

MFK1-FA / CS4 / CSL

MFK1-A / CS4 / CSL

MFK1-FB

MFK1-B

User's Guide

Modular system for measuring magnetic susceptibility,
anisotropy of magnetic susceptibility,
and temperature variation of magnetic susceptibility.

AGICO
Advanced Geoscience Instruments Co.
Brno
Czech Republic

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Introduction to the User's Guide

Thank you for purchasing magnetic susceptibility meter AGICO Kappabridge MFK1 series.

Kappabridge and its optional accessories represent modular system designed for measurement of magnetic susceptibility and its anisotropy in variable fields and optionally at three different frequencies. In conjunction with furnace or cryostat apparatus, also for measurement of temperature variation of magnetic susceptibility.

Preface

The User's Guide is divided into two parts.

- The Part 1, **Kappabridges MFK1-FA, FB, A, B**, contains general common information, description and specifications of individual modules, and describes the capabilities of the system. The attention is focused on measurement of anisotropy of magnetic susceptibility (AMS) and automatic field variation measurement using the Kappabridges MFK1-FA or MFK1-A equipped with an up-down mechanism and a rotator for spinning specimen measurement method. The options MFK1-FB or MFK1-B are intended for AMS measurement using static specimen method with manual holder (15 directions method) and manual holder susceptibility measurement of individual specimens and/or field variation.
- The Part 2, Apparatus **CS4 / CSL**, describes the measurement of temperature variation of magnetic susceptibility using the high temperature furnace CS4 and low temperature cryostat CSL.

KAPPABRIDGE
MFK1-FA
MFK1-A
MFK1-FB
MFK1-B

User's Manual

Instrument for measuring magnetic susceptibility
and its anisotropy in variable fields at three frequencies

AGICO
Advanced Geoscience Instruments Co.
Brno
Czech Republic

Warranty

AGICO warrants that this product will be free from defects in materials and workmanship for a period of usually 1 (one) year from date of installation. However, if the installation is performed later than 3 (three) months after the date of shipment due to causes on side of Customer, the warranty period begins three months after the date of shipment. If any such product proves defective during this warranty period, AGICO, at its option, either will repair the defective product without charge for parts and labour, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify AGICO of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. AGICO will decide if the repair is to be performed by AGICO technician or AGICO delegated serviceman in customers laboratory, or product shall be sent for repair to the manufacturer. In latter case, customer shall be responsible for packaging and shipping the defective product to the AGICO service centre. In both cases, all the costs related to a warranty repair shall be at expenses of AGICO.

The warranty becomes invalid if the Customer modifies the instrument or fails to follow the operating instructions, in case of failure caused by improper use or improper or inadequate maintenance and care, or if the Customer attempts to install the instrument without explicit written permission of AGICO company. AGICO shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than AGICO representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification increases the time or difficulty of servicing the product.

This warranty is given by AGICO with respect to this product in lieu of any other warranties, expressed or implied. AGICO and its vendors disclaim any implied warranties of merchantability or fitness for a particular purpose. AGICO's responsibility to repair or replace defective products is the sole and exclusive remedy provided to the Customer for breach of this warranty. AGICO and its vendors will not be liable for any indirect, special, incidental, or consequential damages irrespective of whether AGICO or vendor has advance notice of the possibility of such damages.

General Safety Summary

Review the following safety precautions to avoid and prevent damage to this product or any products connected to it.

Only qualified personnel should perform service procedures.

Convention



Symbol **Attention** is used to draw attention to a particular information.



Symbol **Prohibition** is used to accent important instruction, omission of which may cause loss of properties, damage or injury.

Injury Precautions

Use Proper Power Cord. To avoid fire hazard, use only the power cord specified for this product.

Do Not Operate Without Covers. To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Fasten Connectors. Do not operate the instrument if all connectors are not properly plugged and fixed by screws.

Do Not Operate in Wet / Damp Conditions. To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere. To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Disconnect Power Source. To avoid risk of electric shock unplug the instrument from mains before reinstalling or removing unit.

Product Damage Precautions

Use Proper Power Source. Do not operate this product from a power source that applies more than the voltage specified.

Use Proper Fuses only. Do not use fuses which are not specified by the manufacturer. If a fuse with a different characteristics or value is used, the protection is not effective.

Operator's Training. Operator should be familiar with operation of the instrument and Safety Regulations.

Use Manufacturer's Cables Only. Other devices can be connected to the instrument via the appropriate cables only.

Do Not Disconnect Connectors. To avoid damage of the instrument never disconnect any connector while the device is on.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Getting Started

In addition to a brief product description, this chapter covers the following topics:

- Specifications of Individual Modules.
- Declaration of Conformity.
- Unpacking Instructions.
- Storage and Transportation.

MFK1-FA, FB, A, B Description

The **MFK1 Kappbridges** are probably the most sensitive commercially available laboratory instruments for measuring magnetic susceptibility and anisotropy of magnetic susceptibility (AMS). The Kappbridges have the following features:

- High sensitivity.
- Automatic zeroing over the entire measuring range.
- Automatic compensation of both real and imaginary susceptibility components.
- Auto-ranging.
- Measuring at three different frequencies (version FA and FB).
- Measuring of in-phase and relative change of out-of-phase component.
- Slowly spinning specimen (version FA and A).
- Quick AMS measurement (FA and A).
- Easy manipulation.
- Automated field variation measurement (FA and A).
- Only three manual manipulations for measuring AMS (FA and A).
- Built-in circuitry for controlling the furnace CS4 and cryostat CSL.
- Full control by computer.
- Sophisticated hardware and software diagnostics.

The Kappabridge apparatus consists of the Pick-Up Unit, Control Unit and Computer. In principle the instrument represents a precision fully automatic inductivity bridge. It is equipped with automatic zeroing system and automatic compensation of the thermal drift of the bridge unbalance as well as automatic switching appropriate measuring range. The measuring coils at frequency F1 are designed as 6th-order compensated solenoids with a remarkably high field homogeneity. Special diagnostics was embedded in MFK1 Kappabridges, which monitors important processes during measurement with MFK1 and also with CS4 or CSL unit.

The digital part of the instrument is based on micro-electronic components, with two microprocessors controlling all functions of the Kappabridge. The instrument has no control knobs, it is fully controlled by external computer via serial channel RS-232C. The main advantage of the new models MFK1-FA and MFK1-FB is the possibility to measure bulk susceptibility and AMS at three different frequencies. The auto-ranging and auto-zeroing work over the entire measuring range. Automatic zeroing compensates real and imaginary components, the zeroing circuits are digitally controlled by firmware. The output signal from pick-up coils is amplified, filtered and digitalized, raw data are transferred directly to the computer which controls all the instrument functions.

The **MFK1-FB** and **MFK1-B** versions measure the AMS of a static specimen fixed in the manual holder. In the static method, the same as in KLY-2, KLY-3 and KLY-4 bridges, the specimen susceptibility is measured in 15 different orientations following rotatable design. From these values six independent components of the susceptibility tensor and statistical errors of its determination are calculated. The specimen positions are changed manually during measurement.

The **MFK1-FA** and **MFK1-A** versions measure the AMS of a spinning specimen fixed in the rotator. In the spinning method, the same as in KLY-3S and KLY-4S bridges, the specimen rotates with small speed of 0.4 r.p.s. inside the coil, subsequently about three axes. From these data, the deviatoric susceptibility tensor can be computed. This tensor carries information only on anisotropic component of the specimens. For obtaining complete susceptibility tensor one complementary measurement of bulk susceptibility must be done. The zeroing of the bridge which works over the entire measuring range enables to zero the bridge prior to the anisotropy measurement, after inserting the specimen into the measuring coil. The 'background' bulk susceptibility is eliminated and the bridge measures only the susceptibility changes during specimen rotation and thus the most sensitive range can be used. The result is high precision of measurement and determination of principal directions of susceptibility tensor.

The specimen is adjusted only in three perpendicular positions. Thus the specimen measurement time was dramatically shortened. The measurement is rapid, about two or three minutes per specimen (depending on range), and precise, profiting from many susceptibility determinations in each plane perpendicular to the axis of specimen rotation. The static method of the measurement can also be used.

Software **SAFYR** combines the measurements in three perpendicular planes plus one bulk value to calculate a complete susceptibility tensor. The errors in determination of this tensor are estimated using a special method based on multivariate statistics principle.

MFK1 Specifications

Specimen Size ¹		<i>Spinning Specimen</i> ²	<i>Static Specimen</i> ³	
	Cylinder	Diameter	25.4 mm (+0.2, -1.5)	25.4 mm (+1.0, -1.0)
		Length	22.0 mm (+0.5, -1.5)	22.0 mm (+2.0, -2.0)
	Cube		20 mm (+0.5, -1.5)	20 mm (+0.5, -2.0)
	Cube			23 mm (+0.5, -2.0)
	ODP box			26 x 25 x 19.5 mm ³
	Fragments (bulk. susc.)			40 cm ³
Pick-up coil inner diameter			43 mm	
Nominal specimen volume			10 cm ³	
Up/Down mechanism	ver. FA and A	yes		spinning spec.
	ver. FB and B	no		static spec.
Operating frequency	ver. FA and FB	F1: 976 Hz, F2: 3904 Hz, F3: 15616 Hz		
	ver. A and B	F1: 976 Hz		
Field intensity		2 Am ⁻¹ to 700 Am ⁻¹ peak at F1 2 Am ⁻¹ to 350 Am ⁻¹ peak at F2 2 Am ⁻¹ to 200 Am ⁻¹ peak at F3		
Field homogeneity	F1 and F2	0.5 %		
	F3	1 %		
Measuring range	F1: 976 Hz	0 to 0.9 SI		
	F2: 3904 Hz	0 to 0.3 SI		
	F3: 15616 Hz	0 to 0.7 SI		
Sensitivity:	F1, 400 Am ⁻¹ peak, SI units	2 x 10 ⁻⁸		
	F2, 200 Am ⁻¹ peak, SI units	6 x 10 ⁻⁸		
	F3, 200 Am ⁻¹ peak, SI units	12 x 10 ⁻⁸		
Operating temperature range		+ 15 to + 35 °C		
Accuracy within one range		0.1 %		
Accuracy of the range divider		0.3 %		

¹ Holders for specimens of slightly different size can be supplied on request.

