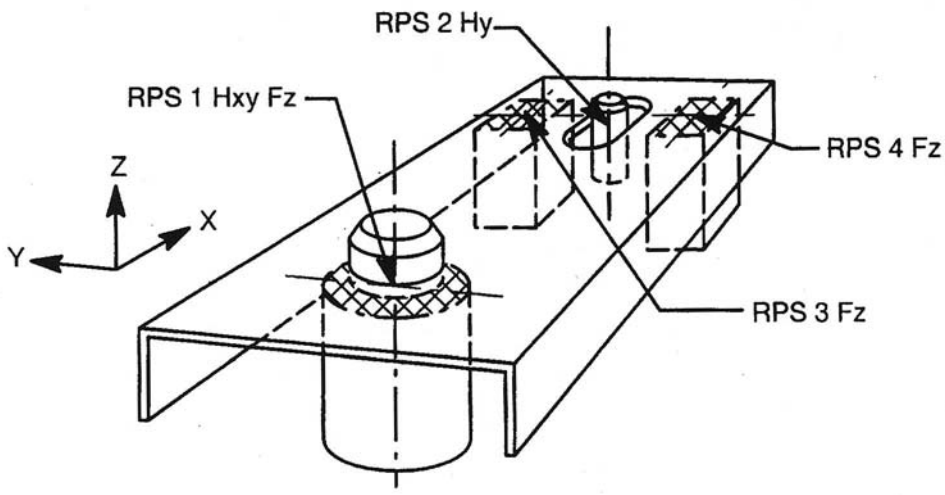



Figure 3. Application of the 3-2-1 rule

The three mountings in z direction restrict three degrees of freedom: translation in z direction and rotation around the x and y axes. The pin in the round hole prevents motion parallel to the axes in the x and y directions and, finally, the pin in the long hole prevents rotation around the z axis, Figure 3.

This rule applies equally to any other rigid component, even if its structure is much more complex. With a system of rigid bodies, the elements of which are interconnected by joints or guides, more than 6 degrees of freedom must be fixed using additional main mountings.

For non-rigid components, additional support points must be defined for supporting the components according to RPS aspects.

RPS 1 shall be the point that binds the most degrees of freedom.

## 4 Designation and Drawing Representation

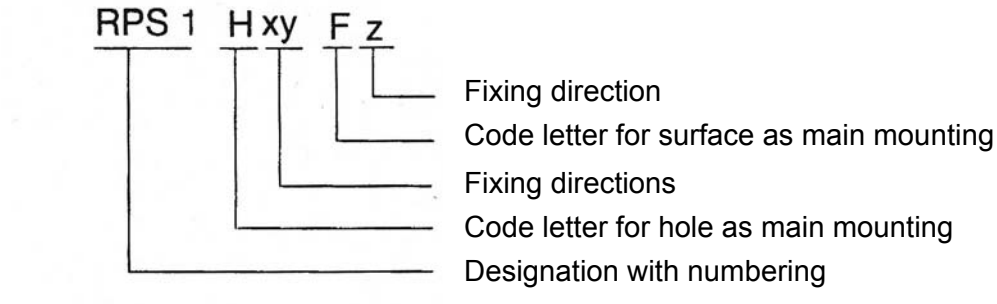
### 4.1 RPS Designation

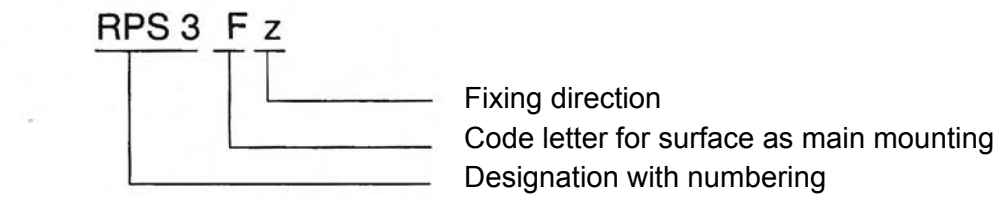
All RPS points must be included in the part drawing.

