prostep ivip

Recommendation

FUNCTIONAL DATA EXCHANGE

Automated Functional Data Exchange in the Automobile Industry

prostep ivip PSI 20/VDA 5550 Part 3.3

Automated Functional Data Exchange
in the Automobile Industry (FDX)
Part 3.3: Wheel Brake

Abstract Part 3.3: Wheel Brake

This prostep ivip (PSI) / VDA recommendation was drawn up by the Functional Data Exchange (FDX) working group and defines a standard format and a machine-readable specification of a data model/data format for the transfer of functional data (e.g., characteristic diagrams, characteristic curves, characteristic values) between customers and their suppliers.

It enables the exchange of highly structured data. This recommendation aims at facilitating consistent and efficient implementation of these processes in the automotive industry.

Objectives:

- Harmonization of the exchange of functional data between OEMs and suppliers
- Improved quality and availability of functional data for CAE/simulation purposes
- Elimination of discrepancies in functional data between ordered and delivered data
- Higher level of automation for data generation, data exchange and data use

Disclaimer

prostep ivip documents (PSI documents) are available for anyone to use. Anyone using these documents is responsible for ensuring that they are used correctly.

This PSI documentation gives due consideration to the prevailing state-of-the-art at the time of publication. Anyone using PSI documentations must assume responsibility for his or her actions and acts at their own risk. The prostep ivip Association and the parties involved in drawing up the PSI documentation assume no liability whatsoever.

We request that anyone encountering an error or the possibility of an incorrect interpretation when using the PSI documentations contact the prostep ivip Association (psi-issues@prostep.org) so that any errors can be rectified.

Copyright

Table of Contents

Figures

Tables

1 Introduction

1.1 Background and objectives

This VDA 5550 / PSI 20 recommendation describes a data model and format for the standardized and traceable exchange of functional data and relevant, associated meta data.

This document, Part 3.3, describes the data format for the part-specific elements of wheel brakes, the wheel attached parts of the brake system. An explanation of the functional data relevant for wheel brakes and the test programs used, is provided.

The data model is suitable for the exchange of function data for conventional passive and infinitely adjustable telescopic dampers. Special valve functions not fully covered by this model (e.g. frequency- or amplitude-selective function) may have to be transferred in a data format that needs to be agreed separately.

1.2 Structure of the VDA recommendation

This VDA recommendation is structured as shown in *Figure 1.1.*

It comprises the main document (Part 1 of the recommendation) covering the topic in general, part 2, which contains more detailed information about the attribute list and the data model, and parts 3.3, which contain part-specific contents provided in the form of PDF documents and templates, i.e. ATFX files that contain part-specific application administration. More detailed information is provided in a number of appendixes. An overview of a component in its entirety is therefore provided by Part 1, Part 2 and the respective part-specific section in part 3.3.

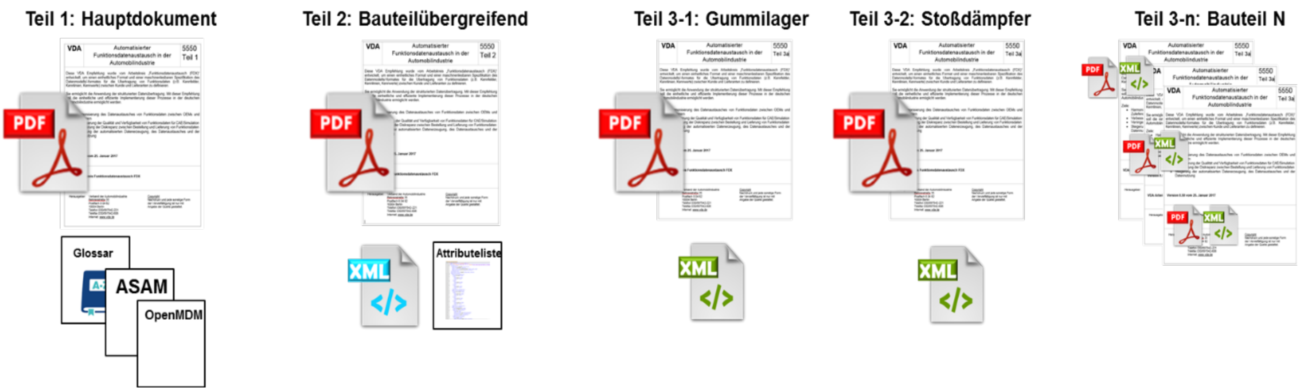

Figure 1.1: Structure of the VDA recommendation

1.3 Formatting conventions

References to the Attributes Data Sheet (Annex A of Part 2 of the PSI 20 / VDA 5550 Recommendation) have the following format: *LabelName {FieldName}*.

The notation *LabelName {Category.Subcategory.FieldName}* is used as needed to improve understanding, e.g. eliminate ambiguities. The values for fields are enclosed in double quotes.

Categories, subcategories, and field names for the basic prostep ivip / VDA model start with the prefix *“BASE__”*. This allows user-specific extensions (with their own prefix) to be used for a field name with the same name within a subcategory.

