

 <p>CHAMP</p>	<p>Format Description: The CHAMP Data Format</p>	<p>Doc.: CH-GFZ-FD-001 Issue: 2.0 Date: 2002-05-31 Page: 1</p>
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CH-GFZ-FD-001

<p>Format Description: The CHAMP Data Format</p>
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The CHAMP Data Format

Format version: 2.0
Update: 31.05.2002

0. Change Records:

Update	Topic	Description of change
29.11.00	Error in the description of the sequence of the angular acceleration components	correction of the description of the sequence of the angular acceleration components
29.11.00	acc record specification	description of the Lorentz force acceleration
08.12.00	Error in the thr record description	Correction: Reversion of all signes describing the orientation of the thruster actions
08.12.00	General	Stylistic revision
28.02.01	acl,aca records	More digits for the Number of 1-sec-samples per measurement
28.02.01	att record	Real format for the attitude accuracy
28.02.01	hka record	A new record type: selected H/K data in the Level-2 data
14.03.01	+acl... and +aca... records of the ACC Level-2 header	format of the calibration patameters
23.08.01	Format version 1.1 =====	
	att record specification	extension of the meaning of the star camera 1 - 4 flags, new feature: '0000' is possible
	Header records for attitude data (ASC-data):	
	+filt-record	Additional parameter 'length of filter interval'
	calibration data records	Replacement of the +asc2sc__-record by three new records: +ascXcr_e, +ascXcr_q and +cr2sc__
	+format__-Record	New, used for pure attitude data only
01.03.02	Format version 1.2 =====	
	aca record	Change of the sequence of the first two angular acceleration components, the sequence is now the following: Phi - Theta - Psi
	aca and acl records	3 numbers (instead of only 1 formerly) of individual 1-sec-samples, one for each component
	New: acc 02 record	A new correction for the radial (x-) component of the linear acceleration
08.03.02	+acl_k.. and +aca_k.. records (header)	- deletion of the quadratic terms of the calibration parameters: +acl_k2 and +aca_k2 - specification of the rule for the application of bias and scale factor
31.05.02	Format version 2.0 =====	
	no changes	Identical with format version 1.2



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1. General: =====

- The length of a line doesn't not exceed 80 characters
- The CHAMP-formatted data files consists of a header and data lines.
- Comment lines are possible at any position except of the first line.
The first character of a comment line is '*'
- This data format description is common for several CHAMP data products, for instance:
 - * Accelerometer level1 and level2 data
 - * Star camera level-2 data
 - * Housekeeping and thruster firing data

2. Header: =====

The header consists of

- the first line (= format identification line), which starts with '%'
- additional lines, which consists of the first character '+', followed by a keyword (9 characters) and header data (details given below), this lines may be given in any order

The header ends with the first line, which does'nt start with '*', '%' or '+'.

Detailed header lines format description:

- First line (format and data revision identification line)

Columns 1 - 6	A6	'%chxxx'	format identifier: '%chacc' = Accelerometer data Level-1 or -2 '%chasc' = only Advanced Stellar Compass Level-2 data '%chfgm' = only formatted fgm-data '%chshk' = only satellite housekeeping data
Column 7	1X		unused
Column 8 -19	A12	'version x.x '	format version
Column 20	1X		unused
Columns 21-32	A12	'revision y '	data revision
Column 33	1X		unused
Columns 34-37	I4		year of file creation
Column 38	1X		unused
Columns 39-40	I2		month of file creation
Column 41	1X		unused
Columns 42-43	I2		day of file creation
Column 44	1X		unused
Columns 45-46	I2		hour of file creation
Column 47	1X		unused
Columns 48-49	I2		minute of file creation
Columns 50	1X		unused
Columns 51-59	A9		Name of the institution (abbreviated)
Columns 60	1X		unused
Columns 61-80	A20		Name of the operator

- satellite identification

Columns 1 -10	A10	'+satellite'	keyword
Column 11	1X		unused
Columns 12-18	I7		SLR adopted COSPAR number of the satellite
Column 19	1X		unused
Columns 20-39	A20		name of the satellite

- data type specification

This line specifies the data, which are kept in the file.