² MFK1 versions FA and A

³ MFK1 all versions

Accuracy of the absolute calibration	3 %
HF Electromagnetic Field Intensity Resistance	1 Vm ⁻¹
Power requirements	240, 230, 120, 100 V ±10 %, 50 / 60 Hz
Power consumption	40 VA
Relative humidity	max. 80 %
Dimensions / Mass	
MFK1 Control Unit	230 mm x 210 mm x 130 mm / 4 kg
MFK1 Pick-up Unit	280 mm x 355 mm x 320 mm / 11 kg
Rotator	320 mm x 70 mm x 65 mm / 1 kg

CS4 / CSL Description

The **CS4** and **CSL (High/Low Temperature Apparatuses)** have been designed for measurement in connection with MFK1-FA or MFK1-A Kappabridges.

The **CS4 High Temperature Furnace Apparatus** is used for measurement of the temperature variation of low-field magnetic susceptibility of minerals, rocks and synthetic materials in the temperature range from ambient temperature to 700 °C. The apparatus consists of non-magnetic furnace with a special platinum thermometer, CS4 temperature control unit, laboratory power supply EA-PS, cooling water reservoir with pump, and argon flow meter. The specimen is placed in a measuring vessel which is heated by a platinum wire in three selectable heating rates. The temperature is measured by special platinum thermosensor. The protective argon atmosphere can be applied during heating to prevent oxidation of measured specimen. In order to perform susceptibility measurement at a chosen temperature range, the equipment moves the furnace automatically into and out of the pick-up coil of the Kappabridge. The quasi-continuous measurement process is fully automated, being controlled by the software.

The **CSL Low Temperature Cryostat Apparatus** is used for measurement of the temperature variation of low-field magnetic susceptibility of minerals, rocks and synthetic materials in the temperature range from minus 192 °C to ambient temperature. The apparatus consists of non-magnetic cryostat with a special platinum thermosensor, CS4 temperature control unit and laboratory power supply EA-PS. The specimen is placed in a measuring vessel which is cooled inside the cryostat by liquid nitrogen and then heated spontaneously to a given temperature. The argon gas is needed for depleting the liquid nitrogen out of cryostat. Temperature is measured by platinum thermosensor. The quasi-continuous measurement process, after cooling the specimen, is fully automated, being controlled by the software.

CS4 / CSL Specifications

Maximum specimen volume (fragments or powder)	0.25 cm ³
Inner diameter of measuring vessel	6.5 mm
Sensitivity to susceptibility changes (976 Hz, 400 Am ⁻¹)	1 x 10 ⁻⁷ SI
Temperature range CS4	ambient temperature to 700 °C
Temperature range CSL	-192 °C to ambient temperature
Accuracy of temperature sensor	± 2 °C, see also IEC 751- Pt100
Argon gas flow requirement (protect atmosphere)	approx. 100 ml min ⁻¹
Amount of liquid nitrogen (cooling cryostat)	approx. 0.25 l for one cooling
Power requirements	240, 230, 120, 100 V ±10 %, 50 / 60 Hz
Power consumption	350 VA
Dimensions / Mass	
Temperature control unit	230 mm x 190 mm x 130 mm / 1.7 kg
Laboratory power supply EA-PS	310 mm x 240 mm x 130 mm / 8 kg
Water container with Pump	380 mm x 380 mm x 700 mm / 2 kg (without water)
Argon flow meter	32 mm x 32 mm x 140 mm / 1 kg
Furnace/Cryostat	diameter 60 mm, length 220 mm / 0.5 kg

EC Declaration of Conformity

We,

AGICO, s.r.o., Ječná 29a, CZ - 621 00 Brno, IČO 607 313 54,

declare that the product:

Name: Modular system for measuring magnetic susceptibility, anisotropy of magnetic susceptibility and temperature variation of magnetic susceptibility.

Modulus Type: *MFK1* *indicator of susceptibility and its anisotropy at variable fields,*

Modifications: *MFK1-FA* *indicator of susceptibility and anisotropy of susceptibility at 3 frequencies, with rotating sample,*

MFK1-A *indicator of susceptibility and anisotropy of susceptibility with rotating sample,*

MFK1-FB *indicator of susceptibility and anisotropy of susceptibility at 3 frequencies,*

MFK1-B *indicator of susceptibility and anisotropy of susceptibility,*

Modulus Type: *CS4* *indicator of temperature variation of susceptibility from room temperature to 700 °C,*

Modulus Type: *CSL* *indicator of temperature variation of susceptibility from -192 °C to room temperature,*

Manufacturer: *AGICO, s.r.o., Ječná 29a, CZ - 621 00 Brno, IČO 607 313 54*

Place of producing: *AGICO, s.r.o., Ječná 29a, CZ - 621 00 Brno, IČO 607 313 54*

fulfils the applicable requirements of following regulations / normative documents and technical specifications:

ČSN EN 55022 class B	EN 55022:1998, ČSN EN 55022:1999 + A1:2001 + A2:2001 + Z2:2001
ČSN EN 61326-1 for basic requirements	EN 61326-1:2006, ČSN EN 61326-1:2006
ČSN EN 61000-4-2 criterion B	EN 61000-4-2:1995 + A1:1998, ČSN EN 61000-4-2:1997 + A1:1999
ČSN EN 61000-4-3 criterion A	EN 61000-4-3:2006, ČSN EN 61000-4-3 ed.3:2006
ČSN EN 61000-4-4 criterion B	EN 61000-4-4:2004, ČSN EN 61000-4-4 ed.2:2005
ČSN EN 61000-4-5 criterion B	EN 61000-4-5:2006, ČSN EN 61000-4-5 ed.2:2007
ČSN EN 61000-4-6 criterion A	EN 61000-4-6:1996 + A1:2001, ČSN EN 61000-4-6:1997 + Z1:2001
ČSN EN 61000-4-11	EN 61000-4-11:2004, ČSN EN 61000-4-11 ed.2:2005
- criterion A for short-time dip	
- criterion B for short-time interrupt	

The judgement of conformity was performed in co-operation with the ITI TUV s.r.o., Prague

Place and date of issue: Brno, March 2009

Responsible person: Ing. Petr SUZA, development engineer

Unpacking Instructions

Remove carefully the instrument and its accessories from the box and packing material, referring to the packing list included to confirm that everything has been delivered. Briefly inspect each item for shipping damage. If anything is missing or damaged, contact the manufacturer or your dealer immediately. You may want to retain the box and other packing material in case you need to ship the instrument.

Storage and Transportation

The properly wrapped instrument can be stored and transported at a temperature $-20\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$ and relative humidity up to 80 %. In both cases the instrument should be stored in suitable place, free of dust and chemical evaporation.

Installation Procedures

The first installation and training is performed exclusively by the AGICO technician or by the authorised representative. If you need later to reinstall the apparatus, due to the moving the instrument to another place or any other reasons, be sure the following conditions are met to achieve guaranteed parameters.

Choosing the place

Place the apparatus to a room with relatively magnetically clean environment.



- The instrument must not be placed near sources of alternating magnetic field, e.g. big transformers, electric motors, electricity power source wires, thermal sources etc.
- Do not place the instrument near thermal and electrical sources and prevent the pick-up coils from direct sunshine. The pick-up unit must not be exposed to heat from the sun or from other sources, which would affect the precision of measurement.
- Do not place the pick-up coils near the other instruments or computer monitors.
- Do not place the instrument to a draughty room. Air condition may sometimes cause higher thermal drift of coils, prevent the direct air flowing in the room .



- The temperature in the room should be stable as much as possible. The temperature variation in the room should not exceed 2 °C / hour.
- Place the instrument and pick-up unit on a wooden table with good stability which has no iron part under working desk.
- It is recommended to place the pick-up unit on a separate stand or a small table which should be of such a height so that the middle of the pick-up unit coincides with the level of the working table. This arrangement makes the operation easier.