2 Definitions

2.1 Coordinate systems

The functional characteristics of brakes are mainly described in 0D/1D. For this reason, a coordinate system is not applicable.

When describing the movement of parts, the x-axis is represented as the axis along the movement.

2.2 Conventions for operational signs

In brake applies, torque on wheels is considered to be positive.

3 Part Specific Information {AddInfoPartSpec}

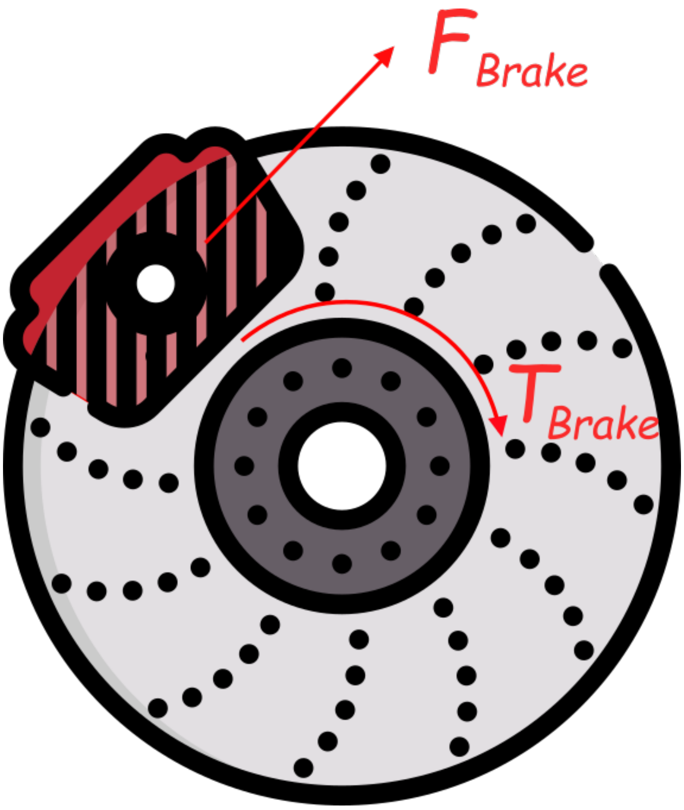

Figure 3.1: Schematic of a disc brake **(freepik.com)**

The part-specific additional information allows further detailed information to be provided on wheel brakes. In some cases, data is entered directly (e.g. length values) and in some cases values are selected from a drop-down menu.

The most important distinction between wheel brakes is done by the part type. This can be specified by selecting attributes from a predefined list (multiple selection possible). It is possible, and in some cases expedient, to select multiple attributes. No check is made to determine whether the selected combination is reasonable.

The following attributes can be selected for *Part Type {PartType}:*

- Disc Brake
- Drum Brake

This enumeration is purely informative in nature and has no impact on the attribute file list.

The *Disc Brake Type {DiscBrakeType}* is used to distinguish between the main concepts of the caliper representation:

- *'Sliding Caliper' {SlidingCaliper}*
- *'Fixed Caliper' {Fixed Caliper}*

For either type of *Disc Brake Type*, the number of pistons inside the caliper is required to further specify the design of the brake caliper.

- *Number of Brake Pistons {DiscBrakeNrOfPistons}*

The *Installation Location {Location}* is used to select the respective axle the wheel brake is applied to:

- *'Front Axle' {FrontAxle}*
- *'Rear Axle' {RearAxle}*

In the case of *Location* (*Location* = *RearAxle*), the type of *Park Brake Mechanism {ParkBrakeMechanism}* needs to be specified:

- *'Mechanical Park Brake' {MechanicalParkBrake}*
- *'Electric Park Brake' {ElectricParkBrake}*

For definition if brake has *Brake Recuperation {BrakeRecuperation}* feature the following toggle attributes are valid:

- *'Yes' {Yes}*
- *'No' {No}*

In addition, a variety of geometrical dimensions can be specified. These are relevant to calculate the brake torque.

- Effective radius Distance from wheel center to center of brake caliper piston diameter
- Piston diameter : Diameter of piston in brake caliper, in case of >1 piston, quantity and diameter of the piston is required.
- Pad wear thickness }: Wearable thickness of brake pad

4 Test Equipment Setup {Test Equipment}

This section describes the test rig, including the adaptation for clamping the unit under test to the test rig. The latter information is particularly important, since the measurement result normally depends on how the test rig adaptation is designed.

In case simulation is used, the name of the software product and specific model used can be included in this section to accommodate the generation of functional data based on simulations. In this context, the software product is considered a digital test rig.

Functional data can be estimated if neither measurements nor simulations are available. The procedure used for the estimation can be named and a free text can be used to provide further details.

Alongside the attributes for describing the test bench, it is also possible to use the following characteristics to describe adaptation of the part for the test in greater detail:

Test programs for wheel brakes are typically carried out on an inertia brake dynamometer. The unit under test is the complete wheel brake assembly consisting of e.g., brake caliper including brake pad, brake rotor, wheel bearing and knuckle.