Columns 1 -10	A10	'+data____'	keyword
Columns 11-....	n(1X,A3)		list of the keywords of all data types of the data lines below (including the time), the keywords are identical to the keywords used in the data lines n = number of different data types (including time)

- reference systems specification line

<p>Columns 1 -10 A10 '+reference' Columns 11-.... n(1X,A3)</p>	<p>keyword list of the abbreviations of the reference systems of the different data types (including the time), the order of this keywords corresponds with the order of the data type keywords in the '+data____'-line above! Examples for reference system keywords: 'gps' - GPS-Time 'utc' - Coordinated Universal Time 'cis' - Conventional Inertial System 'sbf' - Spacecraft Body Fixed System: Origin: spacecraft centre of mass x = aligned with the long side of the spacecraft towards the boom, in nominal attitude in flight direction (roll axis) y = completing the triad (pitch axis) z = nadir looking, positive downward (yaw axis) 'ifx' - Accelerometer Instrument Fixed System: Origin: Sensor centre of mass x = anti-parallel to spacecraft z-axis y = parallel to spacecraft x-axis z = completing the triad (anti-parallel to spacecraft y-axis) Rotations: Theta = about accelerometer y-axis Phi = about accelerometer x-axis Psi = about accelerometer z-axis '----' - for that kind of data, where no reference system is required (for instance H/K or thruster data)</p>
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- first epoch specification

<p>Columns 1 -10 A10 '+first____' Column 11 1X Columns 12-15 I4 Column 16 1X Columns 17-18 I2 Column 19 1X Columns 20-21 I2 Column 22 1X Columns 23-24 I2 Columns 25 1X Columns 26-27 I2 Columns 28 1X Columns 29-38 F10.7</p>	<p>keyword unused year of first epoch unused month of first epoch unused day of first epoch unused hour of first epoch unused minute of first epoch unused second of first epoch</p>
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- last epoch specification

<p>Columns 1 -10 A10 '+last____' Column 11 1X Columns 12-15 I4 Column 16 1X Columns 17-18 I2 Column 19 1X Columns 20-21 I2 Column 22 1X Columns 23-24 I2 Columns 25 1X Columns 26-27 I2 Columns 28 1X Columns 29-38 F10.7</p>	<p>keyword unused year of last epoch unused month of last epoch unused day of last epoch unused hour of last epoch unused minute of last epoch unused second of last epoch</p>
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- processing software specification

<p>Columns 1 -10 A10 '+software_' Column 11 1X Columns 12-51 A50</p>	<p>keyword unused processing software name and version number</p>
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- Acceleration calibration parameters

Columns 1 - 10	A10	Keyword
		'+acl_k0____' = Linear Acc., Bias, mm/s/s
		'+acl_k1____' = Linear Acc., scale factor
		'+aca_k0____' = Angular Acc., Bias, mrad/s/s
		'+aca_k1____' = Angular Acc., scale factor
Columns 43	3 (F16.10)	Linear or Angular vector components
Column 44	1X	unused
Column 45	I1	application flag
		1 = calibration applied in the data below
		0 = calibration not applied

Remarks:

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- 1) The acceleration calibration parameter are given in the reference system of the acceleration vectors in the data lines
- 2) Bias and scale factor must be applied following this formula:
Corrected_measurement = (Uncorrected_measurement - Bias) * Scale_factor
- 3) Bias and scale factor for the Radial_linear acceleration component are only valid AFTER the application of the acc 02 correction!!!

- Attitude calibration data (quaternions), describing the applied transformation from the ASC system into the S/C system, used in Format version 1.0

Columns 1 - 10	A10	'+asc2sc____'	keyword
Column 11	1X		unused
Columns 12 - 67	4 (X,F13.10)		Attitude value in quaternions (value range of all components: -1.0 ... +1.0)
			Order of the Quaternions: q1,q2,q3 = vector part, q4 = scalar part

- Attitude calibration BOOM data (Euler Angles or Quaternions) for transformation from ASC into CR (common reference) system, used from Format version 1.1

Columns 1 - 10	A10	'+asc'X'cr_e'	keyword
Column 11	1X		unused
Columns 12 - 44	3 (X,F10.5)		Attitude value in Euler Angles (3-1-3) order of euler angles : PHI, THETA, PSI

Columns 1 - 10	A10	'+asc'X'cr_q'	keyword
Column 11	1X		unused
Columns 12 - 67	4 (X,F13.10)		Attitude value in quaternions order of Quaternions: q1,q2,q3 = vector part, q4 = scalar part

'X' = Nr. of Camera Head Unit (CHU)
for example
1 = CHU 1 of BOOM
2 = CHU 2 of BOOM
3 = CHU 3 of BODY
4 = CHU 4 of BODY

- Attitude calibration BODY data (Quaternions) for transformation from CR (common reference) system to S/C system used from Format version 1.1

