TYDEX-Format

Description
and
Reference Manual

Release 1.3

Initiated by the TYDEX Workshop

worked out by

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09.01.1997

Contents

1. Introduction

The Tyre Data Exchange Format (TYDEX) has been developed and unified by an international tyre working group to make the tyre measurement data exchange easier.

This format can be used by anybody without special permission and without paying any licence fee.

Proposals for further extensions to this format should be given to the chairman of the TYDEX Working Group, to persons listed below or to other members of this group.

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1.1 Participating Companies

Following companies or institutes are supporting the TYDEX file format described here:

BMW AG	Germany
Robert Bosch GmbH	Germany
Centro Ricerche FIAT	Italy
Continental AG	Germany
Daimler-Benz AG	Germany
FTH Esslingen	Germany
Ford Werke AG	Germany
Goodyear S.A.	Luxembourg
IPG GmbH	Germany
Mercedes-Benz AG	Germany
Michelin	France
NedCar	The Netherlands
Porsche AG	Germany
PSA	France
Steyr-Daimler-Puch	Austria
Toyota (TCL)	Japan
Volkswagen AG	Germany
Volvo Car Corp.	Sweden
Volvo Truck Corp.	Sweden
TNO	The Netherlands
University of Berlin	Germany
University of Delft	The Netherlands
University of Karlsruhe	Germany
University of Vienna	Austria

2. Description of the File Structure

An example of the file structure can be seen in chapter 2.4.

The proposed file extension of the TYDEX data file is .tdx (e.g. a complete file name may be MEAS01.TDX) .

2.1 General Remarks

The keywords, the physical units and all other text may be written either in upper or in lower case letters or mixed (TIME=Time=time). The 8-bit ANSI-ASCII character set has to be used. National character sets are not allowed.

Each record line may be 80 characters long except the **MEASURDATA, the **MODELCOEFFICIENTS and the **MODELOUTPUTS sections for which it will be more comfortable to have one line per sample. In that case the record length may be up to 255 characters.

Blank lines are ignored. They can be used to structure the file and to improve its readability.

Comments can be given in lines starting with ! (exclamation mark). These lines may have any position in any block of the file, but they will be ignored during reading the file. These comment lines may be helpful to add remarks using an editor.

Example:

```
Column
1           11                                41         51         61         71
!  The rest of this line is comment that will be ignored during reading
```

2.2 Keywords

Every keyword (except **MODELEND and **END) is the header of a section containing special information on the data.

The data file may consist of up to 12 keywords:

**HEADER
**COMMENTS
**CONSTANTS
**MEASURCHANNELS
**MEASURDATA
**MODELDEFINITION
**MODELPARAMETERS
**MODELCOEFFICIENTS
**MODELCHANNELS
**MODELOUTPUTS
**MODELEND
**END

- All keywords start in column 1 with 2 asterisks. They may be written in lower, upper case or mixed case letters (HEADER=Header=header). They must not contain any blanks.
- The keywords **HEADER and **END must appear in every file. The other keywords are optional.
- If sections concerning the tyre model are used, the keywords **MODELDEFINITION and **MODELEND must appear.
- Only one **CONSTANTS section is allowed in one data file. This **CONSTANTS section is valid for all sections referring to the measurement and the model.

- If **MEASURCHANNELS is given also a **MEASURDATA section must occur. Only one **MEASURCHANNELS and one **MEASURDATA keyword is allowed.
- If sections concerning the tyre model are used they have to be pooled in one block. In the beginning of this block the section **MODELDEFINITION appears, in which the used tyre model is defined and a model reference code is shown to avoid mistakes. In the end of the block **MODELEND appears so that it is clear that all sections between **MODELDEFINITION and **MODELEND are related to one tyre model.
- Several blocks of MODEL sections are allowed. This makes it possible to describe lateral force and aligning moment models in consecutive sections within the same file.
  If more than one block of MODEL sections is used in one file, the connected **MODELDEFINITION and **MODELEND also appears several times. The blocks have to refer to the same testing conditions, i.e. to the same **CONSTANTS section.
- For certain tyre models, the mixing of model and measurement data does not appear to be sensible. If model data concerning these tyre models is to be stored in TYDEX format, the keywords **MEASURCHANNELS and **MEASURDATA do not appear.

2.2.1 **HEADER

This section contains information to identify the measurement. It is suitable for the file management.

- This keyword must occur in every TYDEX data file !
- It must be the first keyword.
- It may be written in lower or upper case letters or mixed.

This section consists of only 5 parameters, as shown in the following example:

```
Column
1          11                                  41          51          61          71
**HEADER
RELEASE    Release of TYDEX-Format                         1.3
MEASID     Measurement ID                                  05039ABC
SUPPLIER   Data Supplier                                   MICHELIN
DATE       Date                                            26/01/97
CLCKTIME   Clocktime                                       09:50
```

For further details, see chapter 2.5.1 .

2.2.2 **COMMENTS

This section contains information which cannot be put into other blocks or which is additional user information. This block will be read in during the postprocessing phase and can be printed or plotted (instead of comment lines starting with „!“).

- Lines after this keyword have free format. They can be generated by a computer program as well as using an editor.
- An unlimited number of comment lines is allowed. This section ends one line before the next keyword starting with 2 asterisks (**).
- In this section the quality of the model-to-measurements-fitting can be specified.

2.2.3 **CONSTANTS

This section contains measurement and model data and character information which is constant for the whole measurement or model given in this file. Normally, all information about tyre, rim and test conditions is given in this section if a parameter has been defined (see chapter 2.5). If any information is unknown it can be omitted although there is a parameter. However, the user should be endeavoured to give all information available for the parameters which have been defined.

Numerical values given in the **CONSTANTS section instead of the **MEASURDATA or **MODELOUTPUT sections save disk space, but they can be used as if they were measured or modelled (e.g. by expansion to a full vector during postprocessing).

- The number of constants is not limited.
- The names of the constants are fixed and have definite meanings to use them for an automated postprocessing system (see chapter 2.5.2).

The given physical unit makes it possible to switch automatically to another unit.

The **CONSTANTS section has the following format:

```
Column
1_________11_____________________________41________51________61________71
pppppppp  text                           unit      value
```

using

pppppppp parameter (see parameter list below)
can be written in upper case, lower case or mixed case letters
max. 8 characters long
starting in column 1

text channel text, either in English or in another language
spelling not fixed, max. 29 characters long
starting in column 11

unit physical unit (see list of allowed physical units below)
starting in column 41

value may be either a numerical value or a text string (depending on parameter)
starting in column 51

Example:

```
Column
1          11                                   41        51        61        71
AMBITEMP   Ambient Temperature                  deg C     25
```

The parameter AMBITEMP defines the ambient temperature in degrees Celsius, which was 25 °C during the whole measurement.

2.2.4 **MEASURCHANNELS

This section contains only measured (time dependent) data. The section gives the channel text, the unit and (if necessary) factors for the conversion into physical units. The unit codes and their spelling are defined in chapter 2.3 .

- Only parameters with numerical values are allowed.
- The number of channels is not limited.
- The names of the variables are fixed and have definite meaning to use them for an automated postprocessing system (see chapter 2.5.2).

The given physical unit makes it possible to switch automatically to another unit.

The **MEASURCHANNELS section has the following format:

```
Column
1          11                                   41        51        61        71
pppppppp   text                                 unit      a         b         c
```

using

pppppppp parameter (see list in chapter 2.5)
can be written in upper case, lower case or mixed case letters
max. 8 characters long
starting in column 1

text	channel text, either in English or in another language spelling not fixed, max. 29 characters long starting in column 11
unit	physical unit (see list of allowed physical units in chapter 2.3) starting in column 41
a	factor to convert the measured values into physical values starting in column 51 can be omitted (default: 1)
b	offset to shift the measured values starting in column 61 b has the same unit as $d_{measured}$ can be omitted (default: 0)
c	offset to shift the physical values starting in column 71 c has the same unit as $d_{physical}$ can be omitted (default: 0)

The following formula is used to convert the measured values into physical values:

$$d_{physical} = a \bullet (d_{measured} + b) + c$$

using

$d_{physical}$	physical value
$d_{measured}$	measured value (e.g. integer values)

- If 'b' or 'c' or both are given 'a' has to be set to 1 explicitly.

Example:

```
Column
1          11                                   41          51          61          71
TRDTEMP    Tread Surface Temperature            deg C       1           0           -273.15
```

The measurement values in the **MEASURDATA section (see below) have to be changed using the following formula to convert them into degrees Celsius (°C):

$$d_{physical} = 1 \bullet (d_{measured} + 0) - 273.15$$

(in this special case the measured values are given in Kelvin).

2.2.5 **MEASURDATA

In this section all measured data is given sample by sample.

- All measured data is listed in the same order as in the **MEASURCHANNELS section.
- Every new measurement sample starts in a new line.
- The format of the values in this section can be integer or real, but all values have to be separated by at least one blank.

The number of values per line corresponds to the number of channels in the **MEASURCHANNELS section. If there is not enough space to put all values of one sample into one line, the number of measurement values per line can be given after the **MEASURDATA keyword as follows:

```
**MEASURDATA nn
```

with

nn number of measurement values per line
nn is separated by at least 1 blank from **MEASURDATA
can be omitted (default: all values in one line)

This feature makes it possible to store an unlimited number of channels in the data file.