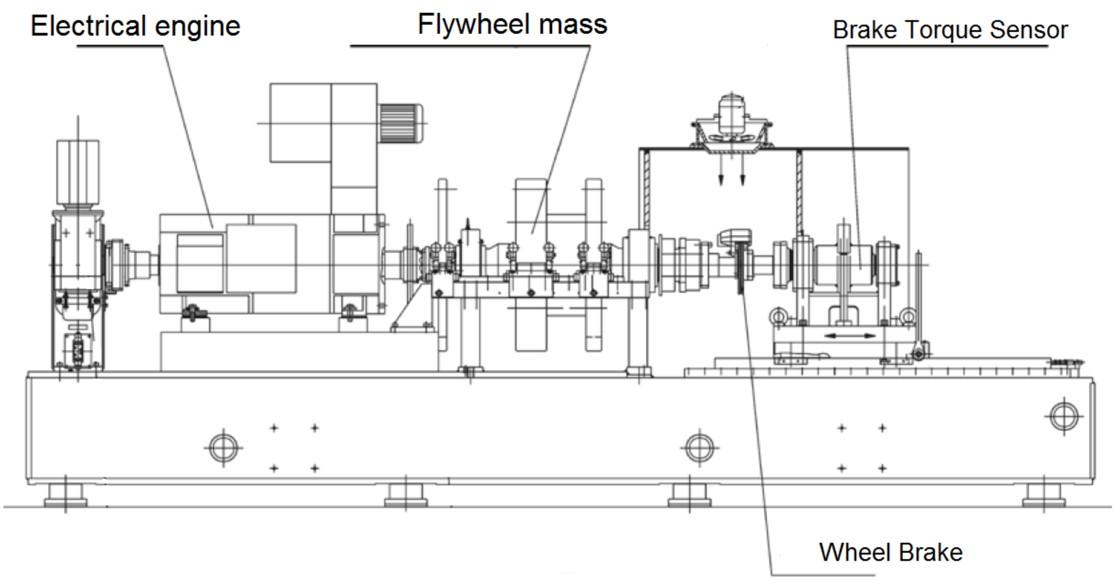

Figure 4.1: Inertia brake dynamometer (Breuer, 2012)

5 Test Equipment Parameters (part-specific) {Test Sequence}

5.1 General

5.1.1 Classification

Test equipment parameters bring together information required to determine the instance data. They will reflect the way in which the instance data is determined on the test rig and form a considerably simplified basis for the testing program used.

5.1.2 Specifying data points

- See prostep ivip / VDA Recommendation 5550 Part 2.

5.2 Preconditioning – Dynamometer {TPmDynoPC}

Test programs can be used for both the actual testing and for preconditioning the component prior to testing. A bedding in, also known as burnishing, procedure for brake pads and rotor is to be run before testing.

The test programs used for preconditioning and the actual measurement are independent from each other, i.e., they can be different and can also include different parameters.

5.2.1 Bedding-in or burnishing procedure of wheel brakes {TPmDynoPC}

The pre-conditioning is applied before testing to prepare brake pads and rotors to run in stabilized condition at brake applies.

In general, the bedding-in or burnishing is realized by performing multiple brake applies from an initial speed, e.g., 50kph to 0kph.

Since the preconditioning is carried out in the same way and on the same machine as the actual measurement, a detailed description of the attributes is only documented in section 5.3.1.

5.3 Test programs

5.3.1 Measurement – Dynamometer {TpmDynoMS}

The „AK-Master" – Dynamometer Global Brake Effectiveness provides an overall picture of the friction value for a wheel brake. This test procedure evaluates the effective indicators of friction material, considering the different pressure, temperature and speed conditions for motor vehicles equipped with hydraulic brakes. The main purpose of SAE J2522 is to compare the friction material as closely as possible under similar conditions. To consider the different characteristics of the brake cooling systems of different dynamometers, the fade section is temperature controlled.

The following parameters on the inertia dynamometer are to be documented:

Basic attributes:

- *Inertia {Inertia}*
- *Velocity Start {VelocityStart}*
  (in case velocity is given as local speed at the contact surface)
- *Velocity Stop {VelocityStop}*
  (in case velocity is given as local speed at the contact surface)
- *Rotational Velocity Start {RotationalVelStart}*
  (in case velocity is given as rotational dynamometer speed)
- *Rotational Velocity Stop {RotationalVelStop}*
  (in case velocity is given as rotational dynamometer speed)

Control type to define the mode of deceleration. This control type affects the visibility of all the following attributes:

- *Control Type Deceleration {ControlTypeDecPress}* with the following values
  - *Deceleration {Deceleration}*
  - *Pressure {Pressure}*

Control type to define test programs when the mode of deceleration is pressure controlled:

- *Control Type Pressure {ControlTypeDynPress}* with the following values
  - *Step Size {StepSize}*
  - *Supporting Points {SupportingPoints}*
  - *Constant {Constant}*

  (in case *{ControlTypeDecPress}* = *'Pressure'*)

Definition of pressure-controlled deceleration:

- *Constant Pressure {PressureConst}*
  (in case *{ControlTypeDynPress}* = *'Constant'*)
- *Pressure Start {PressureStart}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{ControlTypeDynPress}* = *'StepSize'*)
- *Pressure Stop {PressureStop}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{ControlTypeDynPress}* = *'StepSize'*)
- *Pressure Step Size {PressureStepSize}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{ControlTypeDynPress}* = *'StepSize'*)
- *Pressure {Pressure}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{ControlTypeDynPress}* = *'SupportingPoints'*)

Definition of temperature-controlled measurements within the pressure-controlled regime:

- *Control Type Temperature {PrControlTypeTemp}* with the following attributes
  - *Step Size {StepSize}*
  - *Supporting Points {SupportingPoints}*
  - *Initial Temperature {Constant}*

  (in case *{ControlTypeDecPress}* = *'Pressure'*)
- *Initial Temperature {PrTemperatureInitial}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeTemp}* = *'Constant'*)
- *Temperature Start {PrTemperatureStart}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeTemp}* = *StepSize'*)
- *Temperature Start {PrTemperatureStop}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeTemp}* = *StepSize}*)
- *Temperature Start {PrTemperatureStepSize}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeTemp}* = *StepSize}*)
- *Temperature {PrTemperature}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeTemp}* = *SupportingPoints*)

Definition of snub- or application-controlled measurements within the pressure-controlled regime:

- *Control Type Applications {PrControlTypeSnubs}* with the following attributes
  - *Step Size {StepSize}*
  - *Supporting Points {SupportingPoints}*
  - *Constant {Constant}*

  (in case *{ControlTypeDecPress}* = *'Pressure'*)
- *Constant Number of Applications {PrSnubsConst}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeSnubs}* = *'Constant'*)
- *Applications Start {PrSnubsStart}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeSnubs}* = *StepSize'*)
- *Applications Start {PrSnubsStop}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeSnubs}* = *StepSize}*)

- *Applications Start {PrSnubsStepSize}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{PrControlTypeSnubs}* = *StepSize}*)
- *Applications {PrTemperature}*
  (in case *{ControlTypeDecPress}* = *'Pressure'* and *{ PrControlTypeSnubs}* = *SupportingPoints*)

Control type to define test programs when the mode of deceleration is pressure controlled:

- *Control Type Dynamometer {ControlTypeDynDec}* with the following values
  - *Step Size {StepSize}*
  - *Supporting Points {SupportingPoints}*
  - *Constant {Constant}*

  (in case *{ControlTypeDecPress}* = *'Deceleration*)

Definition of deceleration-controlled deceleration:

- *Constant Deceleration {DecelerationConst}*
  (in case *{ControlTypeDynDec}* = *'Constant'*)
- *Deceleration Start {DecelerationStart}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{ControlTypeDynDec}* = *'StepSize'*)
- *Deceleration Stop {DecelerationStop}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{ControlTypeDynDec}* = *'StepSize'*)
- *Deceleration Step Size {DecelerationStepSize}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{ControlTypeDynDec}* = *'StepSize'*)
- *Deceleration {Deceleration}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{ControlTypeDynPress}* = *'SupportingPoints'*)

Definition of temperature-controlled measurements within the deceleration-controlled regime:

- *Control Type Temperature {DecControlTypeTemp}* with the following attributes
  - *Step Size {StepSize}*
  - *Supporting Points {SupportingPoints}*
  - *Initial Temperature {Constant}*

  (in case *{ControlTypeDecPress}* = *'Deceleration'*)
- *Initial Temperature {DecTemperatureInitial}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeTemp}* = *'Constant'*)
- *Temperature Start {DecTemperatureStart}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeTemp}* = *StepSize'*)
- *Temperature Start {DecTemperatureStop}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeTemp}* = *StepSize}*)
- *Temperature Start {DecTemperatureStepSize}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeTemp}* = *StepSize}*)
- *Temperature {DecTemperature}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeTemp}* = *SupportingPoints*)

Definition of snub- or application-controlled measurements within the deceleration-controlled regime:

- *Control Type Applications {DecControlTypeSnubs}* with the following attributes
  - *Step Size {StepSize}*
  - *Supporting Points {SupportingPoints}*
  - *Constant {Constant}*

  (in case *{ControlTypeDecPress}* = *'Deceleration'*)
- *Constant Number of Applications {DecSnubsConst}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeSnubs}* = *'Constant'*)
- *Applications Start {DecSnubsStart}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeSnubs}* = *StepSize'*)
- *Applications Start {DecSnubsStop}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeSnubs}* = *StepSize}*)

- *Applications Start {DecSnubsStepSize}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{PrControlTypeSnubs}* = *StepSize}*)
- *Applications {DecTemperature}*
  (in case *{ControlTypeDecPress}* = *'Deceleration'* and *{ PrControlTypeSnubs}* = *SupportingPoints*)

J2522A: Dynamometer Global Brake Effectiveness - SAE International

5.3.2 Wear Test Procedure SAE-J2707 {TPmBrkWearMS}

The SAE J2707 describes a Wear Test Procedure on inertia dynamometer for brake friction materials. With that, it is possible to compare wear characteristics of brake pad and rotor for different combinations and set-ups.