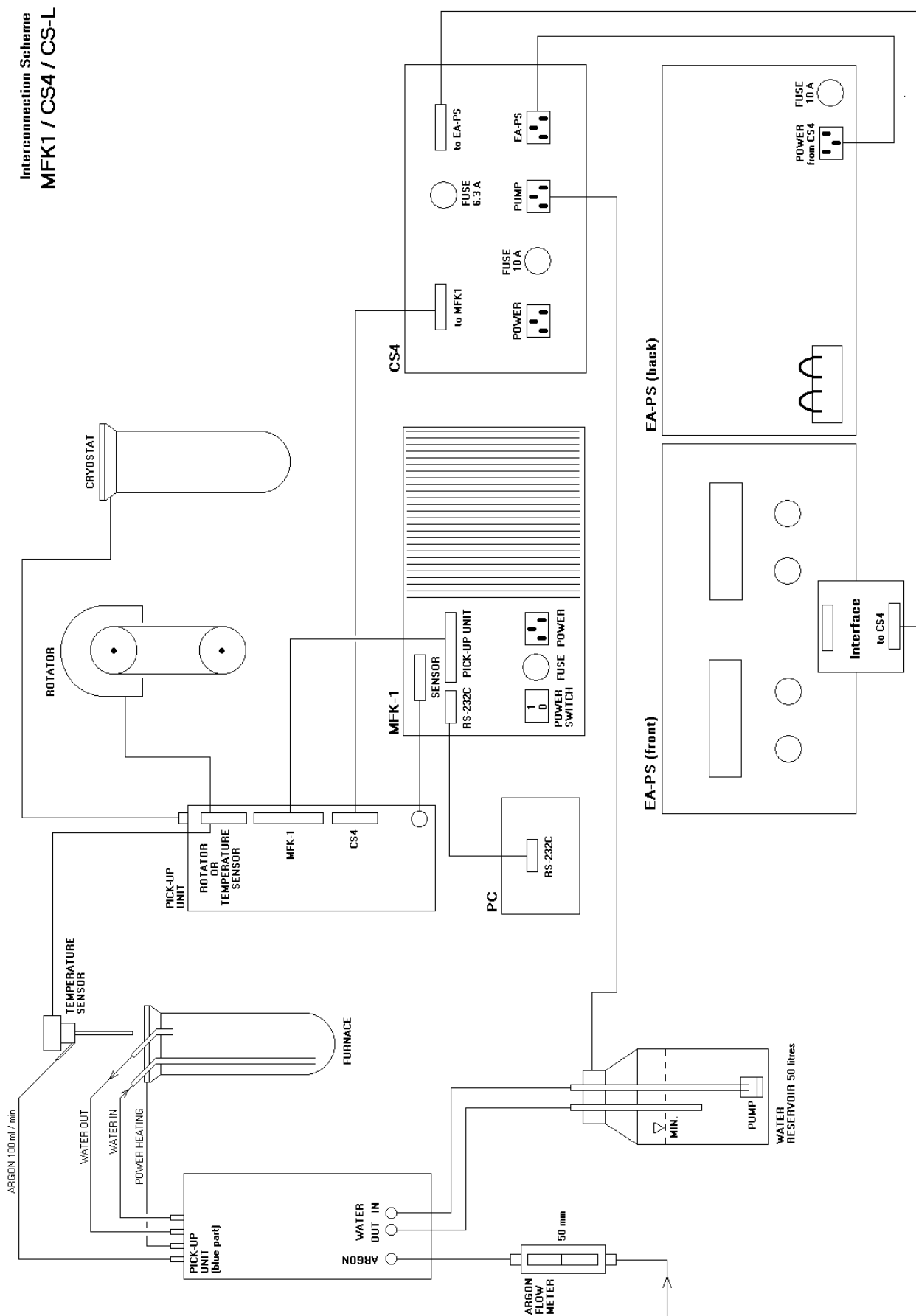


- During measurement prevent motion of magnetically objects (metal parts of chairs, doors, furniture, watches, rings, tools, components of your clothes, etc.)

Interconnection of Units

Fig. 1 shows the Interconnection Scheme. If you are installing only Kappabridge do not consider CS4, laboratory power supply EA-PS and its accessories. **Be sure the instrument is unplugged from mains during connecting the cables. Do not manipulate with any connector while the instrument is ON.** Fix the connectors by screws, plug the mains socket and switch the Kappabridge on.

Fig. 1 Interconnection Scheme MFK1-FA / CS4 / CSL



Connection Kappabridge to computer

- Copy the software SAFYR to your computer exactly in the same structure as it is on original diskette and run program SAFYR.EXE.
- After the program is started the communication of the instrument with your computer via serial channel RS-232C COM1 or COM2 is tested automatically each time you run the program SAFYR. If there is something wrong in the communication, the following message appears on the screen :

RS-232 COMMUNICATION ERROR

- In this case it is recommended to switch the instrument off and to check the connection of the instrument with the computer or to check whether the serial port COM1 or COM2 is enabled in your computer.
- If the communication is O.K., the initial procedure is started and the messages received from Kappabridge subsequently appear on the screen of the computer. These information inform the user of the current activities of the instrument. They differ with MFK version and with current configuration. In case there are no problems, the offer of the MAIN MENU appears. For detailed information and explanation of the main menu see chapter Operating Basics.

Testing the magnetic environment

- See chapter *Choosing the place* before running test. If you do not use notebook or computer with LCD display (we recommend it), take attention to your PC monitor. The monitor distance from pick-up coils and its azimuth position can have sometimes great influence. Be sure there are no other instrument in the vicinity of pick-up coils.
- Run program SAFYR.EXE.
- In the MAIN menu select function Key10 Aux, then press Key2 Acmd. If you have Kappabridge versions FA or A, disable *Up/Down Mechanism*, disable *Rotator* and Select S to start the test measurement routine called “Sigma Test” (see *AuxKey2 – Standard Error Test*, p. 45.)
- The measured data (empty coil measurement at F1 and 400 A/m peak) are stored in the files which names are derived from current time in format HHMMSS with extensions K00 and R00. The file K00 contains the all measured data, file R00 contains only the results (average and standard error) of 10 repeated measurements in one set. Number of sets is also 10. The test takes approx. 40 minutes. Do not disturb test during measurement by moving anything in the vicinity of instrument.
- Check the results saved at the end of files .K00 and .R00 denoted as “ ** Total Average “, the total average of measurement of the real component of susceptibility and its standard error, calculated as the average of averages of individual measurement sets (10 x 10 measurements). Check also all individual averages of each measurement set and its distribution.

Operating Basics

This chapter covers the following topics:

- ❑ Main Menu of the SAFYR
 - Brief description of the Main Menu
 - Measuring of AMS using static specimen method in 15 Directions
 - Measuring of AMS using spinning specimen method with Rotator
 - Field and Frequency Setting

- ❑ Auxiliary Menu of the SAFYR
 - Brief description of the Auxiliary Menu
 - Measuring Bulk Susceptibility and Field Variation
 - Setting Parameters (Configuration, Calibration Standard, Volume, Mass ...)
 - Calibration
 - Correction for the Holder

- ❑ Appendices
 - List of Magnetic Anisotropy Factors
 - Structures of Data Files
 - Selection of Coordinate Systems
 - Geological Locality Data

Brief description of the Main Menu

F1	<15dir>	Measuring Anisotropy in 15 Directions using manual holder (instrument option FB and B).
F1	<Ax1>	Measuring Anisotropy in Pos.1 - rotation about axis 1 (instrument option FA and A).
F2	<Ax2>	Measuring Anisotropy in Pos.2 - rotation about axis 2.
F3	<Ax3>	Measuring Anisotropy in Pos.3 - rotation about axis 3.
F4	<TSus3>	Measuring Total (directional) Susceptibility in Pos.3.
F4	<TSus>	Measuring Total Susceptibility in a Current Position.
F5	<Field>	Set Field.
F5	<Eval>	When measuring anisotropy is completed in all positions, <Eval> is on. The specimen data can be entered from the keyboard or read from the Geological file. The anisotropy tensor and anisotropy factors are computed.
F6	<ActVol>	Enter Actual Volume of a specimen -in mode Volume.
F6	<Mass>	Enter Actual Mass of a specimen - in mode Mass.
F7	<Help>	This key invokes this HELP.
F8	<Freq>	Set Frequency - instrument options FA and FB.
F8	<Stop>	The current measuring action is stopped. The previous data is preserved. Sets the Holder and Rotator to initial position.
F9	<Kill>	Breaks the current activities, the data is cleared. Sets the Holder and Rotator to initial position.
F10	<Aux>	Switches to 'AUX' menu.

Measuring of AMS – static specimen method

The measurement of AMS using static specimen method with manual holder is available with the MFK1-FB or MFK1-B Kappabridges and also with MFK1-FA or MFK1-A (with user option adjustment U/D DISABLED and ROTATOR DISABLED).



Do not forget to insert the plastic cylinder into the coil before the measurement. The plastic cylinder ensures the placing of the specimen fixed in manual holder in the middle of measuring coil.

During measurement process, the susceptibility of the specimen is measured subsequently in 15 directions following the rotatable Jelinek's design in exactly the same way as in the KLY-2, KLY-3 and KLY-4 Kappabridges. Using the least squares method, the susceptibility tensor is fit to these measurements of the 15 directional susceptibilities and the errors of the fit are calculated. The results of the measurement, in the form of various parameters derived from the susceptibility tensor and orientations of the directions of the principal susceptibilities in various coordinate systems, are presented on the screen or written on the disk. The tensor elements together with orientations of mesoscopic foliations and lineations can be also written on the disk (into standard AMS file which is binary random access file with extension .ran) from where they can be read in advanced processing.

Function Key 1 *Dir 15*

The procedure serves for the measurement of 15 directional susceptibilities. The Jelinek's design of the 15 directions is shown in the following scheme. The position design is the same for the cubic and cylindrical specimens. After pressing F1, the following appears on the screen

DATA MEASURED

RESIDUALS

Next direction 1

Press <SpaceBar> to continue

Put the specimen into the holder in the Pos.1 (see following scheme), be sure the slot is up and five black strips are visible front of you, press the SpaceBar key and wait the computer's beep. Then, insert the specimen into the measuring coil from where pull it out after the second beep. Then, change the specimen position and continue analogously until the first 5 directional susceptibilities are measured. Then fix the specimen to initial position for next 5 directional susceptibilities P6..P10, be sure the slot is up and black strips are visible front of you and follow the next five directions with the same design but now using the double arrow. Continue with last 5 directional susceptibilities, set the initial position for P11..P15 and follow the same design with triple arrow.