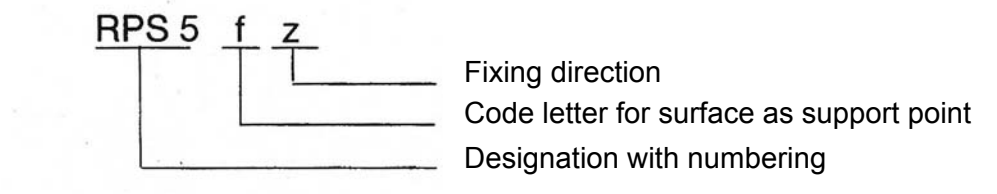
The designation is subdivided as follows:

- Main mounting points = Capitals
  - → H = Hole
  - → F = Surface
  - → T = Theoretical point is the mean of two support points
- Support points = Small letters
  - → h = Hole
  - → f = Surface
  - → t = Theoretical point is the mean of two support points
- Mounting types
  - → Location holes/pins = Code letter H,h
  - → Surfaces/edges/ball/tip = Code letter F,f
  - → Theoretical point = Code letter T,t
- Fixing directions = Small letters
  - → x, y, z for component-oriented reference systems parallel to the coordinate system
  - → a, b, c for rotated, component-oriented reference systems

Examples of designation:




Numbering begins with the RPS 1 point for each single part and for each assembly.

### 4.2 Drawing Representation

Drawing representation takes place according to the valid drawing guidelines.

The RPS surfaces shall be identified by means of cross-hatching.

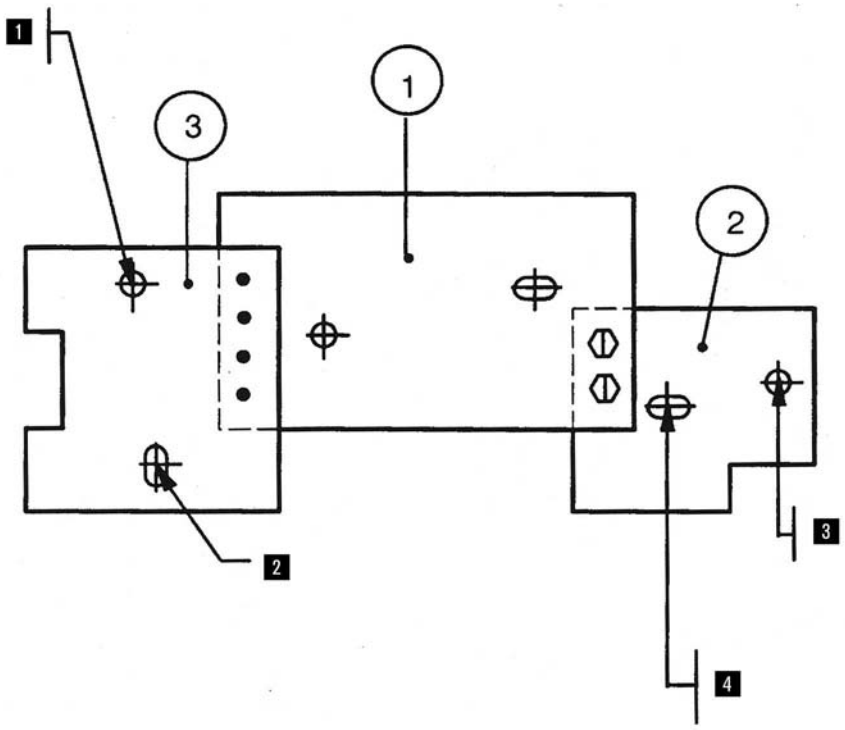
If a part drawing does not exist yet, RPS Dimensions Sheet FE 515 [1)] shall be used.

As soon as the part drawing exists, the specifications from the RPS Dimensions Sheet are adopted directly in the drawing or adopted in text macro NO-F23 [2)]. Administration of these specifications in the text macro is mandatory.

### 4.3 Procedure for Assemblies (ASSY) with Components with no Separate Drawing (ND):

The RPS points for components with no drawing (ND) must be identified by specifying the item number or part number.

A drawing exists for part 1; ND for parts 2 and 3, Figure 4.