Columns 1 - 10	A10	'+cr2sc____'	keyword
Column 11	1X		unused
Columns 12 - 67	4 (X,F13.10)		Attitude value in Quaternions order of Quaternions: q1,q2,q3 = vector part, q4 = scalar part

- Indication of the filter used for smoothing the Attitude data

Columns 1 - 10	A10	'+filt_____'	keyword
Column 11	1X		unused
Columns 12 - 14	A3		keyword for the applied filter:
			' no' - No filter applied
			'gau' - FFT-gauss filter
			'cos' - FFT-cos filter
			'pol' - polynomial filter
			'box' - boxcar average
			'spl' - cubic spline interpolation
			' no' - used no filter
Column 15	1X		unused
Columns 16 - 18	I2		length of filter interval in sec

- Spacecraft and cold gas masses and their time epoch of validity

Columns 1 - 10	A10	'+scmass_____'	Keyword
Column 11	1X		unused
Column 12 - 18	F7.3		total mass of the satellite in kg
Column 19	1X		unused
Column 20 - 25	F6.3		cold gas mass in kg
Column 26	1X		unused
Columns 27 - 30	I4		year
Column 31	1X		unused
Columns 32 - 33	I2		month
Column 34	1X		unused
Columns 35 - 36	I2		day
Column 37	1X		unused
Columns 38 - 39	I2		hour
Column 40	1X		unused
Columns 41 - 42	I2		minute
Column 43	1X		unused
Columns 44 - 53	F10.7		second

- Format description record, used for attitude data

Columns 1 - 10	A10	'+format_____'	keyword
Column 11	1X		unused
Columns 12 - 14	A3		format keyword
Columns 15	1X		unused
Column 16 - 33	A18		format description for keyword
Column 34	1X		unused
Columns 35 - 37	A3		format keyword
Columns 38	1X		unused
Column 39 - 68	A30		format description for keyword

3. Data

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The data are given in data lines combined in data blocks. The basic structure of a single line is a keyword of 3 characters, followed by the data. A data blocks starts with a data line containing a measurement epoch. All these following data lines are related to this epoch and these lines may be given in any order. A new epoch line starts a new data block. The last data block ends with the '%eof'-line.

Detailed data lines format description:

Measurement time epoch data line

- Epoch line (measurement epoch)

Columns 1 - 3	A3	'tim'	keyword
Column 4	1X		unused
Columns 5 - 8	I4		year
Column 9	1X		unused
Columns 10-11	I2		month
Column 12	1X		unused
Columns 13-14	I2		day
Column 15	1X		unused
Columns 16-17	I2		hour
Column 18	1X		unused
Columns 19-20	I2		minute
Column 21	1X		unused
Columns 22-31	F10.7		second

Acceleration measurement data lines

- Linear acceleration line (accelerometer measurements)

Columns 1 - 3	A3	'acl'	keyword
Column 4 - 8	5X		unused
Columns 9 -50	3(X,F13.10)		linear acceleration vector components (x,y,z), in mm/s/s
Columns 51-53	X,3I5		Numbers of individual 1-sec-samples per acl record, one number for each component, given in the sequence of the components, 0 = no normal point

- Angular acceleration line (accelerometer measurements)

Columns 1 - 3	A3	'aca'	keyword
Column 4 - 8	5X		unused
Columns 9 -50	3(X,F13.9)		angular acceleration vector components (rotations around Phi, Theta, Psi), in mrad/s/s
Columns 51-53	X,3I5		Numbers of individual 1-sec-samples per aca record, one number for each component, given in the sequence of the components, 0 = no normal point

Star camera level-2 data line

- Attitude line (star camera measurements)

Columns 1 - 3	A3	'att'	keyword
Column 4	1X		unused
Columns 5 - 8	4(I1)		star camera 1 - 4 flags, indicate the different Camera Head Units (CHU) in the order: CHU1, CHU2, CHU3, CHU4, meaning: CHU included to this data '0' = not included '1' = included Special case: '0000' = interpolated value over a data gap of more than 1 second
Column 9	1X		unused
Columns 10 - 64	4(X,F13.10)		Attitude value in quaternions (value range of all components: -1.0 +1.0) order of Quaternions: q1,q2,q3 = vector part, q4 = scalar part
Column 63	1X		unused
Column 64	F5.2		accuracy of the quaternions '0.0' = no accuracy information available