Example:

The measurement consists of 20 measurement channels (20 values per sample), but only 8 values can be put into one line. The **MEASURDATA section starts as follows (only 2 samples are shown):

```
**MEASURDATA 8

1231.7      8467.3      0.02604     329.6       -142E3      0.01828     17.947      182.9
48.9274     27.2        2483        -3.192      -93716      -1024       +4.7E-3     9376.
111.11      222.22      3333.3      4444.4
1231.7      8467.3      0.02604     329.6       -143E3      0.01828     17.947      182.9
48.9274     27.2        2483        -3.512      -93716      -1024       +4.7E-3     9179.
111.11      222.22      3333.3      4444.4
```

This format is not very clearly arranged, but there is no problem to read the data set with a computer program automatically.

2.2.6 **MODELDEFINITION

This section is the first one for a model description. The first line is formatted and contains the keyword MODELREF followed by the name of the model in column 11, the supplier’s model reference code in column 41 and the supplier name in column 51.

Example:

```
Column
1_________11_____________________________41________51________61________71
**MODELDEFINITION
MODELREF  IPG-TIRE                       3.6       IPG
```

The following lines in this section are used to define which are the inputs and the outputs of the model. For input data, the minimum and maximum values allowed for each parameter can be specified in order to lay down a validity domain.

The unit codes and their spelling are defined in chapter 2.3.

- The number of lines is not limited.
- The model supplier is allowed to use variables not mentioned in the parameter list (see chapter 2.5), but in this case he is obliged to give a definition to his customer.

The given physical unit makes it possible to switch automatically to another unit.

The second and the following lines in the **MODELDEFINITION section have the following format:

```
Column
1         11                                    41        51        61        71

pppppppp  text                                  unit      f         min       max
```

using

pppppppp parameter
can be written in upper case, lower case or mixed case letters
max. 8 characters long
starting in column 1

text text, either in English or in another language
spelling not fixed, max. 29 characters long
starting in column 11

unit physical unit (see list of allowed physical units in chapter 2.3)
starting in column 41

f — indicator for input / output of the model
'out' denoting output data of the model
'in' denoting input data of the model
starting in column 51

min — minimum value allowed for the input channel
starting in column 61
can be omitted (default: no limit)
no value for output channels

max — maximum value allowed for the input channel
starting in column 71
can be omitted (default: no limit)
no value for output channels

If some specific information about the model has to be given to the user of the model (e.g. the quality of the model-to-measurements-fitting) it may be transmitted as comment lines.

Example:

```
Column
1         11                                    41          51          61          71
**MODELDEFINITION
MODELREF  Pacejka Magic Formula (FYH)           ADY9006A    MICHELIN
FYH       Lateral Force                         N           out
FZH       Vertical Force                        kN          in          0.5         10
SLIPANGL  Slip Angle                            deg         in          -9          9
INCLANGL  Inclination Angle                     deg         in          -5          5
!
!      -----    Quality identification of the  model    -----
! ETR       Residual Standard Deviation         N           55.10
! TAUXERR   Error Ratio                         %           2.47
! ECARTMAX  Maximum deviation                   N           118.45
```

2.2.7 **MODELPARAMETERS

This section contains the list of named parameters necessary to describe the tyre model. Each line is formatted and contains one single parameter. This section is particularly dedicated to models which are using parameters with physical meanings *(example: IPG-TIRE, BRIT).* The format is similar to the one used for the **CONSTANTS section.

The number mm of parameters is indicated in the line **MODELPARAMETERS after the keyword.

```
**MODELPARAMETERS mm
```

The number mm is separated by at least 1 blank from **MODELPARAMETERS.

Example 1:

```
Column
1         11                                  41          51          61          71
**MODELPARAMETERS 8
OVALLDIA    Overall Diameter                  mm          576
ITFYVMY     Relat. G-/H-Frict. Coeff. FY                  0.9
ITFXAVMY    Relat. G-/H-Frict. Coeff. FXA                 0.9
ITFXDVMY    Relat. G-/H-Frict. Coeff. FXD                 0.9
ITVS        Vertical Stiffness                            175000.0
ITVD        Vertical Damping                              500
ITRLLO      Rel. Relax.-Length Longitud.                  0.05
ITRLLA      Rel. Relax.-Length Lateral                    0.5
```

Example 2:

```
Column
1           11                                41          51          61          71
**MODELPARAMETERS 58
M           Mass                              kg          10
IR          Rim_Inertia                       kgm2        0.5
RTTR        Rel_Tread_Transv_Radius           %           165
. . .
```

The model supplier is allowed to use parameters not mentioned in the parameter list (see chapter 2.5), but in this case he is obliged to give a definition to his customer.

2.2.8 **MODELCOEFFICIENTS

This section is a free format part. The description of the contents of this section is the model supplier's responsibility (referring to MODELREF in the **MODELDEFINITION section). He must send to his customer the necessary information how to read this section. Some files used by IPG in IPG-TIRE may represent a good example for the use of this section.

<u>Example:</u>

```
**MODELCOEFFICIENTS

!  Side Force
   1    2    6  140
  0.000E+00  5.983E+03  0.000E+00  1.475E-02  2.950E-02
  5.900E-02  1.180E-01  1.571E+00 -1.379E-14  1.945E-31
  1.379E-14 -5.514E-14  1.461E-01 -1.858E-01 -2.907E-01
 -2.907E-01 -2.907E-01 -2.907E-01  2.663E-31 -5.399E-48
.
.
.
  5.029E+03  4.969E+03  4.944E+03 -4.546E-01 -6.206E-01
 -7.866E-01  4.337E-02  2.411E+03  3.915E+03  4.981E+03
  5.030E+03  4.969E+03  4.945E+03  1.000E+00  9.000E-01

! Longitudinal Force acc.
   1    2    6  140
  0.000E+00  5.992E+03  0.000E+00  3.540E-03  7.080E-03
  1.416E-02  2.832E-02  1.000E+00 -4.800E-18  9.499E-35
  4.800E-18 -1.920E-17 -9.850E-01  4.702E+00 -1.944E+00
 -1.944E+00 -1.944E+00 -1.944E+00  0.000E+00  0.000E+00
.
.
.
  4.657E+03  4.657E+03  4.657E+03  1.967E-14 -3.891E-31
 -1.967E-14  7.870E-14  1.456E+03  3.347E+03  4.657E+03
  4.657E+03  4.657E+03  4.657E+03  1.000E+00  9.000E-01

! Longitudinal Force dec.
   1    2    6  140
  0.000E+00  5.946E+03  0.000E+00  5.774E-03  1.155E-02
  2.309E-02  4.619E-02  1.000E+00  4.808E-18 -9.499E-35
 -4.808E-18  1.923E-17  2.090E+00 -1.412E+00  1.953E+00
  1.953E+00  1.953E+00  1.953E+00 -6.672E-35  1.318E-51
.
.
.
```

2.2.9 **MODELCHANNELS

This section has to be used in combination with a **MODELOUPUTS section in the same way as **MEASURCHANNELS and **MEASURDATA sections are linked. The section gives the channel text and the units of the data following in the **MODELOUTPUTS section.

The unit codes and their spelling are defined in chapter 2.3.

- Only parameters with numerical values are allowed.
- The number of channels is not limited.
- The model supplier is allowed to use variables not mentioned in the parameter list (see chapter 2.5), but in this case he is obliged to give a definition to his customer.

The given physical unit makes it possible to switch automatically to another unit.

The **MODELCHANNELS section has the following format:

```
Column
1         11                                      41        51        61        71

pppppppp  text                                    unit
```

using

pppppppp parameter
can be written in upper case, lower case or mixed case letters
max. 8 characters long
starting in column 1

text channel text, either in English or in another language
spelling not fixed, max. 29 characters long
starting in column 11

unit physical unit (see list of allowed physical units in chapter 2.3)
starting in column 41

Example:

```
Column
1_________11________________________________41________51________61________71
**MODELCHANNELS
CORNSFY     Cornering Stiffn. Lat. Force       N/deg
ALIGNSMZ    Aligning Stiffness                 Nm/deg
FZH         Vertical Force                     N
INFLPRES    Inflation Pressure                 bar
```

2.2.10 **MODELOUTPUTS

In this section, all input and output data concerning the used tyre model is given sample by sample.

- All modelled data is listed in the same order as in the respective **MODELCHANNELS section.
- Every new data sample starts in a new line.
- The format of the values in this section may be either integer or real, but all values have to be separated by at least one blank.
- Several couples of **MODELCHANNELS/**MODELOUPUTS sections may appear in one file, but they have to be arranged together

The number of values per line corresponds to the number of channels in the respective **MODELCHANNELS section. If there is not enough space to put all values of one sample into one line, the number of modelling values per line can be given after the **MODELOUTPUTS keyword as follows:

```
**MODELOUTPUT nn
```

with

nn number of modelling values per line
nn is separated by at least 1 blank from **MODELOUTPUTS
nn can be omitted (default: all values one line)

This feature makes it possible to store an unlimited number of channels in the data file.

Example:

The model consists of 20 modelling channels (20 values per sample), but only 8 values can be put into one line. The **MODELOUTPUTS section starts as follows (only 2 samples are shown):

```
 **MODELOUTPUTS 8
1231.7     8467.3     0.02604    329.6      -142E3     0.01828    17.947     182.9
48.9274    27.2       2483       -3.192     -93716     -1024      +4.7E-3    9376.
111.11     222.22     3333.3     4444.4
1231.7     8467.3     0.02604    329.6      -143E3     0.01828    17.947     182.9
48.9274    27.2       2483       -3.512     -93716     -1024      +4.7E-3    9179.
111.11     222.22     3333.3     4444.4
```

This format is not very clearly arranged, but there is no problem to read the data set with a computer program automatically.

2.2.11 **MODELEND

This keyword indicates the end of the block with model sections concerning one tyre model. The number of keywords **MODELEND corresponds to the number of keywords **MODELDEFINITION which again corresponds to the number of used tyre models.

2.2.12 **END

This keyword indicates the end of the file.