Static specimen measuring positions



POS. 1



POS. 2



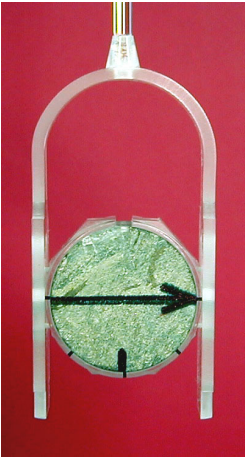
POS. 3



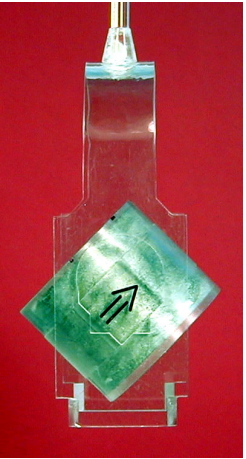
POS. 4



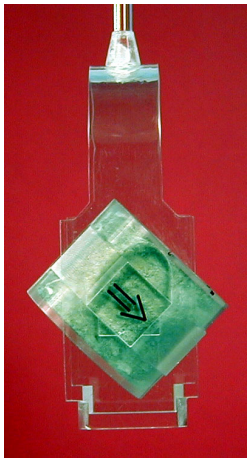
POS. 5



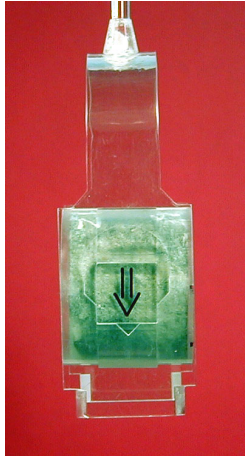
Initial position P6 .. P10



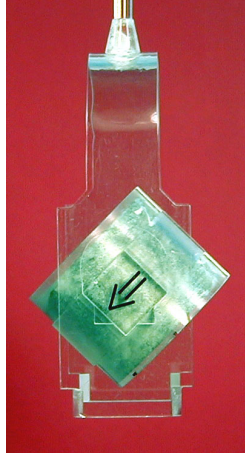
POS. 6



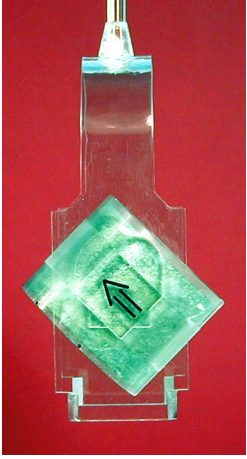
POS. 7



POS. 8



POS. 9



POS. 10



Initial position P11..P15



POS. 11



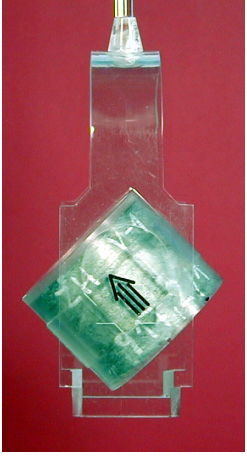
POS. 12



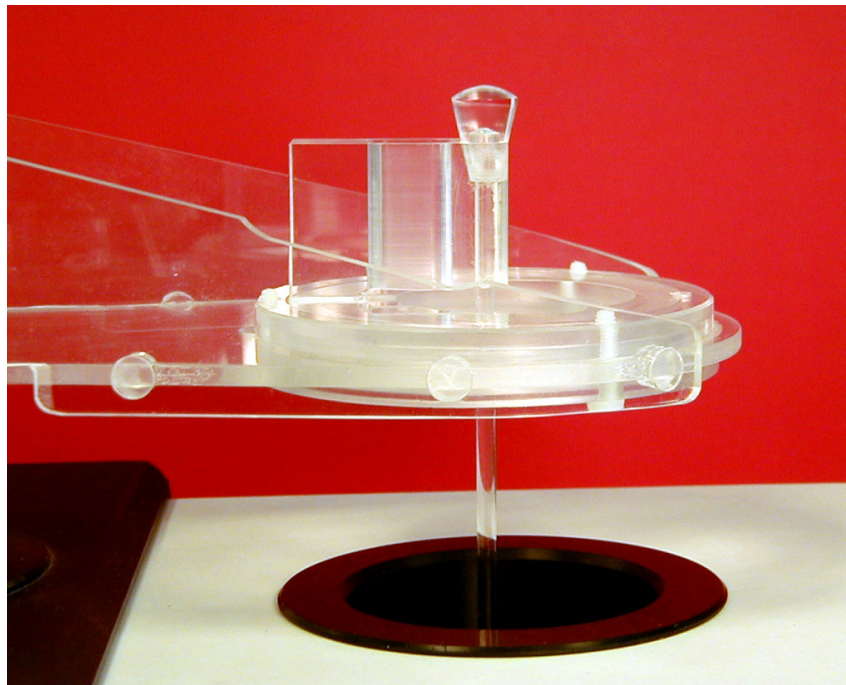
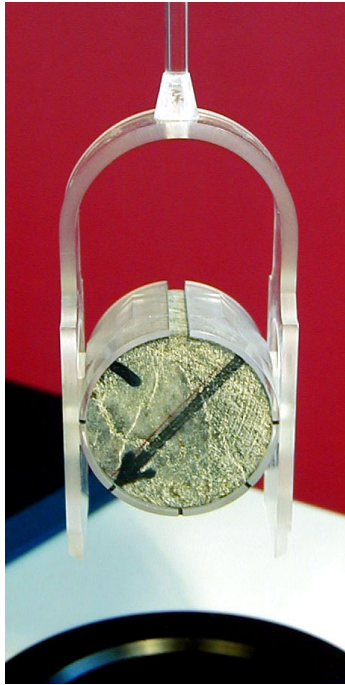
POS. 13



POS. 14



POS. 15



The users of the Kappabridges MFK1-FA or MFK1-A can use the arrangement with manual holder adapter.

This is useful for automatic field susceptibility variation measurement, but can be used also for AMS static specimen measurement if one prefers such a way. In this case do not insert the plastic cylinder into the coil.

Set the ROTATOR DISABLED and U/D ENABLED (*AuxKey 2* in Auxiliary Menu).

The results look like in the following example

DATA MEASURED			RESIDUALS in %		
30.41E-03	32.25E-03	31.54E-03	-0.12	-0.19	0.03
31.27E-03	31.42E-03	31.79E-03	-0.11	-0.13	0.05
30.60E-03	31.20E-03	32.63E-03	-0.13	-0.28	-0.12
30.44E-03	32.33E-03	31.60E-03	-0.02	-0.05	0.24
30.29E-03	31.45E-03	31.85E-03	-0.03	-0.02	0.22
			Std. error : 0.18		
Anisotropy test : 356.1 322.9 135.6					
Confidence angles : 3.3 5.1 2.0					

1 2 **Corr** 3 4 5 **Eval** 6 7 8 9 **Kill** 10 **Aux**

- The three columns DATA MEASURED show the values of 15 directional susceptibilities measured. The data RESIDUALS represent the deviations of the measured and fitted data. After fitting the susceptibility ellipsoid to the measured data using the least squares method, the susceptibility in each measuring direction is calculated from the fitted tensor and subtracted from the measured value; this is the residual. The residuals are the lower the higher is the measuring accuracy and better fit. Ideally, the residuals are as low as the measuring errors of individual directional susceptibilities. Std. error is the mean value of the absolute values of the residuals.
- The quality of the measurement can be evaluated also from the values of *Anisotropy test* and *Confidence angles*. The Anisotropy test values are the values of the F-test for anisotropy/isotropy and for triaxial/rotational prolate and for triaxial/rotational oblate ellipsoids. If the left value is higher than 3.48, then the differences between the principal susceptibilities determined by measurement compared to measuring errors are great enough that the specimen can be considered anisotropic from the statistical point of view (on the 95% level of significance). If the central and right values are higher than 4.25, then the ellipsoid is triaxial. The Confidence angles values are the angles defining the statistical accuracy of the determination of the individual principal susceptibilities directions on the 95% level of significance (for more details see AGICO Print No.1).

Function Key 2 **Corr**

This key may be activated during or after the 15 directional susceptibilities are measured. It enables any imprecisely measured directional susceptibility to be re-measured (during the measurement pressing **Corr** sets the position number to the current position minus one). After complete measurement and pressing F2, input the *Direction to be repeated* and re-measure the corresponding directional susceptibility. The proper specimen position should be prepared before pressing F2 key. The re-measurements in various directions can be repeated until the expected accuracy is reached.

Function Key 5 **Eval**

This procedure evaluates the measured data through the determination of the susceptibility tensor and its related parameters. Before this procedure is activated, it is possible to repeat measurement of any of the 15 directional susceptibilities in order to get the best data for the evaluation. After the evaluation is once started, none of the directional susceptibilities can be re-measured; only the whole specimen can be re-measured.

- If the **Eval** procedure is started for the first time, the following questions subsequently appear on the screen

Path ? drive:\ dir1\dir2\...\ <CR>...current

Name of file ? without extension, 8 chars max.

Each of associated files contains x record(s)

Specimen name (# means new file) ?

- After the above information are input, the question appears for the way of inputting the geological orientation data

Select:

Using geological file [1]

Manual input from memo-book [2]

Non-oriented specimen [3]

If you selects [1] the data are read from the geological data file created earlier (the geological data file can be created using the ANISOFT program package) which must be located in the same directory as the standard AMS data file. The geological data are used in the calculations and also copied into the standard AMS file (see Appendix 2).

If you select [2], two sampling angles have to be entered from keyboard.

Input angles of the orientation of the specimen, the first is azimuth of the fiducial mark of the specimen, the second is the dip or plunge of the fiducial mark separated by comma, for details see the AGICO Print No. 6.

Number of tectonic systems (0 to 2):

- If 0 is input (for example if non-foliated and non-lineated volcanic or plutonic rock is measured), no other geological data are input.
- If 1 or 2 is input, the following data must also be input

1: Code, 4 tectonic angles ?

The two-character code characterizes the measured mesoscopic foliation and lineation, the angles are azimuth of the dip (or strike if the orientation parameter P4 is 90), dip of the first mesoscopic foliation, trend, plunge of the first mesoscopic lineation, respectively. If only foliation exists, the second character in the code must be zero and the last two angles are also zeros.