A RPS 1 Hxy; RPS 1 Hxy for Item 3
D RPS 1 Hxy only for Item 2
S RPS 2 Hx only for Item 3
F RPS 2 Hy; RPS 2 Hy for Item 2

Fig. 4 ASSY with RPS points
Graphical representation, not adopted in drawing

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[1)] Stored in design data administration system under FEO 000 515

[2)] Stored in design data administration system under NOF 000 023

# 5 Dimensioning and Tolerancing

## 5.1 General

Dimensions and tolerances can be entered directly in the drawing or via the table, Figure 5.

The starting point for dimensioning the components is generally the origin of the reference system.

Form and functional dimensions with tolerances shall always be referenced to the origin of the reference system.
Example: The holes within a hole group are dimensioned with respect to each other. The position of the hole group is dimensioned with respect to the reference planes.

In the fixing direction, the main mountings are positioned without tolerance with respect to the vehicle coordinate system / reference system.

The origin/reference point is shown in the drawing or table. If two or three fixing directions are bound at one point, tolerancing must be separated according to the hole or surface. In this case, the surface must be identified one line lower in the table. Here, the surface is set to zero in the tolerance zone. In the line in which the hole is set to zero, the tolerance zone for the surface shall be identified with a horizontal line, see the table in Figure 5.

The support-point tolerances shall be defined according to the requirements.

## 5.2 Component-Oriented Reference Systems Parallel to the Coordinate System

The origin of the reference system is defined without tolerances in the global vehicle coordinate system by means of a translation, Figure 5

## 5.3 Rotated, Component-Oriented Reference Systems

With rotated reference systems, the theoretical angles of rotation must be specified in RPS Dimensions Sheet FE 515 [1)] or in the drawing table text macro NO-F23 [2)].

If there are several angles of rotation, the angle specification and thus the sequence of rotations shall be obtained from the drawing. "See drawing" must be added to the table instead of the angle entry.

The position of the reference point is determined by means of its x, y and z coordinates in the global vehicle coordinate system.

Angles of rotation around the x, y and z axes are entered using mathematically positive or negative values. Positive angles are specified counterclockwise and negative angles clockwise.

In the coordinate system, the horizontal axis is assigned an angle of zero.

Nominal dimensions and tolerances are specified in a, b and c values in the RPS table.
The fixing directions of the RPS points are specified as a, b and c values in the table and/or drawing, e.g. RPS 1 HabFc, Figure 6 and Figure 7.