The following parameters on the inertia dynamometer are to be documented:

- *Inertia {Inertia}*
- *Initial temperature {Temperature}*
- *Maximum Wear {WearMax}*
- *Number of Applications per Temperature Slot {NumberStopsPerSlot}*
- *Average Deceleration {AvgDecel}*
- *Initial Velocity {InitVel}*
- *Static Loaded Radius r_stat {TireStaticLoadRadius}*

J2707_202106: Wear Test Procedure on Inertia Dynamometer for Brake Friction Materials

5.3.3 Volume Consumption {TPmVolConsumption}

The measurement of the fluid volume consumption is not part of the dynamometer test program. Therefor a new test program has been defined.

The following parameters are to be documented:

Definition of the mode of measurement

- *Step Size Control {ControlStepSize}* with the following values
  - *Step Size {StepSize}*
  - *Supporting Points {SupportingPoints}*

Definition of pressure values

- *Pressure Start {PressureStart}*
  (in case { *ControlStepSize* } = 'Step Size')
- *Pressure Stop {PressureStop}*
  (in case { *ControlStepSize* } = 'Step Size')
- *Pressure Step Size {PressureStepSize}*
  (in case { *ControlStepSize* } = 'Step Size')
- *Pressure {Pressure}*
  (in case { *ControlStepSize* } = 'SupportingPoints')

5.4 Environmental Parameters {EnvironmentPara}

Due to the temperature dependency of measurements for wheel brakes environmental parameters shall be controlled.

5.4.1 Environmental Temperature {EnvironTempPara}

The environmental temperature shall be kept at a value of 15°C or 20°C unless otherwise specified.

5.4.2 Air Flow {EnvironAirFlowPara}

The airflow used for cooling of the wheel brake between and during brake applies. This airflow needs to be set according to the specific test run on the dynamometer. The two main applications are

1. simulation of airflow of moving vehicle and
2. cooling of wheel brake assembly to reach test specified initial brake rotor temperature.

6 Instance Data

6.1 Functional Data (part-specific) {FunctionalData}

This section contains a description of the utilizable result data and a reference to the test program that should typically be used to determine the values.

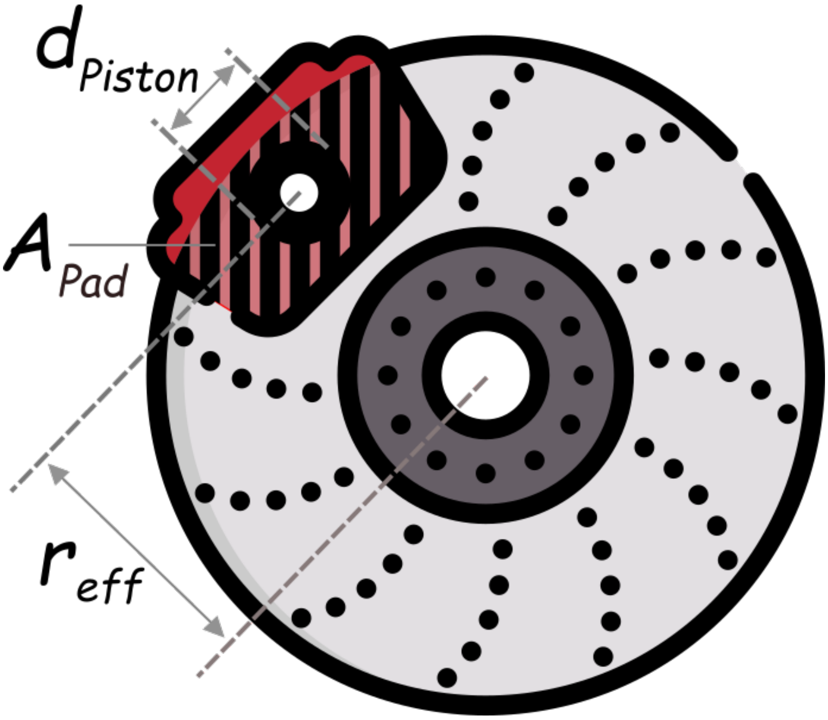

Figure 6.1: Geometrical terms of a disc brake (freepik.com)

6.1.1 Friction value characteristic

The friction value characteristic of a wheel brake can be determined using the AK-Master – Dynamometer Global Brake Effectiveness (SAE J2522) measurement.