- It must absolutely occur in every TYDEX data file to recognize loss of data.
- Any information after this line is ignored.

2.3 Physical Units

The SI-units in the following table 2.3.1 should be preferred, but the units in the table 2.3.2 also can be used. The spelling of the units is fixed to enable a computer program to recognize the units and to convert them into another unit.

Table 2.3.1: **The preferred SI-units**

value	SI-unit
time	s
length, radius	m
angle	rad
velocity	m/s
rotation speed	rad/s
acceleration	m/s2
rotation acceleration	rad/s2
curvature	1/m
force	N
moment	Nm
stiffness	N/m
mass	kg
inertia	kgm2
temperature	K
pressure	Pa
no unit	*[blanks]*

Table 2.3.2: **The alternatives to the SI-units**

SI-unit	alternatives	conversion factor
s	min	1 min = 60 s
m	mm	1 mm = 0,001 m
	km	1 km = 1000 m
	in = inch = ’’	1 in = 0,0254 m
	ft = foot	1 ft = 0,3048 m
	yd = yard	1 yard = 0,9144 m
	mile	1 mile = 1609,34 m
rad	deg	1 deg = 0,01745 rad
m/s	km/h	1 km/h = 0,27778 m/s
	mph	1 mph = 0,44704 m/s
	ft/s	1 ft/s = 0,3048 m/s
	in/s	1 in/s = 0,0254 m/s
rad/s	deg/s	1 deg/s = 0,01745 rad/s
	Hz	n = 1 Hz $\hat{=}$ ω = 6,2832 rad/s
	1/min	n = 1/min $\hat{=}$ ω = 0,1047 rad/s
rad/s2	deg/s2	1 deg/s2 = 0,01745 rad/s2
N	kN	1 kN = 1000 N
	daN	1 daN = 10 N
	lbf	1 lbf = 4,448222 N
Nm	kNm	1 kNm = 1000 Nm
	daNm	1 daNm = 10 Nm
	in·lbf	1 in·lbf = 0,112985 Nm
	ft·lbf	1 ft·lbf = 1,355818 Nm

(continued on next page)

SI-unit	alternatives	conversion factor		
N/m	N/mm	1 N/mm	=	0,001 N/m
	lbf/in	1 lbf/in	=	175,12598 N/m
	lbf/ft	1 lbf/ft	=	14,593832 N/m
kg	lb	1 lb	=	0,4535924 kg
K	deg C	1 deg C	=	1 K[1)]
Pa	bar	1 bar	=	10^5 Pa
	hPa	1 hPa	=	100 Pa
	kPa	1 kPa	=	1000 Pa
	MPa	1 MPa	=	10^6 Pa
	lbf/in2 = psi	1 lbf/in2	=	6894,76 Pa
-	%	1 %	=	0,01

[1)] valid for temparature difference

2.4 Examples

Example 1: **Measurement Data and Model Data in One File**

```
Column
1        11                            41        51         61        71        80
**HEADER
RELEASE  Release of TYDEX-Format                 1.3
MEASID   Measurement ID                          05039ABC
SUPPLIER Data Supplier                           MICHELIN
DATE     Date                                    01/02/97
CLCKTIME Clocktime                               09:50

**COMMENTS
This section can be used to put in any comment. The format is free. Blank lines can be
used.
The section ends at the next keyword starting with **.

**CONSTANTS
NOMWIDTH Nominal Section Width of Tyre mm        185
ASPRATIO Nominal Aspect Ratio          %         70
TYSTRUCT Tyre Structure                          radial
RIMDIAME Nominal Rim Diameter          inch      13
LOADIND  Load Index                              84
INFLPRES Inflation Pressure            bar       2.5
!  The rest of this line is comment that will be ignored during reading
INCLANGL Inclination Angle             deg       -3
AMBITEMP Ambient Temperature           deg C     25
NOTAVAIL Value for not available Data            1E99

**MEASURCHANNELS
MEASNUMB Measurement Point No.
RUNTIME  Running Time                  s         0.01
FZH      Vertical Force                kN        0.001
!  The rest of this line is comment that will be ignored during reading
SLIPANGL Slip Angle                    deg
LONGSLIP Longitudinal Slip             %         100.
FYH      Lateral Force                 N
FX       Longitudinal Force            N
MZH      Aligning Moment               Nm
TRDTEMP  Tread Surface Temperature     deg C     1.         0.        -273.15

**MEASURDATA
1         0.        4000      0.00      0.00      0.        0.        0.        343.
2         1.        4000      0.02      -0.01     -200      -100.     20.       344.
3         2.        4100      0.04      1E99      -400.     0.        40.       342.

**MODELDEFINITION
MODELREF Cornering Stiffnesses         DZ/GZ     MICHELIN
CORNSFY  Cornering Stiffn. Lat. Force  N/deg     out
ALIGNSMZ Aligning Stiffness            Nm/deg    out
FZH      Vertical Force                N         in         500       10000
INFLPRES Inflation Pressure            bar       in         1.8       2.8

**MODELCHANNELS
CORNSFY  Cornering Stiffn. Lat. Force  N/deg
ALIGNSMZ Aligning Stiffness            Nm/deg
FZH      Vertical Force                N
INFLPRES Inflation Pressure            bar
```

(continued on next page)

```
Column
1          11                                  41         51         61         71        80
**MODELOUTPUTS
221        5.869      500        1.8
1255       37.42      3000       1.8
3187       104.55     10000      1.8
210        5.472      500        2.0
1189       35.78      3000       2.0
3315       99.61      10000      2.0
204        5.087      500        2.2
1147       33.93      3000       2.2
3407       94.04      10000      2.2
...        ...        ...        ...

**MODELEND

**END
```

Example 2: **File to Transmit IPG-TIRE Data**

```
Column
1        11                            41        51         61        71       80
**HEADER
RELEASE  Release of TYDEX-Format                 1.3
MEASID   Measurement ID                          08*0
SUPPLIER Data Supplier                           Universitaet Karlsruhe (TH)
DATE     Date                                    01/02/97
CLCKTIME Clocktime                               08:50

**COMMENTS
This is an example of a file to transmit model data of IPG-TIRE

**CONSTANTS
TESTRIG  Test Rig                                IPS
NOMWIDTH Nominal Section Width of Tyre mm        185
ASPRATIO Nominal Aspect Ratio          %         60
TYSTRUCT Tyre Structure                          R
LOADIND  Load Index                              82
SPEEDSYM Speed Symbol                            H
RIMDIAME Nom. Rim Diameter             inch      14
RIMWIDTH Rim Width                     inch      6
MANUFACT Manufacturer                            NoName
IDENTITY Identity                                XYZ
PRESEVOL Infl. Press. Evol.                      regulated
INFLPRES Inflation Pressure            bar       2.5
TRDDEPB  Tread Depth before            mm        5.0
TRCKSURF Surface of Track                        Asphalt 0/11
TRCKCOND Condition of Track Surface              dry
AMBITEMP Ambient Temperature           deg C     20
WATDEPTH Waterfilm Depth               mm        0
INCLANGL Inclination Angle             deg       0

**MODELDEFINITION

MODELREF IPG-TIRE                      3.6       IPG

**MODELPARAMETERS 8

OVALLDIA Overall Diameter              mm        576
ITFYVMY  Relat. G-/H-Frict. Coeff. FY            0.9
ITFXAVMY Relat. G-/H-Frict. Coeff. FXA           0.9
ITFXDVMY Relat. G-/H-Frict. Coeff. FXD           0.9
ITVS     Vertical Stiffness                      175000.0
ITVD     Vertical Damping                        500.0
ITRLLO   Rel. Relax.-Length long.                0.05
ITRLLA   Rel. Relax.-Length lat.                 0.5

**MODELCOEFFICIENTS

!  Side Force
   1    2    6  140
  0.000E+00  5.983E+03  0.000E+00  1.475E-02  2.950E-02
  5.900E-02  1.180E-01  1.571E+00 -1.379E-14  1.945E-31
  1.379E-14 -5.514E-14  1.461E-01 -1.858E-01 -2.907E-01
 -2.907E-01 -2.907E-01 -2.907E-01  2.663E-31 -5.399E-48
.
.
.
  5.029E+03  4.969E+03  4.944E+03 -4.546E-01 -6.206E-01
 -7.866E-01  4.337E-02  2.411E+03  3.915E+03  4.981E+03
  5.030E+03  4.969E+03  4.945E+03  1.000E+00  9.000E-01
```

(continued on next page)

```
! Longitudinal Force acc.
   1    2    6  140
  0.000E+00  5.992E+03  0.000E+00  3.540E-03  7.080E-03
  1.416E-02  2.832E-02  1.000E+00 -4.800E-18  9.499E-35
  4.800E-18 -1.920E-17 -9.850E-01  4.702E+00 -1.944E+00
 -1.944E+00 -1.944E+00 -1.944E+00  0.000E+00  0.000E+00
.
.
.
  4.657E+03  4.657E+03  4.657E+03  1.967E-14 -3.891E-31
 -1.967E-14  7.870E-14  1.456E+03  3.347E+03  4.657E+03
  4.657E+03  4.657E+03  4.657E+03  1.000E+00  9.000E-01

! Longitudinal Force dec.
   1    2    6  140
  0.000E+00  5.946E+03  0.000E+00  5.774E-03  1.155E-02
  2.309E-02  4.619E-02  1.000E+00  4.808E-18 -9.499E-35
 -4.808E-18  1.923E-17  2.090E+00 -1.412E+00  1.953E+00
  1.953E+00  1.953E+00  1.953E+00 -6.672E-35  1.318E-51
.
.
.
  5.108E+03  5.108E+03  5.108E+03  9.862E-15  0.000E+00
 -9.862E-15  3.945E-14  1.401E+03  3.902E+03  5.110E+03
  5.110E+03  5.110E+03  5.110E+03  1.000E+00  9.000E-01

!  Aligning Torque
   1    2    8  160
  0.000E+00  5.982E+03  0.000E+00  3.587E-02  7.174E-02
  1.076E-01  1.435E-01  1.793E-01  2.152E-01  1.571E+00
 -4.670E-12 -6.272E-12 -7.873E-12  1.333E-13  2.852E-02
  3.855E-03  6.567E-02  6.567E-02  6.567E-02  6.567E-02
.
.
.
 -6.993E+00 -1.882E+01 -1.942E+01 -1.864E+01 -1.834E+01
  8.506E-03  1.141E-02  1.432E-02 -2.107E-04 -4.567E-01
 -6.979E+00 -1.885E+01 -1.945E+01 -1.868E+01 -1.837E+01
  1.000E+00 -1.000E-01

**MODELEND

**END
```