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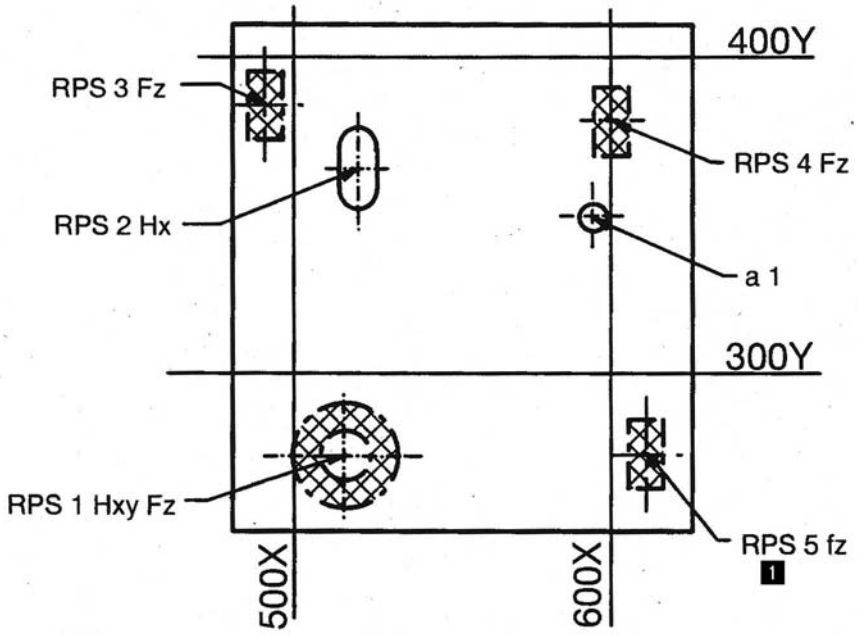
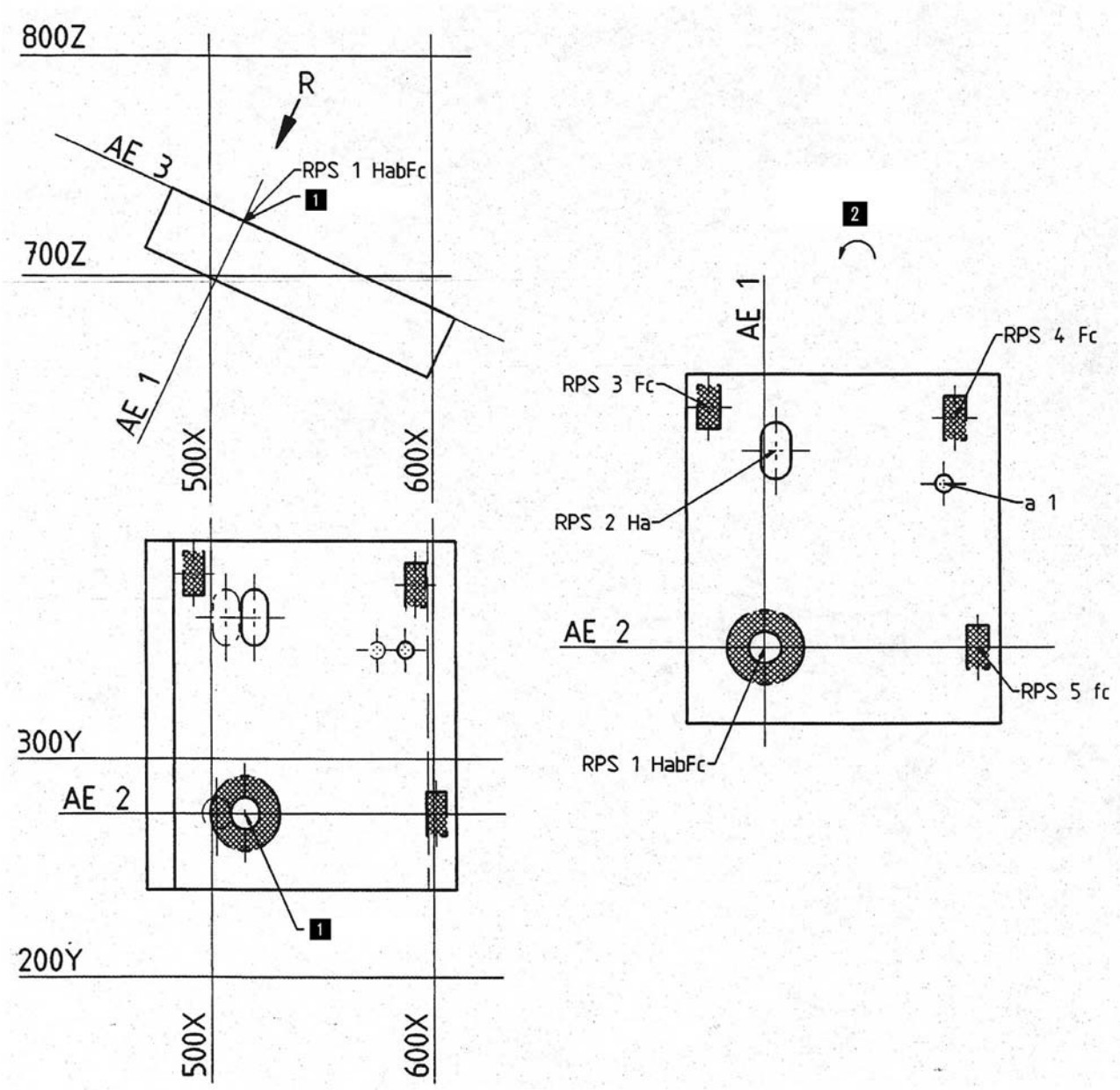
1), 2) see page 6