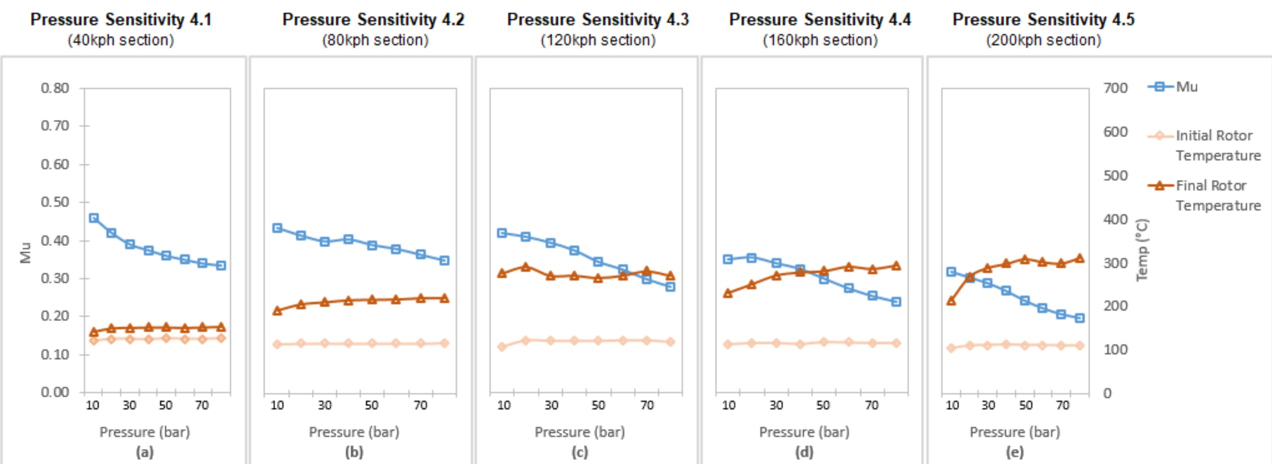

Figure 6.2: Friction coefficient at pressure applies

To obtain the most comprehensive behavior of the friction coefficient a series of test sections are applied. The wheel brake is excited with various pressure applies at different speed ranges (***Figure 6.2: Friction coefficient at pressure applies***

) and different initial brake rotor temperatures (*Figure 6.3*). Besides these checks and behavior sections are applied. Pressure in this context is the hydraulic pressure inside brake lines and brake caliper (not the mechanical pressure between pad and disc). Because the friction coefficient varies over time for each brake snub, an average friction coefficient is calculated for each snub. Therefore, the measurement results must contain the following vectors:

- *Velocity*
- *Pressure*
- *Temperature*
- *Friction Coefficient*

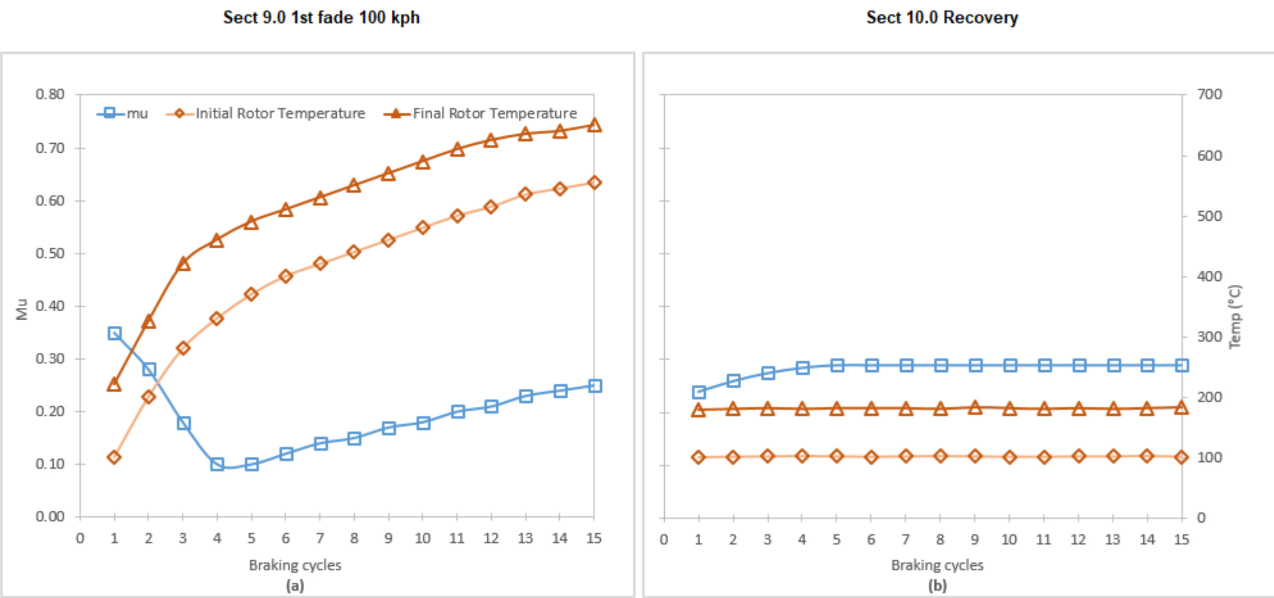

Figure 6.3: Friction coefficient over temperature

As result of the different measurements a friction map should be generated with Friction Coefficient {Mu} is described over Pressure {Pressure} and Temperature {Temperature}. An Example of a friction map is shown in *Table 6.1* or visualized in Figure 6.4: Field of friction coefficient over pressure and temperature