Example 3: **File to Transmit Data of a Mathematical Fit Model**

```
Column
1        11                           41         51          61         71        80
**HEADER
RELEASE  Release of TYDEX-Format                 1.3
MEASID   Measurement ID                          05438REG
SUPPLIER Data supplier                           MICHELIN
DATE     Date                                    28/11/96
CLCKTIME Clocktime                               14:26

**COMMENTS
This is an example of a file to transmit a tyre model using Magic formula

**CONSTANTS
NOMWIDTH Nominal Section Width of Tyre mm        175
ASPRATIO Nominal Aspect Ratio         %          70
TYSTRUCT Tyre Structure                          radial
RIMDIAME Nominal Rim Diameter         inch       13
LOADIND  Load Index                              82
SPEEDSYM Speed symbol                            T
RIMWIDTH Rim Width                    inch       5.0
RIMPROF  Rim Profile                             J
MANUFACT Tyre Manufacturer                       MICHELIN
IDENTITY Commercial Name                         MXT Energy
PARTNUM  Part Number                             1476_UR_35866
INFLPRES Inflation Pressure           bar        2.3
PRESEVOL Inflation Pressure Evolution            regulated
LONGVEL  Longitudinal Velocity        m/s        22.22
AMBITEMP Ambient Temperature          deg C      25

**MODELDEFINITION
MODELREF Pacejka Magic Formula (MZH)  ADN9006A   MICHELIN
MZH      Aligning Moment              Nm         out
FZH      Vertical Force               kN         in          0.5        8
SLIPANGL Slip Angle                   deg        in          -9         9
INCLANGL Inclination Angle            deg        in          -5         5

**MODELPARAMETERS 18
C1       1st coefficient                         -2.93100
C2       2nd coefficient                         -12.4106
C3       3rs coefficient                         .556792
C4       4th coefficient                         -3.32826
C5       5th coefficient                         -.542216
C6       6th coefficient                         .525567E-02
C7       7th coefficient                         -1.98749
C8       8th coefficient                         15.0666
C9       9th coefficient                         -32.5694
C10      10th coefficient                        -.152919E-01
C11      11th coefficient                        .566944E-02
C12      12th coefficient                        .242555E-01
C13      13th coefficient                        -.342984
C14      14th coefficient                        .738268E-01
C15      15th coefficient                        -.478472
C16      16th coefficient                        .838845
C17      17th coefficient                        -1.80052
C18      18th coefficient                        2.23066

**MODELEND

**END
```

Example 4: **Array Form Model**

```
Column
1        11                           41        51          61        71        80
**HEADER
RELEASE  Release of TYDEX-Format                1.3
MEASID   Measurement ID                         9253KLB
SUPPLIER Data supplier                          MICHELIN
DATE     Date                                   21/12/96
CLCKTIME Clocktime                              16:33

**COMMENTS
This is an example of a file to transmit tyre characteristics (linearization model) such as
cornering stiffnesses and aligning stiffnesses vs load for different inflation pressures.

**CONSTANTS
NOMWIDTH Nominal Section Width of Tyre mm       185
ASPRATIO Nominal Aspect Ratio         %         60
TYSTRUCT Tyre Structure                         radial
RIMDIAME Nominal Rim Diameter         inch      14
LOADIND  Load Index                             82
SPEEDSYM Speed Symbol                           H
RIMWIDTH Rim Width                    inch      5.5
RIMPROF  Rim Profile                            J
MANUFACT Tyre Manufacturer                      MICHELIN
IDENTITY Commercial Name                        Energy MXV3A
PARTNUM  Part Number                            1476_EB_18745
PRESEVOL Inflation Pressure Evolution           regulated
LONGVEL  Longitudinal Velocity        m/s       22.22
AMBITEMP Ambient Temperature          deg C     25

**MODELDEFINITION
MODELREF Cornering Stiffnesses vs Load DZGZ_V2.0 MICHELIN
CORNSFY  Cornering Stiffn. Lat. Force N/deg     out
ALIGNSMZ Aligning Stiffness           Nm/deg    out
FZH      Vertical Force               N         in          500       10000
INFLPRES Inflation Pressure           bar       in          1.8       2.8

**MODELCHANNELS
CORNSFY  Cornering Stiffn. Lat. Force N/deg
ALIGNSMZ Aligning Stiffness           Nm/deg
FZH      Vertical Force               N
INFLPRES Inflation Pressure           bar

**MODELOUTPUTS
221       5.869     500       1.8
1255      37.42     3000      1.8
3187      104.55    10000     1.8
210       5.472     500       2.0
1189      35.78     3000      2.0
3315      99.61     10000     2.0
204       5.087     500       2.2
1147      33.93     3000      2.2
3407      94.04     10000     2.2
. . .

**MODELEND

**END
```

Example 5: **File to Transmit Data of a Physical Tyre Model**

```
Column
1        11                            41        51         61        71        80
**HEADER
RELEASE  Release of TYDEX-Format                 1.3
MEASID   Measurement ID                          5937URS
SUPPLIER Data Supplier                           MICHELIN
DATE     Date                                    18/01/97
CLCKTIME Clocktime                               08:56

**COMMENTS
This is an example of a file to transmit a physical tyre model

**CONSTANTS
NOMWIDTH Nominal Section Width of Tyre mm        205
ASPRATIO Nominal Aspect Ratio          %         60
TYSTRUCT Tyre Structure                          radial
RIMDIAME Nominal Rim Diameter          inch      15
LOADIND  Load Index                              90
SPEEDSYM Speed Symbol                            H
RIMWIDTH Rim Width                     inch      6.0
RIMPROF  Rim Profile                             J
MANUFACT Tyre Manufacturer                       MICHELIN
IDENTITY Commercial Name                         Energy MXV3A
PARTNUM  Part Number                             7476_TR_87523
INFLPRES Inflation Pressure            bar       2.4
PRESEVOL Inflation Pressure Evolution            regulated
LONGVEL  Longitudinal Velocity         m/s       1.0
AMBITEMP Ambient Temperature           deg C     25

**MODELDEFINITION
MODELREF Simple Brush/String Model     Test_1    MICHELIN
FYH      Lateral Force                 N         out
FZH      Vertical Force                N         in         1000      7000
SLIPANGL Slip Angle                    deg       in         -5        5

**MODELPARAMETERS 13
A        1st coef. cont. patch length  m/N0.5    0.134E-2
B        2nd coef. cont. patch length  m/N       0.419E-4
C        Width of the cont. patch      m         0.142
H0       Tread depth                   m         0.008
CSR      Contact surface Ratio         %         73
G        Rubber shear modulus          Pa        2.2E06
TAU      Load distribution cont. patch           0.66
MU       Adherence Coefficient                   0.87
K6       Ply-steer Coefficient                   1.942
ALPHA1   Ply-steer Angle               deg       0.207
KY       Lateral stiffness of the belt N/m       1.27E+5
S2       Lat. bending stiffn. of belt  Nm        1.24E+4
T        Torsional stiffness of belt   Nm/rad    6855

**MODELEND

**END
```

Example 6: **File to Transmit Data of a Semi Empirical Tyre Model**

```
Column
1        11                         41        51         61        71        80
**HEADER
RELEASE  Release of TYDEX-Format              1.3
MEASID   Measurement ID                       4789TGH
SUPPLIER Data Supplier                        MICHELIN
DATE     Date                                 03/02/97
CLCKTIME Clocktime                            18:55

**COMMENTS
This is an example of a file to transmit a semi empirical tyre model that includes a mix of
various types of datas.

**CONSTANTS
NOMWIDTH Nominal Section Width of Tyre mm     165
ASPRATIO Nominal Aspect Ratio         %       65
TYSTRUCT Tyre Structure                       radial
RIMDIAME Nominal Rim Diameter         inch    13
LOADIND  Load Index                           76
SPEEDSYM Speed Symbol                         Q
RIMWIDTH Rim Width                    inch    5.0
RIMPROF  Rim Profile                          J
MANUFACT Tyre Manufacturer                    MICHELIN
IDENTITY Commercial Name                      M+S Alpin
PARTNUM  Part Number                          5741_CB_84239
INFLPRES Inflation Pressure           bar     2.1
PRESEVOL Inflation Pressure Evolution         regulated
AMBITEMP Ambient Temperature          deg C   -2

**MODELDEFINITION
MODELREF Variable Adherence Model     XYZ_V1  SUPPLIER XYZ
FYH      Lateral Force                N       out
FXH      Longitudinal Force           N       out
MZH      Aligning Moment              Nm      out
FZH      Vertical Force               N       in         100       10000
SLIPANGL Slip Angle                   deg     in         -5        5
INCLANGL Inclination Angle            deg     in         -5        5
MYC      Driving / Braking Moment     Nm      in         -2000     2000
WATDEPTH Waterfilm Depth              mm      in         0         6
LONGVEL  Longitudinal Velocity        m/s     in         0         40

**MODELPARAMETERS 5
OVALLDIA Overall Diameter             mm      576
VS       Vertical Stiffness           N/m     175000.0
VD       Vertical Damping             Ns2/m   500.0
RLLO     Rel. Relax. Length longitud.         0.05
RLLA     Rel. Relax. Length lateral           0.5

**MODELCOEFFICIENTS
1024.45  399.21   3560.09  45.87    456.33   5902.10  498.34   638.71   63.98    12.587
457.025  478.12
567.78   5639.05  4378.78  653.82   375.19   4289.50  387.05   530.03   490.38   471.025
4573.01  578.34
. . .

**MODELCHANNELS
CORNSFY  Cornering Stiffn. Lat. Force N/deg
ALIGNSMZ Aligning Stiffness           Nm/deg
FZH      Vertical Force               N
```