A if necessary

| Feld Sect. | RPS / F.-Pkt./ Funct. point | Globale Koordinaten Global coordinates x | y | z | Aufnahmeart/ Bemerkung Mounting type/ note | Bezugspunkt: Reference point: x: 515 y: 275 z: 725<br>Theor. Drehwinkel um Achse: Theor. angle of rotat. around axis: x: y: z:<br>Nennmasse/ Nominal sizes AE x/a | AE y/b | AE z/c | Toleranzen/ Tolerances x/a | y/b | z/c | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1HxyFz | 515 | 275 | 725 | Hole Ø 14.5+0.2 | 0 | 0 | 0 | 0 | 0 | – | . |
| | . . . . . | . | . | . | Surface Ø 34.5+1 | . | . | . | ±1 | ±1 | 0 | . |
| | 2Hx . . | 520 | 365 | 725 | Long hole 13+0.2 x 26+0.4 | 5 | 90 | 0 | 0 | ±0.5 | . | . |
| | 3F . . z | 490 | 385 | 725 | Surface 10+1 x 20+1 | 25 | 110 | 0 | ±1 | ±1 | 0 | . |
| | 4F . . z | 600 | 380 | 725 | Surface 10+1 x 20+1 | 85 | 105 | 0 | ±1 | ±1 | 0 | . |
| | 5F . . z | 610 | 275 | 725 | Surface 10+1 x 20+1 | 95 | 0 | 0 | ±1 | ±1 | ±0.5 | . |
| | a 1 | 595 | 350 | 725 | Hole Ø 8+0.2 | | | . | . | . | . | 0.2 |
| | | | | | | | | | | | | |

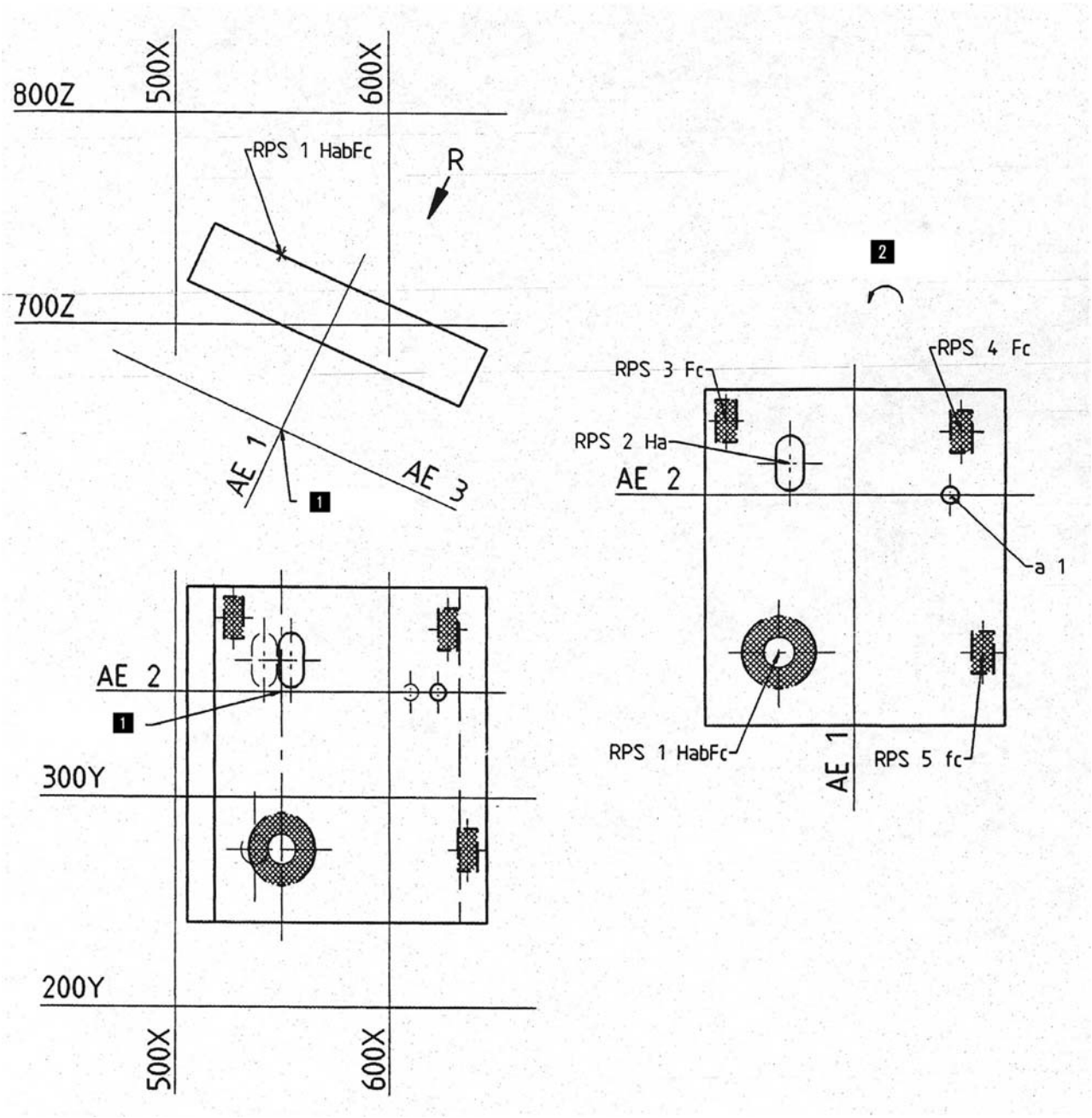
Fig. 5 Dimensioning with text macro NO–F23