Pressure [bar] / **Temperature [°C]**	**5**	**10**	**25**	**50**	**120**
20	0.21	0.27	0.30	0.32	0.32
100	0.24	0.30	0.34	0.36	0.36
200	0.22	0.28	0.32	0.33	0.34
…	…	…	…	…	…
600	0.16	0.20	0.22	0.23	0.24

Table 6.1: Example of MapBrkFricVal

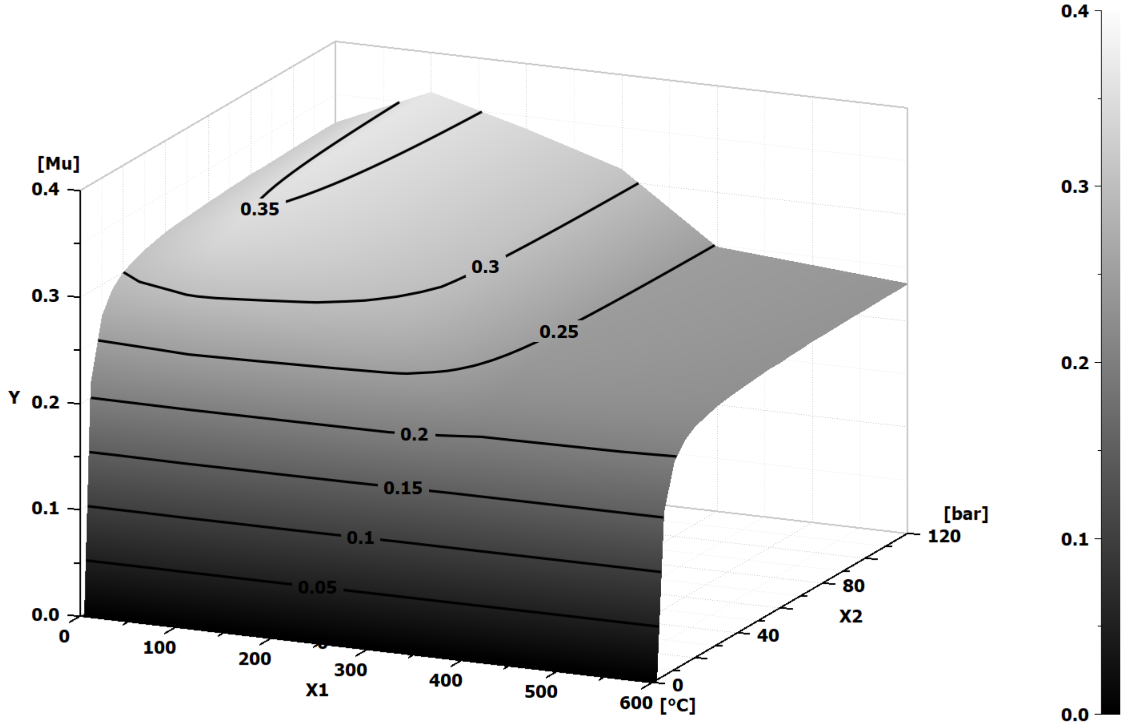

Figure 6.4: Field of friction coefficient over pressure and temperature

6.1.2 Brake lining wear characteristic

The brake lining wear characteristic is commonly generated by measuring the brake lining thickness at several measurement points at the brake lining surface before and after a series of brake applies at a specific initial temperature of the brake rotor. A series hereby usually consists of 500 or 1000 repetitive brake snubs. It is also foreseen to perform this series at the different brake rotor temperatures in an ascending and descending walk of temperature steps like shown in Table 6.2**:**

Temperature [°C]	Pad (mm)	No of Snubs
40°C	0.1	500
100°C	0.1	500
200°C	0.15	1000
300°C	0.35	1000
200°C	0.15	1000
100°C	0.10	500
40°C	0.05	500

Table 6.2: Example of brake lining wear characteristic

In that way not only stepwise heating up the brake is considered in the lining wear measurement, but also a second measurement when the lining has experienced the higher temperatures.

Beside of this the *Wear Test Procedure SAE-J2707 {TPmBrkWearMS}* might be a test procedure to use when measuring brake lining wear.

In the end, either test scenario should account to result in the following vectors:

- Temperature
- Lining wear

6.1.3 Low velocity friction curves

A velocity dependent friction characteristic is measured to obtain the transition of stiction to sliding of a pad-disc pair. The results shall show the behavior of the friction coefficient in a low velocity regime between 0 m/s (stiction) to at least 0.3 m/s in a high-resolution fashion. The measurement results at a defined contact pressure, temperature and relative humidity are described using the following vectors:

- Velocity
- Coefficient of friction

The measurement data that represents the friction curves are shown as followed in Table 6.3 and Figure 6.5

Velocity m/s	Friction coeff. -
0.0001	0.4129
0.0002	0.4128
0.0003	0.4126
0.0004	0.4125
0.0005	0.4124
…	…
0.2997	0.3592
0.2998	0.3592
0.2999	0.3592
0.3	0.3592