- If 2 is input, the following data must also be input

2: Code, 4 tectonic angles ?

The two-character code characterizes the measured mesoscopic foliation and lineation, the angles are azimuth of the dip (or strike if the orientation parameter P4 is 90), dip of the second mesoscopic foliation, trend, plunge of the second mesoscopic lineation, respectively. If only foliation exists, the second character of the code must be zero and the last two angles are also zeros.

- After the geological data are input the program displays the results and after pressing ESC key, the data can be saved in the data file. They are written on the disk as an ASCII file in the same format as they appear on the screen (later they can be re-printed on the paper if necessary). The extension of this file is .ASC and the file is located in the same directory as the standard AMS file.
- After measuring the second or later specimen only the question for the specimen name appears on the screen. The data are handled in the same way as those of the first specimen. If one wishes to change the file, one inputs # instead of the specimen name and the inputting is made as in the first specimen.
- Then, the calculated data are shown on the screen in the form whose example is shown on the page 30. The meaning of the presented results is as follows :

Azi first orientation angle (mostly azimuth of the dip or strike of the fiducial mark on the specimen)

Dip second orientation angle (dip of the fiducial mark or plunge of the cylinder axis)

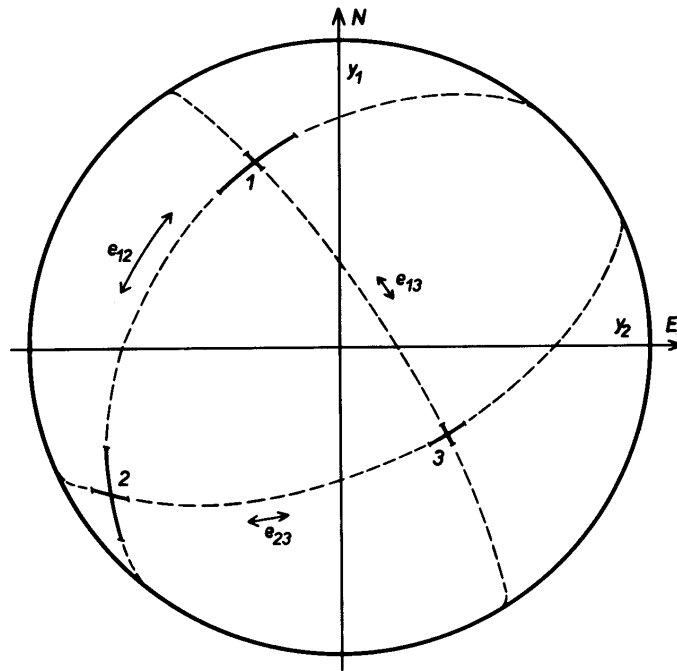
O.P. orientation parameters (see the section **OrPar**)

Nom.vol. nominal volume of the calibration standard (10 cm³)

Act.vol. the volume of the specimen measured (in cm³)

Demag.fac. information whether the demagnetizing factor of the specimen was considered in the calculation of the mean susceptibility

Holder	susceptibility of the holder (measured in the section Hol)
T1	code for the first pair of mesoscopic foliation and lineation
F1	orientation angles for the first foliation
L1	orientation angles for the first lineation
T2	code for the second pair of mesoscopic foliation and lineation
F2	orientation angles for the second foliation
L2	orientation angles for the second lineation
Field and Frequency	peak field in A/m and F1, F2 or F3
Mean	mean susceptibility, SI units
Standard err. [%]	error in fitting the susceptibility tensor of the measured data
F, F12, F23	statistics for anisotropy, triaxiality and uniaxiality testing
Normed principal susceptibilities	principal susceptibilities normed by the norming factor and errors in their determination
95% confidence angles, E12, E23, E13	confidence angles (on the 95 % probability level) in the determination of the orientations of the principal susceptibilities



Anisotropy factors

values of the selected anisotropy parameters

Principal directions

orientations of principal susceptibilities (in decreasing succession) as declination (D) and inclination (I) in various coordinate systems

Normed tensor

values of the normed susceptibility tensor in the appropriate coordinate system; the upper line gives the diagonal tensor elements (consecutively K_{11} , K_{22} , K_{33}), while the lower line gives the non-diagonal elements (K_{12} , K_{23} , K_{13})

Azi 5 O.P. : 12 90 6 0 Nom. vol. 10.00
 Dip 20 Demag. fac. : YES Holder -1.69E-06 Act. vol. 10.00

T1 F1 L1 T2 F2 L2
 CD 10/20 30/40 0/0 00/00 00/00

Directional Total Susc.			Residuals [%]		
11.32E-03	72.45E-04	81.87E-04	0.05	-0.18	0.12
10.27E-03	88.80E-04	90.29E-04	-0.02	-0.51	0.46
11.22E-03	10.36E-03	59.48E-04	-0.69	0.60	0.71
11.35E-03	71.86E-04	81.93E-04	0.35	-0.82	0.17
10.31E-03	88.81E-04	89.72E-04	0.42	-0.49	-0.17

Field	Mean	Standard	Tests for anisotropy		
[A/m]	susc.	err. [%]	F	F12	F23
200 F1	9.186E-03	0.586	2593.2	262.2	3625.0

Normed principal susceptibilities			95% confidence angles		
			E12	E23	E13
1.2575	1.1222	0.6203	3.6	1.0	0.8
+ - 0.0037	0.0037	0.0037			

Anisotropy factors (principal values positive)

L	F	P	'P	T	U	Q	E
1.121	1.809	2.027	2.136	0.678	0.575	0.237	1.614

Principal directions					Normed tensor		
Specimen system	D	337	67	245	1.2327	1.1256	0.6417
	I	0	12	78	-0.0571	0.0911	0.0444
Geograph system	D	314	75	173	0.7308	1.1342	1.1350
	I	59	17	25	0.0315	-0.0650	0.2305
Paleo 1 system	D	337	75	172	0.9205	1.1277	0.9518
	I	45	8	44	0.0106	-0.0595	0.3107
Tecto 1 system	D	37	135	232	1.0668	0.9815	0.9518
	I	45	8	44	-0.0950	0.2393	0.2069

Measuring of AMS – spinning specimen method

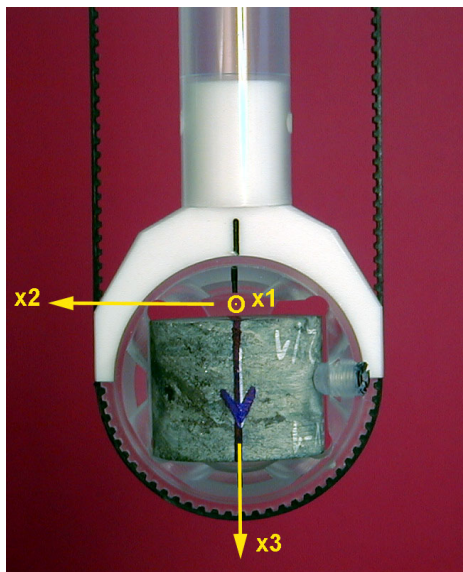
The measurement of AMS using spinning specimen method with rotator is available with the MFK1-FA or MFK1-A Kappabridges (options U/D ENABLED and ROTATOR ENABLED).

During measurement, the specimen slowly rotates subsequently about three perpendicular axes (in the same way as KLY-3S and KLY-4S Kappabridges). The bridge is zeroed after inserting the specimen into the measuring coil so that susceptibility differences are measured during specimen spinning (64 measurements are made during one spin) which results in very sensitive determination of the anisotropic component of the susceptibility tensor profiting from the measurement on the lowest possible and therefore most sensitive range. Then, one bulk susceptibility value is measured along one axis and the complete susceptibility tensor is combined from these measurements. The measured data, in the form of various parameters derived from the susceptibility tensor and orientations of directions of the principal susceptibilities in various coordinate systems are presented on the screen. The tensor elements together with orientations of mesoscopic foliations and lineations can be written on the disk (into standard AMS file which is binary random access file) from where they can be read in advanced processing.

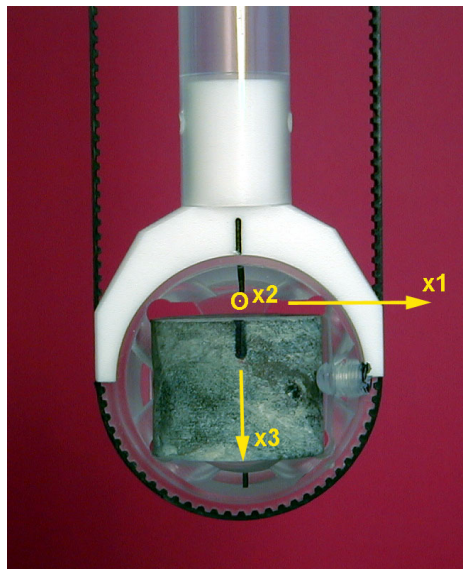


Do not forget to remove the plastic cylinder from the coil in case the previous measurement was done using the manual holder and with the option U/D DISABLED.