A Reference point S View R

| Feld Sect. | RPS / F.-Pkt./ Funct. point | Globale Koordinaten Global coordinates x | y | z | Aufnahmeart/ Bemerkung Mounting type/ note | Bezugspunkt: Reference point: x: 515 y: 275 z: 725<br>Theor. Drehwinkel um Achse: Theor. angle of rotat. around axis: x: 0° y: 25° z: 0° | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Nennmasse/ Nominal sizes | | | Toleranzen/ Tolerances | | | |
| | | | | | | AE1 x/a | AE2 y/b | AE3 z/c | x/a | y/b | z/c | ⌖ Ø1 |
| | 1HabFc | 515 | 275 | 725 | Hole Ø 14.5+0.2 | 0 | 0 | 0 | 0 | 0 | – | . |
| | . . . . . | . | . | . | Surface Ø 34.5+1 | . | . | . | ±1 | ±1 | 0 | . |
| | 2Ha . . | 519.5 | 365 | 722.9 | Long hole 13+0.2 x 26+0.4 | 5 | 90 | 0 | 0 | ±0.5 | . | . |
| | 3F . . c | 492.3 | 385 | 735.6 | Surface 10+1 x 20+1 | 25 | 110 | 0 | ±1 | ±1 | 0 | . |
| | 4F . . c | 592 | 380 | 689.1 | Surface 10+1 x 20+1 | 85 | 105 | 0 | ±1 | ±1 | 0 | . |
| | 5f . . c | 601.1 | 275 | 684.8 | Surface 10+1 x 20+1 | 95 | 0 | 0 | ±1 | ±1 | ±0.5 | . |
| | a 1 | 587.5 | 350 | 691.2 | Hole Ø 8+0.2 | | | . | . | . | . | 0.2 |
| | | | | | | | | | | | | |

Fig. 6 Reference point is formed directly via RPS main mountings.




A Reference point S View R

| Feld Sect. | RPS / F.-Pkt./ Funct. point | Globale Koordinaten Global coordinates x | y | z | Aufnahmeart/ Bemerkung Mounting type/ note | Bezugspunkt: Reference point: x: 550 y: 350 z: 650<br>Theor. Drehwinkel um Achse: Theor. angle of rotat. around axis: x: 0° y: 25° z: 0°<br>Nennmasse/ Nominal sizes AE1 x/a | AE2 y/b | AE3 z/c | Toleranzen/ Tolerances x/a | y/b | z/c | ⌖ Ø1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1HabFc | 550 | 275 | 732.8 | Hole Ø 14.5+0.2 | 35 | 75 | 75 | 0 | 0 | – | . |
| | . . . . . | . | . | . | Surface Ø 34.5+1 | . | . | . | ±1 | ±1 | 0 | . |
| | 2Ha . . | 554.5 | 365 | 730.6 | Long hole 13+0.2 x 26+0.4 | 30 | 15 | 75 | 0 | ±0.5 | . | . |
| | 3F . . c | 527.3 | 385 | 743.3 | Surface 10+1 x 20+1 | 60 | 35 | 75 | ±1 | ±1 | 0 | . |
| | 4F . . c | 627 | 380 | 696.8 | Surface 10+1 x 20+1 | 50 | 30 | 75 | ±1 | ±1 | 0 | . |
| | 5f . . c | 636.1 | 275 | 692.6 | Surface 10+1 x 20+1 | 60 | 75 | 75 | ±1 | ±1 | ±0.5 | . |
| | a 1 | 622.5 | 350 | 699 | Hole Ø 8+0.2 | | | . | . | . | . | 0.2 |
| | | | | | | | | | | | | |