Table 6.3: Example of a velocity dependent friction coefficient measurement

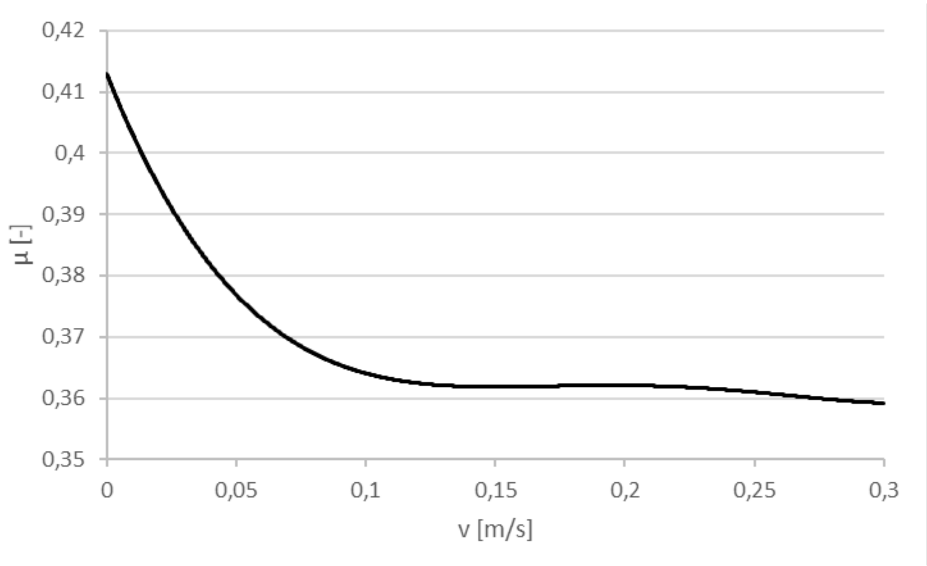

Figure 6.5: Velocity dependent characteristics of the friction coefficient

The following parameters must be provided for each set of velocity dependent friction curves:

- Contact pressure
- Temperature
- Relative humidity

6.1.4 Volume Consumption of Brake Caliper

A representative volume consumption is measured either at different levels of hydraulic pressures for hydraulic or of force for non-hydraulic applied brake. To have a complete picture of a brake calipers volume consumption, application levels shall comprise the complete range of application, e.g., for hydraulic brakes pressures from 5 bar to 120 bar are usually applied. The measurement results are described using the following vectors:

- Pressure
- Consumed Volume

The derivate of the measurement is a characteristic curve representing the volume consumption like shown in *Table 6.4*:

bar	cm³
0	0
5	0.77
20	1.115
40	1.47
60	1.81
100	2.375
160	3.1

Table 6.4: Example of volume consumption (CurveVolConsCaliper)

Beside the characteristic curve of volume consumption (CurveVolConsCaliper) the following parameters should be provided as derived characteristics

- Push-out pressure
- Running clearance
- Parameters of approximation function V = A*p/(B+p) + C*p:
  A: Pressure compliance factor [cm³]
  B: Curvature factor of the non-linear share of the pad characteristic [bar]
  C: Compliance of brake caliper and linear share of pad characteristic [cm³/bar]
  V: volume consumption

6.2 Derived Characteristics (part-specific)

For the AK-Master SAE-J2522 {TPmAKMasterMS} measurement the following characteristic values can be derived and are typically shared

	Reference to SAE-J2522	Reference in FDX Document	Description
General Characteristic Value	3		Average friction value
Pressure Sensitivity Value 1	4.3	Fig. 6.2c	Average friction value
Pressure Sensitivity Value 2	4.5	Fig. 6.2e	Average friction value
Post Speed Characteristic Value	5		Average friction value
40°C Brake Apply	6		Average friction value
Second Motorway Apply	7		Average friction value
Post Motorway Characteristic Value	8		Average friction value
Fade 1	9	Fig. 6.3a	Minimum friction value
Recovery Characteristic Value	10	Fig. 6.3b	Average friction value
Temperature Sensitivity Value	12		Minimum friction value
Characteristic Check Value	13		Average friction value
Fade 2	14		Minimum friction value
Post Fade Characteristic Value	15		Average friction value

Table 6.5 Characteristic values from AK Master

The stipulations for calculating each of the characteristic values will be agreed on an individual basis between the client and the supplier.

7 Closing Remarks

A description of the generally applicable, non-part-specific concepts can be found in Part 2. A complete overview and brief description of all part-specific and non-part-specific attributes can be found in the Attributes Data Sheet (Annex A to Part 2).

8 Table of Attributes

9 References

Breuer, B. (2012). Bremsenhandbuch.

freepik.com. (2023). Retrieved from https://www.freepik.com/free-icon/tools-utensils_14433173.htm?query=brake#from_view=detail_alsolike

prostep ivip association

Dolivostraße 11
64293 Darmstadt
Germany

Phone+49-6151-9287336
Fax +49-6151-9287326

psev@prostep.com www.prostep.org

ISBN 978-3-948988-27-2
Version 1.0, 2023-7