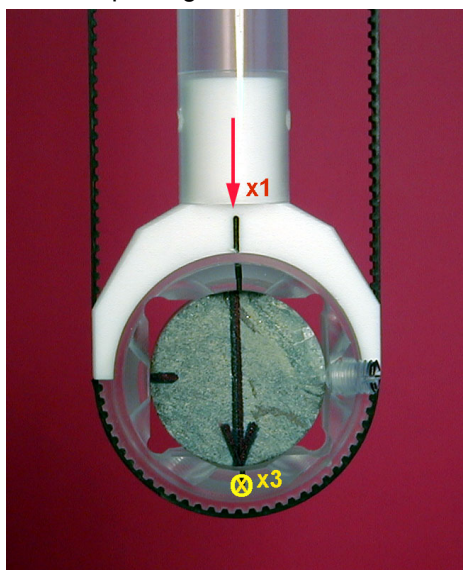
Spinning specimen measuring positions and laboratory marking



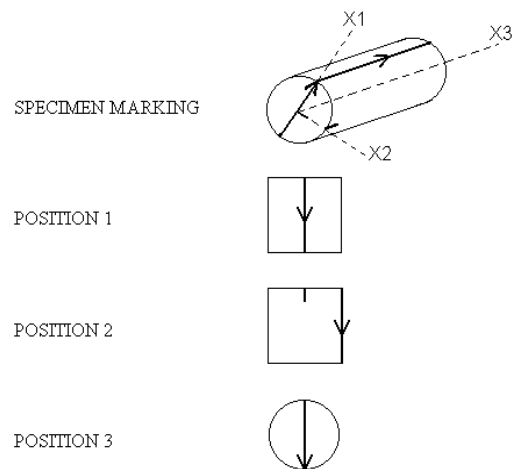
POS. 1 spinning about axis x_1



POS. 2 spinning about axis x_2



POS. 3 spinning about axis x_3 and T_{sus3}



The specimen **laboratory marking** defines the specimen right-handed oriented coordinate system, and must be performed in the way displayed on the above picture and in the agreement with orientation parameters used in the particular laboratory.

Please note the orientation of the fiducial mark on the frontal side of cylinder which defines the X_1 of specimen coordinate system may, or may not be measured in the field and the orientation of the arrow on the case of cylinder drawn in the laboratory and drawn in the field may be in general different.

For this reason, different orientation parameters are used for the information how the fiducial mark is drawn and for the information how the azimuth is measured.

Function Key 1 **Ax1**

This procedure serves for the measurement of the AMS in the x_2, x_3 plane (the specimen spins about the x_1 axis). The spinning is very slow (one revolution per 2.5 seconds) and the susceptibility is measured 64 times during one revolution. As the bridge is zeroed with the specimen inserted into the measuring coil before the specimen starts spinning, the susceptibility differences are measured between the susceptibilities along the respective directions and that of the direction in which the bridge was zeroed. This way of measurement is very advantageous, because one measures only the anisotropic component of the susceptibility which is much lower than the bulk component and one can profit from the higher accuracy of the measurement made on the more sensitive range.

- Before pressing Key F1, the specimen should be fixed into the specimen holder in the measuring position No.1.
- After pressing F1, the specimen is automatically inserted into the specimen coil, the bridge is zeroed and the specimen starts spinning; during spinning the specimen susceptibility is measured.

The results are presented in the form as in the following example

Ax	Range	Cosine	Sine	Error	Error%
1	1	-5.709E-06	-2.102E-06	8.2E-09	0.14

- *Ax* means that the specimen spins about the x_1 axis (the measurement in the x_2, x_3 plane - Position No.1).
- *Range* informs us of the range on which the anisotropy was measured (this is only formal information, because the instrument has a fully auto-ranging feature).
- *Cosine* and *Sine* give the values of the cosine and sine components, respectively, of the average anisotropy curve.
- *Error* gives the standard deviation of the individual curves from the average curve.
- *Error%* gives this deviation divided by the amplitude value.

The *Error* you obtain in each of three AMS axes measurement is standard deviation of the individual curves (there are two sine wave curves for one physical revolution) from the average curve and the *Error%* gives this deviation divided by the amplitude value. This error has only informative meaning and reflects the ratio between the noise and "anisotropy" signal for measurement in one plane only. Thus it depends not only on absolute susceptibility of the specimen measured but mainly on the degree of anisotropy in an individual plane perpendicular to the axis of rotation. In case there is no anisotropy in one of the three planes this error may be over 100% and has no physical meaning. In case the anisotropy in one plane has "reasonable" value, the usual value is lower 5%, but it does not reflect the quality of the measurement, but the level of anisotropy in one

plane. On the other hand it is clear that the sensitivity of the instrument influences this error. For judgement of the quality of AMS measurement, use F test numbers and 95% confidence angles. The general rule is as follows. If the F numbers are high (let say at least above 5) the confidence angles are low and principal direction (directions) is (are) very well defined. The sensitivity of AMS measurement for field 400 Am^{-1} on MFK1 is 2×10^{-8} , the anisotropy of the specimens with mean susceptibility about 5×10^{-6} SI units can be measured, but the confidence angles may be in some cases higher, it depends on type of anisotropy. The sensitivity is approximately linearly decreasing with decreasing field. Due to the influence of rotator motor the AMS measurement may be problematic at frequencies F2 and F3 in case of specimens weaker than 100×10^{-6} SI units and with degree of anisotropy lower than 5%. For this case at F3 it is recommended to use manual measurement method in 15 directions to eliminate the influence of motor of the rotator.

Function Key 2 **Ax2**

This procedure serves for the measurement of the AMS in the $x1, x3$ plane (the specimen spins about the $x2$ axis - Position No.2) in the same way as in the previous case.

Function Key 3 **Ax3**

This procedure serves for the measurement of the AMS in the $x1, x2$ plane (the specimen spins about the $x3$ axis - Position No.3) in the same way as in the previous case.

Function Key 4 **Tsus3**

This procedure measures the bulk susceptibility along the $x1$ axis (corresponding to the specimen in the third measurement position). After pressing F4, the bridge is zeroed, the specimen is inserted into the measuring coil and the bulk susceptibility is measured.

- The knowledge of the bulk susceptibility along the $x1$ axis is necessary in the construction of the complete susceptibility tensor from the deviatoric tensor (based on susceptibility differences) and one bulk value

Function Key 5 **Field**

After pressing the F5key the required integer value of peak Field can be entered. Setting is not available during AMS measurement procedure.

Function Key 5 *Eval*

This key is available if all positions of AMS measurement procedure have been completed. This procedure evaluates the measured data through the determination of the susceptibility tensor and its related parameters. Before this procedure is activated, it is possible to repeat any of the procedures **Ax1**, **Ax2**, **Ax3**, **TSus3** in order to get the best data for the evaluation. When any of the above procedures is completed, the denotation of the respective key is supplemented by an asterisk *. If the evaluation is started, none of the above procedures can be repeated; only the whole specimen can be re-measured.

- If the **Eval** procedure is started for the first time, the following questions subsequently appear on the screen

Path ? drive:\ dir1\dir2\...\ <CR>...current

Name of file ? without extension, 8 chars max.

Each of associated files contains x record(s)

Specimen name (# means new file) ?

- After the above information are input, the question appears for the way of inputting the geological orientation data

Select:

Using geological file [1]

Manual input from memo-book [2]

Non-oriented specimen [3]

One selects [1] if the data should be read from the geological data file created earlier (the geological data file can be created using the ANISOFT program package) which is located in the same directory as the standard AMS file being measured. The reading is made automatically by program. The geological data are used in the calculations and also copied into the standard AMS file (see Appendix 2).

If one selects [2], the following questions appear on the screen

MANUAL INPUT FROM MEMO-BOOK

2 sampling angles ?

One inputs the angles of the orientation of the specimen, the first is azimuth of the fiducial mark of the specimen, the second is the dip or plunge of the fiducial mark, for details see the AGICO Print No. 6.

Number of tectonic systems (0 to 2):

- If 0 is input (for example if non-foliated and non-lineated volcanic or plutonic rock is measured), no other geological data are input.
- If 1 or 2 is input, the following data must also be input

1: Code, 4 tectonic angles ?

The two-character code characterizes the measured mesoscopic foliation and lineation, the angles are azimuth of the dip (or strike if the orientation parameter P4 is 90), dip of the first mesoscopic foliation, trend, plunge of the first mesoscopic lineation, respectively. If only foliation exists, the second character in the code must be zero and the last two angles are also zeros.

- If 2 is input, the following data must also be input

2: Code, 4 tectonic angles ?

The two-character code characterizes the measured mesoscopic foliation and lineation, the angles are azimuth of the dip (or strike if the orientation parameter P4 is 90), dip of the second mesoscopic foliation, trend, plunge of the second mesoscopic lineation, respectively. If only foliation exists, the second character of the code must be zero and the last two angles are also zeros.

If one selects [3], no angle data are necessary.

- After the geological data are input the program displays the results and after pressing ESC key, the program asks

Output to file [Y/N] <Enter> = YES

- Data are written as an ASCII file in the same format as they appear on the screen (later they can be re-printed on the paper if necessary). The extension of this file is .ASC and the file is located in the same directory as the standard AMS file.
- After measuring the second or later specimen only the question for the specimen name appears on the screen. The data are handled in the same way as those of the first specimen. If one wishes to change the file, one inputs # instead of the specimen name and the inputting is made as in the first specimen.
- Then, the calculated data are shown on the screen in the form whose example is shown on the page 38. The meaning of the presented results is as follows :

Azi	first orientation angle (mostly azimuth of the dip or strike of the fiducial mark on the specimen)
Dip	second orientation angle (dip of the fiducial mark or plunge of the cylinder axis)
O.P.	orientation parameters (see the section OrPar)
Nom.vol.	nominal volume of the used pick up unit (mostly 10cm ³)
Act.vol.	the volume of the specimen measured (in cm ³)
Demag.fac.	information whether the demagnetizing factor of the specimen was considered in the calculation of the mean susceptibility