Data lines used in Accelerometer Level-1-Data

- Accelerometer instrument housekeeping data records

Columns 1 - 3	A3	'hk1'	keyword
Columns 4 -47	4(X,F10.6)		VPROOF (Volts), CDET1 - CDET3 (micrometers), VDET (Volts)

Columns 1 - 3	A3	'hk2'	keyword
Columns 4 -47	4(X,F10.6)		CDET4 - CDET6 (micrometers), VDET (Volts)

Columns 1 - 3	A3	'hk3'	keyword
Column 4 - 5	2X		unused
Columns 6 -11	6I		Status Flags: C, DC, QTC, TME, STM, CV (value range of all flags: 0 ... 9)

CV indicates the shift between the S/C clock and the STAR clock:
 0 = all measures are normal (10 sub-measurements per second)
 1 = one measure contains 9 sub-measures
 2 = one measure contains 11 sub-measures
 3 = one measure contains a different number of
 sub-measurements

Column 12	X	unused
Columns 13-14	I2	NBC {1 .. 60} = the number of seconds from the beginning of from the beginning of the past 60-sec cycle when the shift occurred (which is indicated in CV)
Columns 15-58	4(X,F10.6)	TC-SU, TP-ICU, TE-SU, VICU+15, (temperatures in degrees centigrade, voltages in volts)
Columns 1 - 3	A3	'hk4' keyword
Columns 4 - 58	5(X,F10.6)	VICU-15, VICU+5, TE-ICU, VSU+15/48, VSU-15/48 (temperatures in degrees centigrade, voltages in volts)

- Selected spacecraft housekeeping data

Column 1 - 3	A3	'shk'	format identifier
Column 4	1X		unused
Column 5 - 10	F6.1		cold gas pressure in Bar
Column 11 - 16	F6.1		Temperature of the forward gas tank in Celsius
Column 17 - 22	F6.1		Temperature of the backward gas tank in Celsius
Column 23 - 30	F8.1		Electric current consumption of the Accelerometer in Milliampere
Column 31 - 38	F8.1		Electric current of Torquer 1 in Milliampere
Column 39 - 46	F8.1		Electric current of Torquer 2 in Milliampere
Column 47 - 54	F8.1		Electric current of Torquer 3 in Milliampere

Data lines used in Accelerometer Level-2-Data

- Corrections due to calibration and correction models

Columns 1 - 3	A3	'acc'	keyword
Column 4	1X		unused
Columns 5 - 6	I2		number which indicates the typ of the correction (for instance: Lorentz force acceleration, Corrections due to temperature models and so on) 01 - 49 : reserved for corrections to the linear acceleration 50 - 99 : reserved for corrections to the angular acceleration The presently detailed specification: 01 : Lorentz force acceleration 02 : Correction for the radial (x-) component of the linear acceleration (calculated from a model proposed by CNES)
Columns 7	1X		unused
Column 8	A1		application flag: '0' = the corrections have not been applied. Correct usage is to add the corrections to the measurement values '1' = the corrections have been added
Columns 9 -50	3(X,F13.10)		correction vector components, in in mm/s/s (case of linear acceleration) or mrad/s/s (case of angular acceleration)

- thruster line

Columns 1 - 3	A3	'thr'	keyword
Column 4	1X		unused
Columns 5 -18	14(I1)		thruster activation flags (for the 14 cold gas thrusters) meaning: 0 = not activated 1 = activated all flags 9 = no thruster information available

The flags 1 - 12 indicates the action of the so-called Attitude Control Thruster. They are fired in pairs to accelerate the rotation of the spacecraft about its following axes:

```

11000000000000 = -x
00110000000000 = +x
00001100000000 = -y
00000011000000 = +y
00000000110000 = -z
00000000001100 = +z

```

The flags 13 - 14 indicates the action of that thrusters pair, which can be used to accelerate the satellite in the x-direction (so-called Orbit Control thrusters).

Column 19-20	2X	unused
Columns 21-32	F12.3	duration of the thruster pulse (in seconds)

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- Housekeeping data for Level-2 data

Column 1 - 3	A3	'hka'	format identifier
Column 4	5X		unused
Column 5 - 10	F7.3		temperature of the Accelerometer sensor cage

Formatted Fluxgate magnetometer data line

- Magnetic field vectors

Columns 1 - 3	A3	'fgm'	keyword
Columns 4 -36	3(X,F10.1)		Magnetic Field Vector Components (Bx, By, Bz), in nT
Column 37	1X		unused
Column 38	I1		FGM number (1 or 2)

4. Last line
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The content of the last line is '%eof', this indicates the end of the file