(continued on next page)

```
Column
1        11                            41        51         61        71       80
**MODELOUTPUTS
127       2.687      250
221       5.869      500
395       11.047     1000
1255      37.42      3000
2358      69.154     6000
3187      104.55     10000

**MODELCHANNELS
WATDEPTH Waterfilm Depth               mm
LONGVEL  Longitudinal Velocity         m/s
LGMUCOEF Longitudinal max. Adherence
LTMUCOEF Lateral maximum Adherence

**MODELOUTPUTS
0         10         0.92       0.88
0         20         0.87       0.84
0         40         0.78       0.72
0.5       10         0.74       0.70
0.5       20         0.79       0.73
0.5       40         0.69       0.71
1         10         0.72       0.68
1         20         0.67       0.62
1         40         0.60       0.57
2         10         0.70       0.67
2         20         0.61       0.57
2         40         0.48       0.40
4         10         0.71       0.66
4         20         0.52       0.51
4         40         0.33       0.38
6         10         0.71       0.66
6         20         0.41       0.47
6         40         0.08       0.12

**MODELEND

**END
```

2.5 Parameter List

Terms marked with Δ are standardized in ISO 8855 respectively DIN 70000.
Terms marked with ○ are completed according to ISO 8855 respectively DIN 70000.
Terms marked with ◊ are standardized in ISO 3911.
Terms marked with □ are used in ETRTO-Standard.
Terms marked with ◆ are used in SAE J2047.

Note:

- ◆ The term WHEEL (RAD, ROUE) used in this TYDEX-Reference Manual is an abbreviation for the tyre - wheel assembly. The term WHEEL (RAD, ROUE) is capitalized in order to distinguish it from a related term "wheel" (Rad, roue), which is used for rim - disc assembly (see SAE J2047).

2.5.1 HEADER

Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example
RELEASE	release of TYDEX-format Version des TYDEX-Formats No. de vers. du TYDEX-format	-	1.3
MEASID	measurement id. *(local ident. format alphanumeric)* Kennzahl der Messung numéro de la mesure	-	05039ABC
SUPPLIER	data supplier *(name of measurement supplier)* Datenlieferant fournisseur de la mesure	-	MICHELIN
DATE	date *(format dd/mm/yy)* Datum date	-	01/02/97
CLCKTIME	clocktime *(format hh:mm)* Uhrzeit heure	-	10:21

2.5.2 CONSTANTS and CHANNELS

All parameters marked with CR in the last column are character-quantities and have to be used in the paragraph CONSTANTS of the data file only.

Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR

A. General Information

	Abbrev.	Parameter	Unit	Example	CR
	TESTRIG	test rig *(local test bench identity)* Prüfstand banc de mesure	-	RVI	CR
	LOCATION	location *(location of facility)* Ort site de mesure	-	MICHELIN CERL.	CR
	TESTMETH	test method *(local method identity)* Testmethode méthode de test	-	AT2 rev. 2.0	CR
	MEASNUMB	measurement point No. *(counter)* Meßpunktnummer numéro du point de mesure	-	1	
	RUNTIME	running time laufende Zeit temps courant	s	0.1	

B. Tyre and Rim Specifications

	Abbrev.	Parameter	Unit	Example	CR
□ ◆	NOMWIDTH	nominal section width of tyre *(the section width indicated in the tyre size designation; for automobile and aircraft tyres; unit: [inch] or [mm])* Reifennennbreite grosseur boudin nom. du pneu	mm	185	
□ ◆	ASPRATIO	nominal aspect ratio Nennquerschnittsverhältnis rapport nominal d'aspect	-	70	

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
□ ◆	TYSTRUCT	tyre structure *(diagonal, bias belted, radial; the construction codes D, B, R are also allowed)* Reifenstruktur structure de pneu	-	R	CR
□ ◆	LOADIND	load index *(for automobile tyres)* Tragfähigkeits-Kennzahl indice de charge	-	84	
□ ◆	SPEEDSYM	speed symbol *(for automobile tyres)* Geschwindigkeits-Symbol code de vitesse	-	H	CR
	WIDRATIO	rim-tyre width ratio *(for aircraft tyres)* Felge-Reifen-Breitenverhältn. rapport largeur jante-pneu	-	H	CR
	NOMDIAME	nominal diameter of tyre *(nominal outside diameter)* Reifen-Nenndurchmesser diamètre nominal du pneu	inch	40	
	PLYRAT	ply rating Ply Rating ply rating	-	18	
	SPEEDRAT	speed rating *(for aircraft tyres)* Geschwindigkeits-Nennwert vitesse nominale	mph	225	
	LOADRAT	load rating *(for aircraft tyres)* Zul. Tragfähigkeit charge nominale	lbs	29,3	
	RATINFL	rated inflation pressure *(for aircraft tyres)* Basis-Luftdruck f. Tragfähk. pression de gonflage nominale	psi	142	
□ ◊ ◆	RIMDIAME	nominal rim diameter *(for automobile and aircraft tyres)* Felgen-Nenndurchmesser diamètre nominal de jante	inch	13	

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
□ ◊ ◆	RIMWIDTH	rim width Felgen-Maulweite largeur de jante	inch	5.5	
□ ◊ ◆	RIMPROF	rim profile *(tyre-side profile of the rim: B, J, JK,...)* Felgenprofil profil de la jante	-	J	CR
□	MANUFACT	manufacturer *(tyre brand name)* Reifenhersteller fabricant de pneus	-	MICHELIN	CR
□	IDENTITY	identity *(commercial name)* Reifenname nom du pneu	-	MXT	CR
	PARTNUM	part number Identifikations-Nr. numéro d’identification	-	409K02-1	CR
	REFSIDEW	reference sidewall *(marking of the reference sidewall, e.g. DOT, red point,...)* Referenz-Seitenwand flanc de référence	-	DOT	CR
	TYWHASSB	tyre/wheel assembly *(reference sidewall position w.r.t. direction of wheel velocity: refswleft / refswright)* Reifen/Rad-Montageposition pos. du mont. pneu/roue	-	refswleft	CR
□ ◆	OVALLDIA	overall diameter *(real outside diameter)* Außendurchmesser diamètre extérieur	mm	598	
	TYRECAT	tyre category *(passenger / truck / motorcycle / aircraft /...)* Reifenkategorie catégorie de pneu	-	passenger	CR
	TYREMASS	tyre mass *(mass of tyre without rim)* Reifenmasse masse du pneu	kg		
	TYROTIN	tyre rot. inertia about YC *(inertia of tyre about axis of rotation Y_C)* Reifendrehm. um Rot.-Achse YC inertie du pneu autour de YC	kgm2		

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
	TYRESTIN	tyre steer inertia about ZC *(inertia of tyre about vertical axis Z_C)* Reifendrm. um Vert.-Achse ZC inertie du pneu autour de ZC	kgm2		
	TYCGOFFS	lat. centre of grav. offset *(lateral gravity offset of the tyre in Y_C-direction)* Seitl. Schwerp.-Abweichg. déport lat. du cent. de grav.	mm		
◊	INSETWH	inset of wheel *(distance between rim plane and attachment face, negative inset is also called 'outset')* Felgeneinpreßtiefe déport interne de la jante	mm		

C. Tyre Conditions

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
	PRESEVOL	infl. press. evol. *(regulated or free)* Reifenluftdruckverlauf évolution de press. de gonfl.	-	regulated	CR
☐ ◆	INFLPRES	inflation pressure Reifenluftdruck pression de gonflage	bar	2.3	
	INTYTEMP	internal tyre air temperature Reifeninnenlufttemperatur temp. d'air interne du pneu	deg C	54	
	TRDTEMP	tread surface temperature Laufflächentemperatur temp. de la bande de roulem.	deg C	61	
☐ ◆	TRDDEPB	tread depth before *(tread depth before test)* Profiltiefe vorher profond. de sculpture avant	mm	8.0	
☐ ◆	TRDDEPA	tread depth after *(tread depth after test)* Profiltiefe nachher profond. de sculpture après	mm	7.5	

Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR

D. Ambient Conditions

Abbrev.	Parameter	Unit	Example	CR
TRCKTEMP	temperature of track Fahrbahntemperatur température de la chaussée	deg C	22	
CURVTRSF	curvature of track surface *(the curvature of the track surface is negative for internal drum test rigs)* Krümmung der Fahrbahnoberfl. courbure de surface chauss.	1/m	-0.526	
TRCKSURF	surface of track Fahrbahnoberfläche surface de la chaussée	-	safetywalk	CR
TRCKCOND	condition of track surface Zustand der Fahrbahnoberfl. état de surface chauss.	-	wet	CR
WATDEPTH	waterfilm depth Wasserfilmhöhe hauteur de la couche d'eau	mm	3.0	
AMBITEMP	ambient temperature *(outside temperature)* Umgebungstemperatur température extérieure	deg C	20	
HUMIDITY	humidity Luftfeuchtigkeit humidité de l'air	%	60	