Holder	susceptibility of the holder (measured in the section Hol)
T1	code for the first pair of mesoscopic foliation and lineation
F1	orientation angles for the first foliation
L1	orientation angles for the first lineation
T2	code for the second pair of mesoscopic foliation and lineation
F2	orientation angles for the second foliation
L2	orientation angles for the second lineation
Field and Frequency	peak field in A/m and F1, F2 or F3
Mean	mean susceptibility, SI units
Standard err. [%]	error in fitting the susceptibility tensor of the measured data
F, F12, F23	statistics for anisotropy, triaxiality and uniaxiality testing
Normed principal susceptibilities	principal susceptibilities normed by the norming factor and errors in their determination
95% confidence angles for rotation axis Ax1, Ax2, Ax3	semi-axis of the confidence ellipse angles of the orientations of the principal susceptibilities
Anisotropy factors	values of the selected anisotropy parameters
Principal directions	orientations of principal susceptibilities (in decreasing succession) as declination (D) and inclination (I) in various coordinate systems
Normed tensor	values of the normed susceptibility tensor in the appropriate coordinate system; the upper line gives the diagonal tensor elements (consecutively K11, K22, K33), while the lower line gives the non-diagonal elements (K12, K23, K13)

9-4-1 ANISOTROPY OF SUSCEPTIBILITY Program SAFYR ver.1.0

Azi 30 O.P. : 12 0 3 90 Nom. Vol. 10.00
 Dip 60 Demag. fac. : Yes Holder -1.67E-06 Act. vol. 11.00
 T1 F1 L1 T2 F2 L2
 CD 100/20 30/40 SO 140/60 70/80

Field [A/m]	Mean susc.	Standard Err. [%]	Tests for anisotropy				
			F	F12	F23		
420 F1	127.9E-06	0.042	2953.2	2055.3	1564.5		
Normed principal susceptibilities			95% confidence angles				
			Ax1	Ax2	Ax3		
1.0304	0.9985	0.9711	1.6	1.9	0.9		
+ 0.0003	0.0003	0.0003	0.9	1.6	1.9		
Anisotropy factors (principal values positive)							
L	F	P	'P	T	U	Q	E
1.032	1.028	1.061	1.061	-0.063	-0.078	0.738	0.996

Principal directions					Normed tensor		
Specimen system	D	283	193	68	1.0000	1.028	0.9715
	I	4	3	85	-0.0069	0.0046	0.0004
Geograph system	D	40	146	305	1.0095	0.9973	0.9932
	I	9	60	28	0.0254	0.0124	-0.0028
Paleo 1 system	D	34	152	284	1.0153	0.9890	0.9957
	I	26	44	35	0.0162	0.0194	0.0074
Tecto 1 system	D	94	212	344	0.9815	1.0228	0.9957
	I	26	44	35	0.0033	0.0161	-0.0131
Paleo 2 system	D	229	42	133	0.9878	0.9868	1.0254
	I	67	23	2	0.0160	-0.0095	-0.0068
Tecto 2 system	D	249	62	153	0.9774	0.9972	1.0254
	I	67	23	2	0.0126	-0.0112	-0.0031

11-06-2007

--- The data page can be left by pressing ESC key

Function Key 6 **ActVol** or **Mass**

This procedure serves for inputting the actual volume or mass of the measured specimen. If all the specimens measured in a particular collection have the same volume, it is sufficient to input this volume only once. If the volume varies from specimen to specimen, it is necessary, before or after the measurement (but before the evaluation) of each specimen to input the correct volume or mass of the measured specimen. The Mass is possible to input for field variation measurement only, not for AMS.

- After starting this procedure, the Volume or Mass (depending on Volume or Mass mode) saved in the configuration file appears on the screen.
- If the volume of the measured specimen is the same, one only hits ENTER, while if the volume is different, one should input new actual volume of the measured specimen.

Function Key 7 **Help**

This key invokes the help procedure. To quit help page press ESC key.

Function Key 9 **Kill**

This key breaks the current activities and clears the measured and input specimen data.

Function Key 10 **Aux**

This key switches the program to the AUXILIARY MENU.

Brief description of the Auxiliary Menu

- F1 <BSus> Measuring the Bulk (directional) or Mass Susceptibility on a group of specimens in current field.
Measuring field variation of Bulk or Mass Susceptibility of the specimen in current position.
- F2 <ACmd> Auxiliary Command:
Up/Down : set the Holder position out of coil/into the coil,
Enable/Disable Up and Down (options FA and A),
Enable/Disable Rotator (options FA and A),
Zeroing : set the bridge nucleus to zero condition,
Init : set the Holder Up and set the Rotator to index pulse,
- F2 <CStd> Entering the Nominal Directional Susceptibilities of the Calibration Standard.
- F2 <OrPar> Defining the specimen sampling Orientation Parameters, i.e. the meaning of two sampling angles.
- F2 <AnFac> Defining the set of Anisotropy Factors.
- F2 <Vol> Set the Volume mode for bulk susceptibility measurement.
- F2 <Mass> Set the Mass mode for mass susceptibility measurement.
- F2 <Sigma> Execute the test measurement with standard error evaluation.
- F2 <List> List the configuration files.
- F3 <Cal> Calibration, i.e. setting the proper instrument gain.
- F4 <Holder> Measuring of the Holder - real and imaginary susceptibility. These values are subtracted from measured susceptibilities.
- F5 <Field> Set Field.
- F6 <ActVol> Enter Actual Volume of a specimen (depends on mode Vol/Mass).
F6 <Mass> Enter Actual Mass of a specimen.
- F7 <Help> Invokes this HELP.
- F8 <Freq> Set Frequency - options FA and FB.
- F9 <Kill> Breaks the current activities. The data is lost.
Sets the Holder and Rotator to init position.
- F10 <Main> Return to 'MAIN' menu.

Convention

To help you quickly find the information, the name of the Key of the Auxiliary Menu is denoted as Function AuxKey, instead of Function Key in Measuring (Main) Menu, to underline that the key of Auxiliary menu is mentioned. Examples of measurement values are expressed in *Italic*.

Function AuxKey 1 **Bsus****Bulk Susceptibility**

This procedure serves for measurement of the bulk or mass directional susceptibility (in current position) of a group of specimens (for example in monitoring the susceptibility changes due to the demagnetization steps in palaeomagnetism) or for measurement of field variation of the specimen in current position.

- After starting the procedure, the following information appear on the screen :

Measurement of susceptibility in current field or field variation

The current holder susceptibility : *Re -2.57 E-6 Im 1.25 E-9*

New measurement of holder [Y/N] ?

- If 'Y' is selected, the procedure Key 4 **Hol** is made. Than the following selection prompt appears :

Field variation measurement : Standard / Reduced / None [S / R / <CR>]

If one inputs N or <CR>, the procedure continues by bulk measurement in current Field . In this case of individual bulk measurement any measurement is started by pressing <CR> after entering the specimen name. If no name is entered, the current time is used as the name. The bridge is zeroed first, you should wait for a beep, insert (ver. FB and B) the specimen into the pick-up coil, wait for the second beep and pull (ver. FB and B) the specimen out. The measurement is terminated by pressing Esc key. The bulk or mass susceptibility is calculated using the specimen volume which is entered in procedure Key 6 **ActVol** or **Mass**.

To finish measurements, press Esc key

N	Specimen	Bulk
1	XY	-4.58E-06
2	STANDARD	82.75E-03
3	12:45:07	82.75E-03

If you select <S> or <R> the standard (up to 20 fields susceptibility measurements) or reduced (short curve) field variation measurement is performed in the fields predefined in the file MFK.VAR. This file contains for each frequency : the number of field points and fields. The standard curve for frequency F1 is marked e.g . F1S, the reduced F1R, etc. The maximum length of the reduced curve may be also 20 fields points. So you can use the "reduced" curve for reduced measurement in number of field points or use this possibility as field zoom for certain field range, reduced in field range, or both. The number of points has the priority, it is not necessary to edit the rest list of individual fields if you wish to decrease the number of points only. The *Standard* and *Reduced* are the names of two pre-defined curves only, they have no significant meaning.

Examples:

Standard : 20 points

2 5 10 20 30 40 50 60 70 80 100 150 200 250 300 350 400 500 600 700

Reduced : 10 points

5 20 40 60 100 200 300 400 500 700

Reduced : 20 points

15 20 25 30 35 40 45 50 60 65 75 80 85 90 100 110 120 130 140 150

Standard : **15** points *(the curve finished at 300 A/m)*

2 5 10 20 30 40 50 60 70 80 100 150 200 250 **300** 350 400 500 600 700

In case the file MFK.VAR contains any wrong data (the number of points is greater then 20 or field is not available for current frequency) the default field variation set is used and user file MFK.VAR is ignored.

The default field variation set (factory set MFK.VAR) :

```

20 No of points F1 standard
2 5 10 20 30 40 50 60 70 80 100 150 200 250 300 350 400 500 600 700 F1S
10 No of points F1 reduced
5 20 40 60 100 200 300 400 500 700 F1R

16 No of points F2 standard
2 5 10 20 30 40 50 60 70 80 100 150 200 250 300 350 F2S
10 No of points F2 reduced
5 20 40 60 80 100 150 200 250 350 F2R

13 No of points F3 standard
2 5 10 20 30 40 50 60 70 80 100 150 200 F3S
7 No of points F3 reduced
5 20 40 60 100 150 200 F3R
    
```

Function AuxKey 2 **Acmd**

Auxiliary Commands

Auxiliary Commands procedures serve for setting and checking the SAFYR configuration parameters, for control commands and test some instrument functions.

<Ctrl Cmd>	Up/Down : set the Holder position out of coil/in the coil, Enable/Disable Up and Down (options FA and A), Enable/Disable Rotator (options FA and A), Zeroing : set the bridge nucleus to zero condition, Init : set the Holder Up and set the Rotator to index pulse.
<CStd>	Entering the Nominal Directional Susceptibilities of the Calibration Standard.
<OrPar>	Defining the specimen sampling Orientation Parameters, i.e. the meaning of two sampling angles.
<AnFac>	Defining the set of Anisotropy Factors.
<Vol>	Set the Volume mode for bulk susceptibility measurement.
<Mass>	Set the Mass mode for mass susceptibility measurement.
<Sigma>	Execute the test measurement with standard error evaluation.
<List>	List the configuration files.