Fig. 7 Reference point is formed via RPS main mountings with defined distances

# 6 Universal Use

## 6.1 General

The purpose of the RPS is to provide process assurance/capability and repeat accuracy for the procedures in order to make them independent of setting work performed by the worker.

The reference points must be used in all manufacturing, assembly, inspection and installation processes.

In case of self-contained function sectors such as the side panel tank flap, a reference change in combination with functional dimensions to RPS planes is permissible.

Prior to the specification of RPS points, it is absolutely necessary to define the functions of the single part and the relevant assemblies with their required functional tolerances.

Reference points that were established at the beginning of a process must be kept for as long as possible. In order to avoid changes to arranged reference points, they are jointly defined – as early as possible in the design and development process – in consultation with all departments participating in the production process.

Reference points must be positioned at stable areas of a component that will remain unchanged even in further development and/or production processes.

Reference points on components that move relative to the body during driving operation can be considered according to the 3-2-1 rule only in the actual design position.

The RPS points on components that are used several times in vehicles and thus have multiple references to the global coordinate system can be shown without a global coordinate reference in the technical drawing.

The reference point system is equally oriented toward the production process, toward the function sectors and toward the strategic quality goals, e.g. audit, process capability.

## 6.2 Specification of Reference Points

Parallelism to the coordinate system (holes and surfaces) must be observed when entering the reference points. In the case of rotated systems, parallelism to the reference planes must be observed.

The RPS points must be produced in the tool sequence in which the greatest dimensional stability is attained.

Whenever possible, reference points must be produced with a standardized shape (hole, surface), which must be defined in detail.

If holes cannot be made in a component, surfaces or edges must be used to specify reference points.

In the case of COP parts (transfer parts), the respective reference-point positions arise in the ASSY.