∆ E. Wheel Forces and Moments

(forces and moments from tyre to rim)

Abbrev.	Parameter	Unit	Example	CR
∆ ◆ FX	longitudinal force *(longitudinal force at WHEEL, $F_{XC} = F_{XH} = F_{XW}$)* Umfangskraft force longitudinale	N	2000	
FYC	lateral force *(lateral force at WHEEL in C-axis system)* Seitenkraft force transversale	N	1500	

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
	FYH	lateral force *(lateral force at WHEEL in H-axis system, $F_{YH} = F_{YW}$)* Seitenkraft force transversale	N	1605	
∆ ◆	FYW	lateral force *(lateral force at WHEEL in W-axis system, $F_{YW} = F_{YH}$)* Seitenkraft force transversale	N	1605	
	FZC	vertical force *(vertical force at WHEEL in C-axis system)* Radlast force verticale	N	3000	
	FZH	vertical force *(vertical force at WHEEL in H-axis system, $F_{ZH} = F_{ZW}$)* Radlast force verticale	N	2990	
∆ ◆	FZW	vertical force *(vertical force at WHEEL in W-axis system, $F_{ZW} = F_{ZH}$)* Radlast force verticale	N	2990	
	MXC	overturning moment *(overturning moment at WHEEL in C-axis system, $M_{XC} = M_{XH}$)* Kippmoment moment de renversement	Nm	450	
	MXH	overturning moment *(overturning moment at WHEEL in H-axis system, $M_{XH} = M_{XC}$)* Kippmoment moment de renversement	Nm	450	
∆ ◆	MXW	overturning moment *(overturning moment at WHEEL in W-axis system)* Kippmoment moment de renversement	Nm	60	
	MYC	driving / braking moment *(driving / braking moment at WHEEL in C-axis system, the moment from tyre to rim; do not confound it with the moment from axle to rim (in SAE J2047 called WHEEL torque) with reverse sign)* Antriebs-/ Bremsmoment moment entrainem. / freinage	Nm	600	
∆ ◆	MYW	rolling moment *(rolling moment at WHEEL in W-axis system)* Rollmoment moment de roulement	Nm	10	

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
	MZC	aligning moment	Nm	60	

	Abbrev.	Parameter	Unit	Example	CR
		(aligning moment at WHEEL in C-axis system) Rückstellmoment moment d'alignement			
	MZH	aligning moment *(aligning moment at WHEEL in H-axis system)* Rückstellmoment moment d'alignement	Nm	55	
Δ ◆	MZW	aligning moment *(aligning moment at WHEEL in W-axis system)* Rückstellmoment moment d'alignement	Nm	58	

Δ F. Rolling Characteristics

	Abbrev.	Parameter	Unit	Example	CR
◆	TYREDEFW	tyre deflection *(in direction of Z_W-axis)* Reifeneinfederung flèche du pneu	mm	13.2	
	TYREDEFC	tyre deflection *(in direction of Z_C-axis)* Reifeneinfederung flèche du pneu	mm	13.2	
	KROLCIRC	kin. rolling circumference Kinematischer Abrollumfang circonfér. de roulem. kin.	mm	1921	
	KROLRAD	kinematic rolling radius *(radius used for slip computation, explanation in chapter 2.7)* Kinematischer Rollradius rayon de roulement kin.	mm	289.9	

Δ G. Longitudinal Properties

	Abbrev.	Parameter	Unit	Example	CR
Δ ◆	LGFCCOEF	long. force coefficient *(F_{XW}/F_{ZW})* Umfangskraftbeiwert adhérence longitud. utilisée	-	0.64	
Δ ◆	LONGSLIP	longitudinal slip *(explanation in chapter 2.7)* Umfangsschlupf glissement longitudinal	%	11.1	

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
Δ ◆	LFLSGRFX	long. force/long. slip grad. *(longitudinal force/longitudinal slip gradient, $\partial FX / \partial(LONGSLIP)$, FX = FXC = FXH = FXW)* Umfangskr./Umfschl.-Gradient	N/%	1812	

grad. de la force longitudin.
(gradient de la force longitudinale à la roue par rapport au glissement longitudinal, rigidité de pseudo-glissement longitudinal)

○ H. Lateral Properties

Δ ◆	LTFCCOEF	lateral force coefficient *(F_{YW}/F_{ZW})* Seitenkraftbeiwert adhérence latérale utilisée	-	0.59
Δ ◆	SLIPANGL	slip angle *(angle from the X_W-axis to the tangent to the trajectory of the WHEEL intersection point (origin of W-axis system))* Schräglaufwinkel angle de dérive du pneu	deg	8
Δ ◆	CORNSFY	cornering stiffn. lat. force *(cornering stiffness, $-\partial FY / \partial(SLIPANGL)$)* Seitenkr.-Schräglw.-Gradient raideur de dérive fce. trnsv. *(rigidité de poussée de dérive)*	N/deg	1702
◆	ALIGNSMZ	aligning stiffness *($\partial MZ / \partial(SLIPANGL)$)* Rückstm.-Schräglw.-Gradient rig. couple autoalign. dérive *(rigidité de couple d'autoalignement en dérive)*	Nm/deg	77.4
Δ ◆	CAMBSFY	camber stiffness lat. force *($-\partial FY / \partial(INCLANGL)$)* Seitenkr.-Radsturzw.-Gradient raideur de carrossage *(rigidité de poussée de carrossage)*	N/deg	41.7
	CAMBSMZ	camber stiffn. aligning mom. *($\partial MZ / \partial(INCLANGL)$)* Rückstm.-Radsturzw.-Gradient rig. couple autoalign. carr. *(rigidité de couple d'autoalignement en carrossage)*	Nm/deg	1.3

Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR

∆ I. Linear Motion Variables

TRAVDISW travel distance — m — 12400
(travel distance of WHEEL intersection point (origin of W-axis system), integration of velocity in $X_W Y_W$-plane)
Zurückgelegte Wegstrecke
distance parcourue

TRAVDISC travel distance — m — 12400
(travel distance of WHEEL centre, integration of velocity in $X_C Y_C$-plane)
Zurückgelegte Wegstrecke
distance parcourue

◆ **TRAJVELW** trajectory velocity — m/s — 36.2
(velocity of WHEEL intersection point (origin of W-axis system) in $X_W Y_W$-plane)
Bahngeschwindigkeit
vitesse de la trajectoire

◆ **TRAJVELC** trajectory velocity — m/s — 36.0
(velocity of WHEEL centre in $X_C Y_C$-plane)
Bahngeschwindigkeit
vitesse de la trajectoire

LONGDISP longitudinal displacement — mm — 4.3
(in direction of X_W-/X_C-axis)
Auslenkung in Längsrichtung
excursion longitudinale

∆ ◆ **LONGVEL** longitudinal velocity — m/s — 36.1
(longitudinal velocity of WHEEL centre in X_W-/X_C-direction)
Längsgeschwindigkeit
vitesse longitudinale

∆ **LONGACC** longitudinal acceleration — m/s2 — 8.8
(longitudinal acceleration of WHEEL centre in X_W-/X_C-direction)
Längsbeschleunigung
accélération longitudinale

LATDISPW lateral displacement — mm — 7.8
(in direction of Y_W-axis)
Seitliche Auslenkung
excursion latérale

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
	LATDISPC	lateral displacement *(in direction of Y_C-axis)* Seitliche Auslenkung excursion latérale	mm	7.8	
∆ ◆	LATVELW	lateral velocity *(lateral velocity of WHEEL centre in Y_W-direction)* Quergeschwindigkeit vitesse transversale	m/s	0.9	
∆	LATVELC	lateral velocity *(lateral velocity of WHEEL centre in Y_C-direction)* Quergeschwindigkeit vitesse transversale	m/s	0.9	
∆	LATACCW	lateral acceleration *(lateral acceleration of WHEEL centre in Y_W-direction)* Querbeschleunigung accélération transversale	m/s2	0.6	
∆	LATACCC	lateral acceleration *(lateral acceleration of WHEEL centre in Y_C-direction)* Querbeschleunigung accélération transversale	m/s2	0.6	
	DSTGRWHC	dist. ground - WHEEL centre *(vertical to track surface)* Abstand Fahrb. - RAD-Mittelp. dist. chaussée - centre ROUE	mm	297	
	DSTWOWHC	dist. W-origin - WHL. centre *(distance origin of W-axis system (WHEEL intersection point) - WHEEL centre in direction of Z_C-axis)* Abst. W-Ursprung - RAD-Mitt. dist. orig. W - centre ROUE	mm	298	
∆	VERTVELW	vertical velocity *(vertical velocity of WHEEL centre in Z_W-direction)* Vertikalgeschwindigkeit vitesse verticale	m/s	1.1	
∆	VERTVELC	vertical velocity *(vertical velocity of WHEEL centre in Z_C-direction)* Vertikalgeschwindigkeit vitesse verticale	m/s	1.1	
∆	VERTACCW	vertical acceleration *(vertical acceleration of WHEEL centre in Z_W-direction)* Vertikalbeschleunigung accélération verticale	m/s2	10.8	

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
Δ	VERTACCC	vertical acceleration *(vertical acceleration of WHEEL centre in Z_C-direction)* Vertikalbeschleunigung accélération verticale	m/s2	10.8	

Δ J. Angular Motion Variables

	Abbrev.	Parameter	Unit	Example	CR
○	WHROTANG	WHEEL rotation angle *(about Y_C-axis)* Drehwinkel des RADES angle de rot. en roulement	deg	125.1	
Δ ◆	WHROTSPD	WHEEL rotation speed *(about Y_C-axis, instantaneous)* Drehgeschwindigk. des RADES vitesse de rot. d'une ROUE	rad/s	100.1	
	RFROTSPD	WHEEL reference rot. speed *(about Y_C-axis, rotation speed used for slip computation, explanation in chapter 2.7)* Referenzdrehgeschw. des RADES vit. ref. de rot. d'une ROUE	rad/s	102.3	
○	WHROTACC	WHEEL rotation acceleration *(about Y_C-axis)* Drehbeschleunigung des RADES accél. de rot. d'une ROUE	rad/s2	10.4	
Δ ◆	INCLANGL	inclination angle *(this angle will have the same magnitude as the camber angle, see ISO 8855)* Radsturzwinkel angle d'inclinaison du pneu	deg	2	
○	INCLVEL	inclination velocity *(about X_H-axis)* Radsturzgeschwindigkeit vitesse d'inclinaison	rad/s	1.1	
○	INCLACC	inclination acceleration *(about X_H-axis)* Radsturzbeschleunigung accélération d'inclinaison	rad/s2	14.3	
Δ ◆	STEEANGL	steer angle *(road vehicle: angle from the X-axis to X_W-axis, X-axis is the projection of the X_V-axis (vehicle's longitudinal axis) on to the horizontal plane; testrig: angle from the direction of track velocity to X_W-axis)* Radlenkwinkel angle de braquage	rad	8	

	Abbrev. (8 char.)	Parameter (max. 29 characters)	Unit	Example	CR
○	STEERVEL	steer angular velocity Lenkwinkelgeschwindigkeit vitesse de braquage	rad/s	0.8	
○	STEERACC	steer angular acceleration Lenkwinkelbeschleunigung accélération de braquage	rad/s2	0.6	

○ K. Wheel Trajectory Dimensions

∆	PATHRADW	path radius *(path radius of WHEEL intersection point(origin of W-axis system))* Bahnradius rayon de courbure traject.	m	50.2	
∆	PATHRADC	path radius *(path radius of WHEEL centre)* Bahnradius rayon de courbure traject.	m	50.1	
∆	CURVTRJW	curvature of trajectory *(curvature of trajectory of WHEEL intersection point (origin of W-axis system))* Bahnkrümmung courbure de la trajectoire	1/m	0.02	
∆	CURVTRJC	curvature of trajectory *(curvature of trajectory of WHEEL centre)* Bahnkrümmung courbure de la trajectoire	1/m	0.02	

L. Other Parameters

	NOTAVAIL	value for not available data *(if one measurement point is unavailable, measurement should be substituted with this value; NOTAVAIL has to be entered by the data supplier in section CONSTANTS)* Wert f. nicht verfügb. Daten valeur pour dates pas disp.	-	1E99	

2.6 Axis Systems

For the TYDEX-data files three right-hand orthogonal axis systems are defined. These axis systems are explained in the following chapters. In each respective illustration are shown

- a positive slip angle α,
- a positive inclination angle γ and
- a positive wheel rotation speed ω.

Note: The inclination angle is called inclination angle γ in SAE J2047 and inclination angle ε_W in ISO 8855.
It is permissible to use both symbols in context with the TYDEX-Format.

2.6.1 C-Axis System

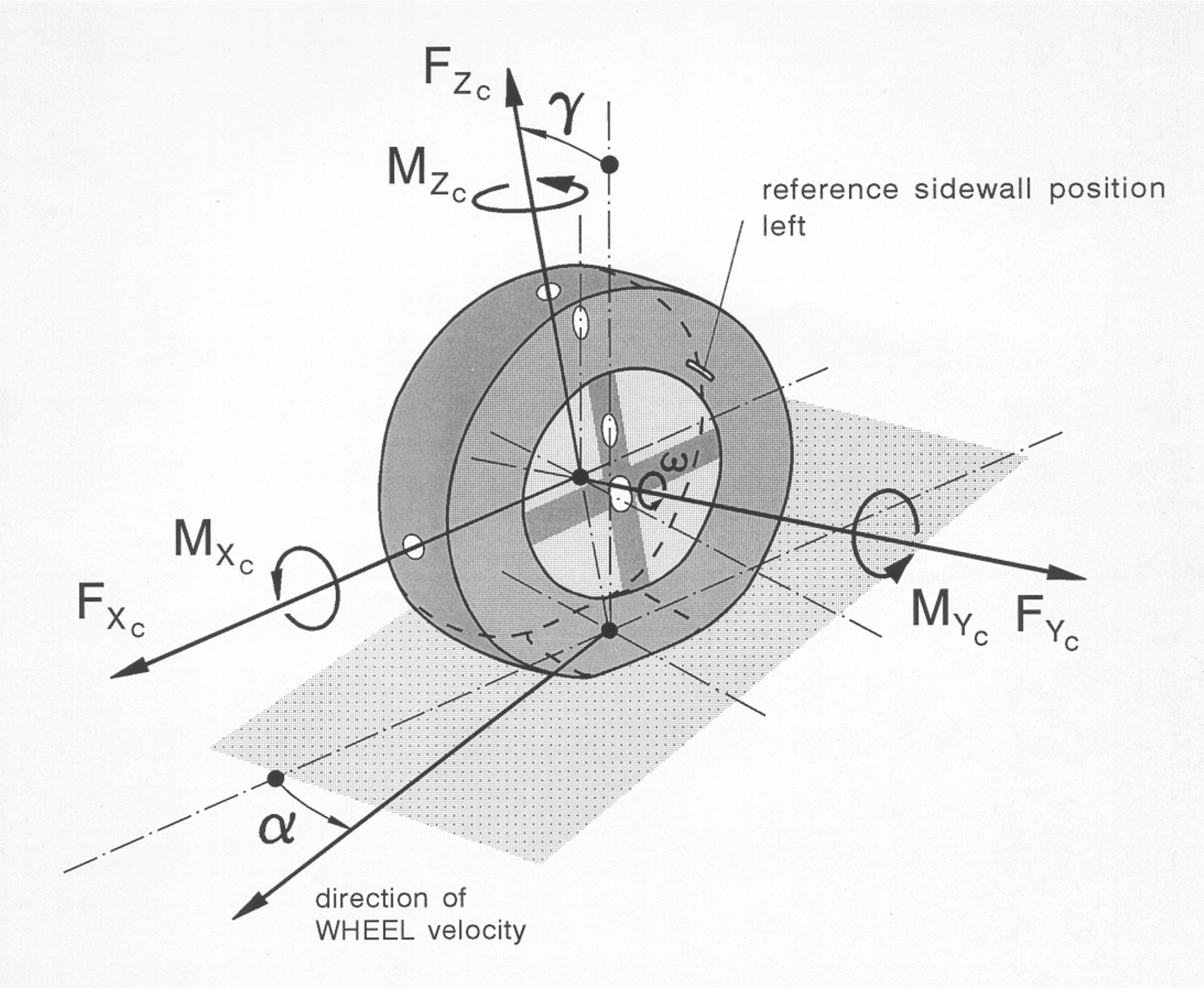
The C-axis system (centre axis system) is shown in illustration 2.6.1. The origin of this axis system is fixed in the centre of the WHEEL.

The X_C-axis is in the central plane of the WHEEL and is parallel to the ground.

The Y_C-axis turns with the inclination angle γ. It is identical with the spin axis of the WHEEL.

The Z_C-axis points upwards and also turns with the inclination angle γ. It is in the central plane of the WHEEL.

Note: In SAE J2047 a C-axis system (WHEEL center system) is also defined. The orientation of this axis system corresponds to the TYDEX C-axis system, but in SAE J2047 the axis system is shown without inclination angle.