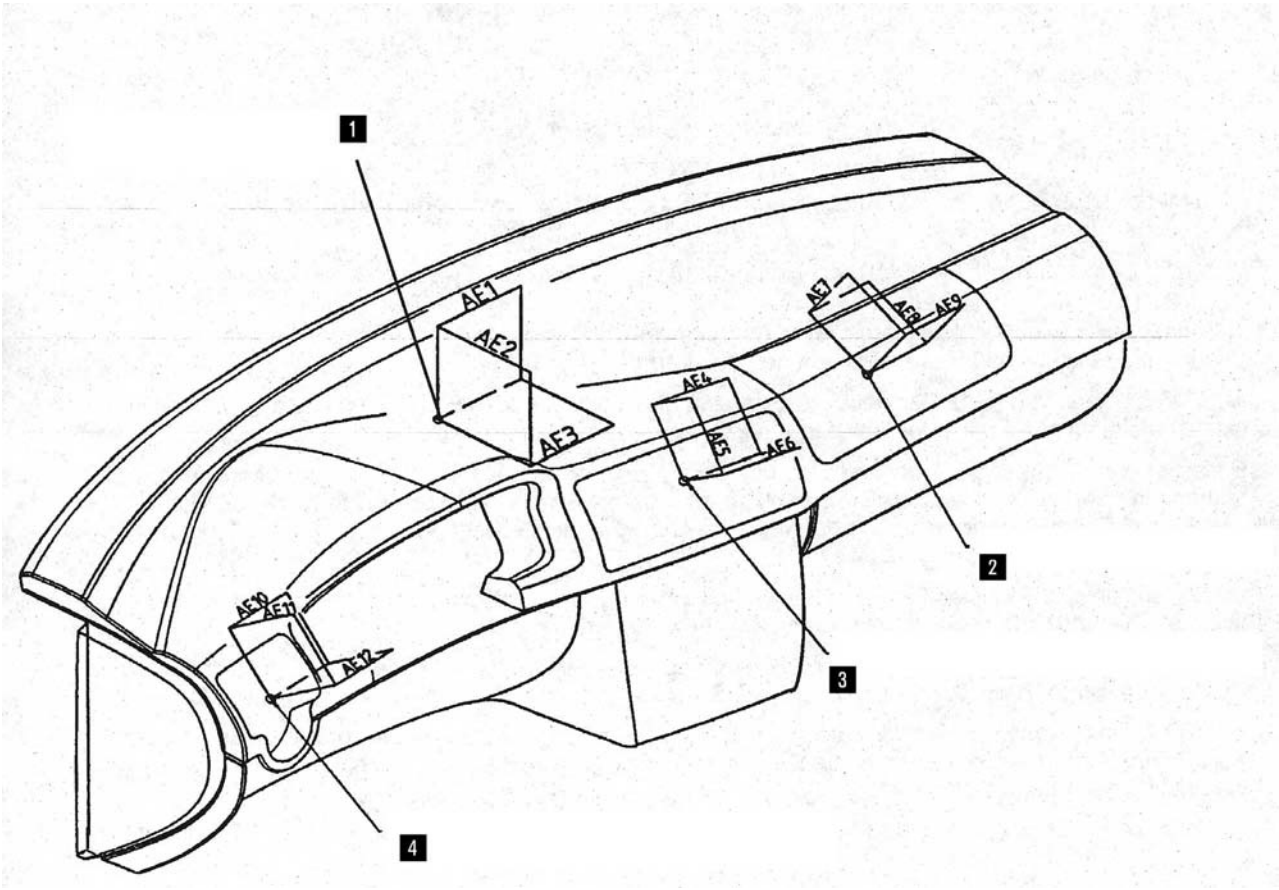
## 6.3 Specification of Function Sectors

Use of the RPS on a complex portion of the vehicle such as the dashboard requires a structure that addresses the development and design engineering systems and includes all parts, single parts and assemblies.

A function sector includes all components in the visible and covered areas that directly affect their surroundings with their function points.

The specification of reference planes depends on the spatial and geometric position relationship of a component with its surroundings.

The reference planes are identical for a function sector. In other words, components or component groups and the surroundings have the same starting basis, Figure 8.




A Dashboard ASSY function sector
D Center-vent function sector
S Airbag function sector
F Air outlet vent function sector FS

Fig. 8

## 7 Referenced Standards

VW 010 52
VW 010 59 T1
VW 010 77
VW 010 78

| Feld Sect. | RPS / F.-Pkt. Funct. point | Globale Koordinaten Global coordinates x | y | z | Aufnahmeart/ Bemerkung Mounting type/ note | Bezugspunkt: Reference point: x.....y.....z..... Theor. Drehwinkel um Achse: x.....y.....z..... Theor. angle of rotat. around axis: Nennmasze/ Nominal sizes AE x/a | AE y/b | AE z/c | Toleranzen/ Tolerances x/a | y/b | z/c | ⌖ Ø t |
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# Typ/Type — RPS-Maßblatt/ RPS Dimensions Sheet

**Funktionsbeschreibung mit Toleranzen/ Discription of function with Tolerances**

Skizze mit Koordinatenkreuz/ Draft with coordinate system

**Tabellenangaben nur bis Erstellung der Teilzeichnung verbindlich**
**Specifications in table are only binding till part drawing is generated**

| RPS / F.-Pkt. / Funct.-pt. | Globale Koordinaten / Global coordinates x | y | z | Aufnahmeart/ Bemerkung / Mounting type/ note |
|---|---|---|---|---|
| ..... | . | . | . | . |
| ..... | . | . | . | . |
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| | Blatt/Sheet |

Form FE 515 1296