The shown forces and moments are acting from tyre to rim

Illustration 2.6.1: C-Axis System

2.6.2 H-Axis System

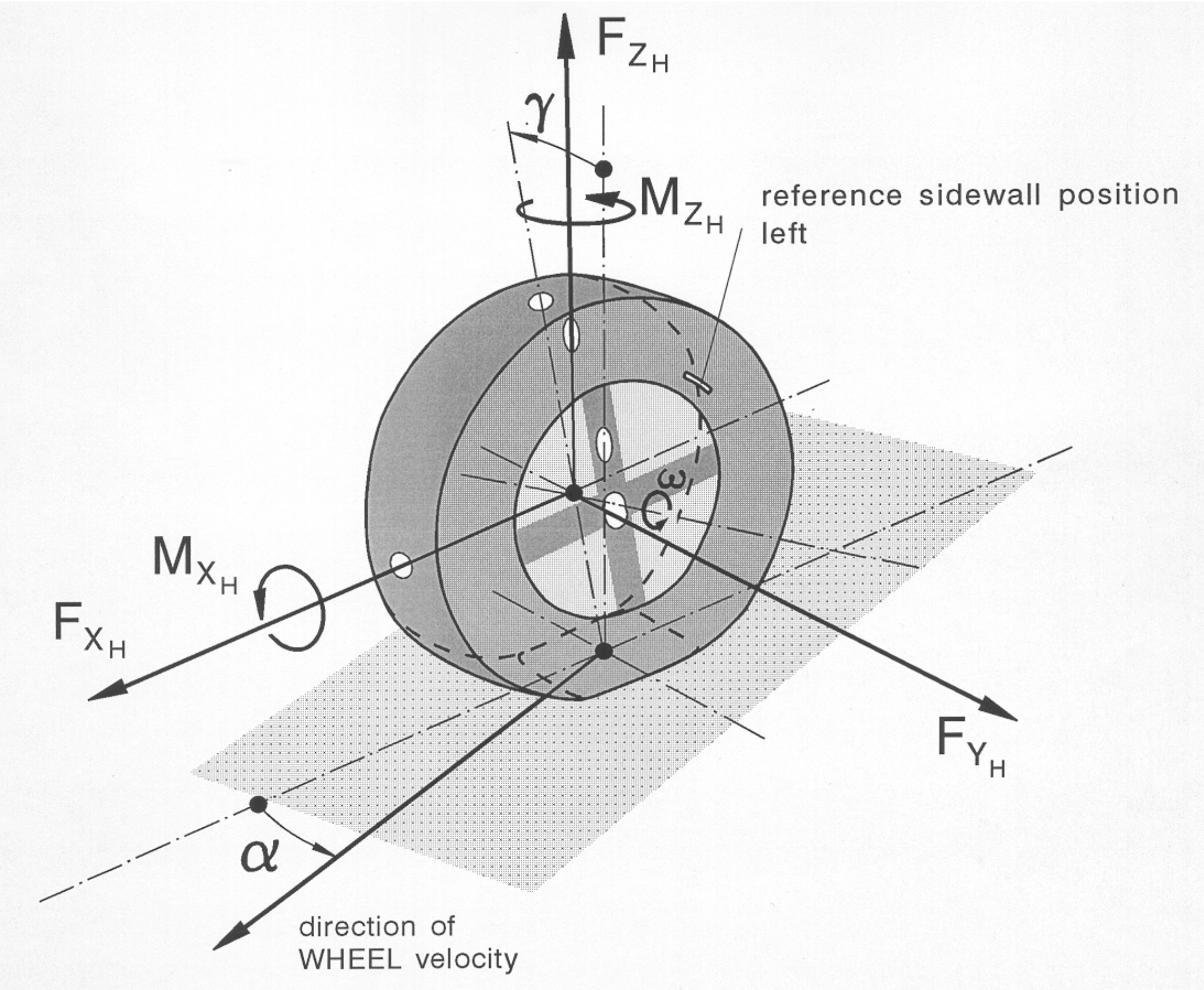
The H-axis system (horizontal axis system) is shown in illustration 2.6.2. The origin of this axis system is fixed in the centre of the WHEEL.

The X_H-axis is in the central plane of the WHEEL and is parallel to the ground.

The Y_H-axis is perpendicular to the X_H-axis and is together with the X_H-axis in a plane parallel to the ground. The Y_H-axis is given by the projection of the spin axis of the WHEEL onto the X_HY_H-plane.

The Z_H-axis points upwards and is perpendicular to the track surface.

Note: The moment M_{YH} is not shown in the illustration, because it makes no sense to measure the driving/braking moment about the Y_H-axis. The Y_H-axis is not the spin axis of the WHEEL.



The shown forces and moments are acting from tyre to rim

Illustration 2.6.2: H-Axis System

2.6.3 W-Axis System

The W-axis system (WHEEL axis system) is standardized in ISO 8855 and is shown in illustration 2.6.3.

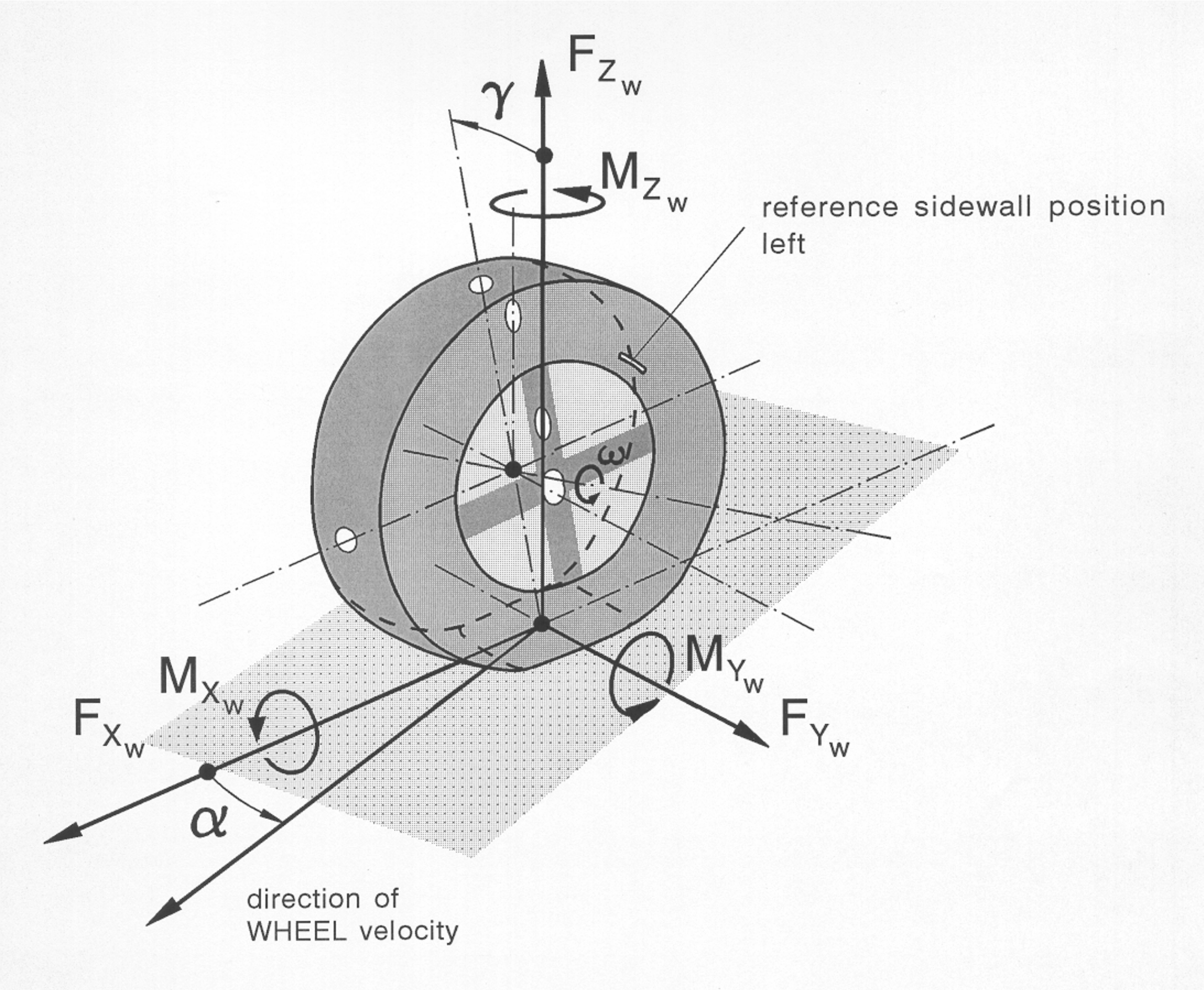
In ISO the track surface is defined as horizontal (horizontal plane = ground plane), but in this TYDEX Axis System also a sloped ground is permissible.

The X_W-axis is given by the intersection of the central plane of the WHEEL with the track surface.

The Y_W-axis is given by the projection of the spin axis onto the ground.

The Z_W-axis is normal to the ground and points upwards.

The origin of the W-axis system is also called "WHEEL intersection point" in this TYDEX-Reference Manual.



The shown forces and moments are acting from tyre to rim

Illustration 2.6.3: W-Axis System

2.7 Longitudinal Slip

2.7.1 Definition

The longitudinal slip is defined by the following equation:

$$\text{LONGSLIP} = \frac{\text{WHROTSPD} - \text{RFROTSPD}}{\left|\text{RFROTSPD}\right|} = s = \frac{\omega - \omega_0}{\left|\omega_0\right|}$$

ω is the actual WHEEL rotation speed

ω_0 is the reference rotation speed at actual velocity, vertical force, slip angle and inclination angle and for longitudinal force $F_x = 0$

With the definition of the kinematic rolling radius

$$\text{KROLRAD} = \frac{\text{TRAJVELW} \cdot \cos(\text{SLIPANGL})}{\text{RFROTSPD}}$$

the longitudinal slip can also be calculated with the following equation:

$$\text{LONGSLIP} = \frac{\text{WHROTSPD} \cdot \text{KROLRAD} - \text{TRAJVELW} \cdot \cos(\text{SLIPANGL})}{\left|\text{TRAJVELW} \cdot \cos(\text{SLIPANGL})\right|}$$

The kinematic rolling radius is determined for longitudinal force $F_x = 0$, but it is no constant factor, as it is a function of velocity, vertical force, slip angle and inclination angle.

2.7.2 Approximation

It is difficult to determine the reference rotation speed for each current slip angle and inclination angle. The following approximation for the slip computation under the responsibility of the tyre data supplier is permissible:

$$\text{LONGSLIP} = \frac{\text{WHROTSPD} - \text{RFROTSPD}(\alpha_0 = \gamma_0 = 0) \cdot \cos(\text{SLIPANGL})}{\left|\text{RFROTSPD}(\alpha_0 = \gamma_0 = 0) \cdot \cos(\text{SLIPANGL})\right|} =$$

$$s = \frac{\omega - \omega_0(\alpha_0 = \gamma_0 = 0) \cdot \cos(\alpha)}{\left|\omega_0(\alpha_0 = \gamma_0 = 0) \cdot \cos(\alpha)\right|}$$

ω_0 is the reference rotation speed at actual vertical force and for

longitudinal force	F_x	$= 0$
slip angle	α_0	$= 0$
inclination angle	γ_0	$= 0$

α is the actual slip angle during tyre testing.

3. Literature

ISO 3911

Wheels/rims - Nomenclature, designation, marking and units of measurement, 1977

ISO 8855

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Straßenfahrzeuge - Fahrdynamik und Fahrverhalten - Begriffe, 1994

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