AuxKey 2 **Ctrl Cmd**

Control Commands

UP / DOWN is used for checking the Up/Down Mechanism performance and speed. The movement up takes a little bit longer time than down, but it should not exceed 3.6 s. The timeout for error message is 4 s. This option is not available for versions FB and B.

ENABLE / DISABLE *Up/Down Mechanism* is used in case you wish to use manual holder measurement routine (AMS in 15 directions) for instruments versions FA and A.

ENABLE / DISABLE *Rotator* is used in case you wish to use manual holder measurement routine in 15 directions for instruments versions FA and A. It is useful also for field variation measurement using manual holder fixed in the adapter instead of rotator, particularly at frequencies F2 and F3 where the influence of rotator may be more significant for weak specimens.

ZEROING is used for checking the zeroing capability and speed. The timeout is about 12 s.

INIT sets the rotator to initial position, checks the belt adjustment and speed of rotation. This option is not available for versions FB and B. In case the *Up/Down* and /or *Rotator* is disabled (versions FA and A) the enabled function is performed.

AuxKey 2 **CStd**

Calibration Standard

This key is used to check or input the susceptibility(ies) of the calibration standard. Please note that the instrument is calibrated by two values (versions FA and A). This is because the calibration standard gives not only the directional bulk susceptibility value, but also the anisotropy which is derived from the susceptibility along the x_3 vertical axis (max. bulk) of the calibration standard and from that along the direction perpendicular to the x_3 axis (min. bulk).

The value Bulk-min is not used for Kappabridge versions FB and B.

Calibration Standard	Bulk-max	Bulk-min
	136.7 E-03	27.00 E-03

The *Bulk-max* and *Bulk-min* values are the same as those written on the calibration standard to be used for the instrument calibration. If you change the calibration standard nominal value(s), the *Holder* correction value(s) is reset to zero.

AuxKey 2 **Orpar**

Orientation Parameters

The scientists use different ways of sampling oriented specimens. In order to respect these differences we have developed such a software solution of the data transformation from the specimen coordinate system to the geographic, palaeogeographic and tectonic coordinate systems that it is controlled through the so called orientation parameters. In this way, any oriented sampling is possible. For definition of these orientation parameters and more details see AGICO Print No. 6.

- The program shows the set of current orientation parameters

Orientation parameters

P1 = 6

P2 = 0

P3 = 6

P4 = 0

Any changes [Y/N] ?

- If you enter 'N', the shown parameters are used in the subsequent calculations.
- If you enter 'Y', new parameters are set up. Computer asks for inputting the P1, P2, P3 and P4 parameters and check them for their validity. These new parameters are written into a configuration file.

AuxKey 2 Anfac**Anisotropy Factors**

Magnetic fabric can be visualized by the shape and orientation of the anisotropy ellipsoid. The eccentricity and shape of the ellipsoid can be characterized by conveniently chosen parameters derived from the principal values (parallel to the axes of the anisotropy ellipsoid). Unfortunately, more than 30 parameters have been suggested for this purpose, even though 2 parameters are sufficient to characterize the eccentricity and shape. Some of them are listed in the enclosed Table. As it is not reasonable to present them all, our program selects up to 8 parameters according to the demands of the user.

- The selection is made as follows. First, the set of the previously used parameters appear on the screen (Current anisotropy factors) together with the question *Any changes [Y/N] ?*
- If you wish to change this set, the program shows the table of factors from which you can select new set and asks for Count of factors. Input the number of selected factors (in our case 8). Then enter the sequential number of the factor and the name (abbreviation) of the factor delimited by comma. This is repeated till the whole set is entered. After entering the last factor the program displays again the whole set and asks *Any changes [Y/N]*. In the case you need to do any change you have to repeat the whole procedure.

AuxKey 2 Vol**Set Volume Mode**

Set the Volume mode for bulk susceptibility measurement. In case the volume mode is active the pre-set actual volume of specimen is displayed and Bulk susceptibility is calculated during susceptibility measurement.

AuxKey 2 Mass**Set Mass Mode**

Set the Mass mode for mass susceptibility measurement. In case the mass mode is active the pre-set actual mass of specimen is displayed and Mass susceptibility is calculated during susceptibility measurement. This option is not available for AMS measurement.

AuxKey 2 Sigma**Standard Error**

Executes the test measurements with standard error evaluation. The data are stored in the files which names are derived from current time in format HHMMSS with extensions K00 and R00. The file K00 contains the all measured data, file R00 contains only the average and standard error of 10 repeated measurements in one set. Number of sets is also 10. The measurements takes approx. 40 min. It is used for testing the instrument sensitivity and/or the magnetic environment in the room where the Kappabridge is installed. The measurement is performed at frequency F1 and the field 400 A/m peak. For this test it is recommended to use manual holder fixed in the adapter in case the test is performed with a particular specimen. For magnetic environment test,

the Up/Down mechanism is usually disabled or empty clean manual holder is used. Do not disturb test measurement by moving anything in the vicinity of instrument. The temperature in the room should be also stable.

AuxKey 2 **List**

Parameters List

This function prints the contents of the configuration files SAFYR.SAV and PAFA.SAV to see the current configuration and calibration parameters.

Function AuxKey 3 **Cal****Calibration**

This procedure serves for the calibration of the instrument. This calibration is made as for the bulk susceptibility value along the vertical x_3 axis of the calibration standard as well as for the anisotropy represented by the susceptibility difference between the standard susceptibility along the x_3 axis and the perpendicular direction. The standard is fixed in the holder **vertically** (in the first measuring position for spinning specimen). Perform the calibration after at least 10 minutes of warm-up time. Generally it is recommended to calibrate the bridge every day before beginning the work. However, since the gain changes of the instrument are usually very small and in the case the absolute value of susceptibility is not precisely important (e.g. in AMS measurement of principal directions) it is not quite necessary to calibrate the bridge every day. The instrument should be always calibrated when the frequency was changed and small susceptibility frequency variation of the specimen measured are expected. The program displays the day of the last calibration and recommends the calibration in case the last one was performed more than 30 days ago.

- After activating this procedure through pressing the AuxKey F3, the calibration procedure starts and the following information subsequently appear on the computer screen

	Auto Range Calibration : 200 A/m PEAK			AUX	200 A/m F1	** ANISO
	Bulk	Cos	Sin	Delta	GainA	GainB
OLD	136.7 E-03	54.85 E-03	0.00 E+00	-22.77	3.5023	3.5005
MEAS	136.6 E-03	54.84 E-03	38.51E-06	-22.77	3.5023	3.5005
NEW	136.7 E-03	54.85 E-03	0.00 E+00	-22.81	3.5027	3.5008

--> Press <Enter> to save calibration data

- *Bulk* - the values of the bulk susceptibility of the calibration standard along the vertical x_3 axis.
- *Cos* - the values of the cosine component of the anisotropy of the calibration standard.
- *Sin* - the values of the sine component of the anisotropy of the calibration standard.
- *Delta* value represents the phase lag of the measured signal relatively to the position of the spinning specimen. This lag is mainly due to the phase characteristics of the output low-pass filter.
- *GainB* is the correction for getting the total gain for the bulk susceptibility to be measured precisely.

- *GainA* is the correction for getting the total gain for the anisotropy to be measured precisely.
- The line headed “OLD” gives the above data of the last calibration corresponding to those written in the configuration file.
- The line “MEAS” gives the data actually measured standard assuming that *Delta*, *GainB* and *GainA* values equal “OLD” values.
- The line headed “NEW” shows the result of the above measurement, but with proper new corrections *Delta*, *GainB*, *GainA*. The constants *Delta*, *GainB*, *GainA* are also written into the configuration file.
- The calibration results are verified to prevent writing erroneous values into the configuration file. Thus, the *GainB* and *GainA* values should be within the interval of 65% to 135% of the nominal values, otherwise the error is indicated.
- If you change the calibration standard nominal value, the *GainB* and *GainA* are undefined until proper calibration is performed successfully.
- After successfully performed and saved calibration the all holder values are zeroed.
- For instrument versions FB and B the part of calibration using rotator is skipped.

Function AuxKey 4 ***Hol***

Holder Correction

This procedure consists of the measurement of the bulk susceptibility and anisotropy of the empty holder in the field **200 A/m PEAK value**. In case of frequency F1, the susceptibility and anisotropy are written into the configuration file. The holder correction values are subtracted from the measured values after measuring the specimen.

- After activating this procedure through pressing the AuxKey F4, the measurement of the empty holder starts and the following information subsequently appear on the computer screen

	AUX	200 A/m	** BULK (** ANISO)
HOLDER	Bulk	Cos	Sin
Old values	-4.138E-06	-10.E-09	-2.7E-09
	-4.179E-06	-29.E-09	-19.E-09
	-4.140E-06	-36.E-09	-13.E-09
	-4.113E-06	-11.E-09	-14.E-09
New values	-4.144E-06	-25.E-09	-15.E-09
Std.error	33.E-09	13.E-09	3.5.E-09

-- Press <CR> to save the data

- In the beginning of the procedure the *Old values* data appear on the screen. These are the data stored in the configuration file obtained in the last measurement of the empty holder.
- The bulk susceptibility of the empty holder is automatically measured three times, its mean value and standard error of the average are calculated. Then the anisotropy of the empty holder (versions FA and A) is measured three times and the mean value and standard error of the average are also calculated.
- If the measurements are inconsistent (for example, if holder bulk susceptibility does not lie within the expected interval or the standard error is greater than 0.1×10^{-6}) the New values are blinking. It is upon the operator whether to save the holder or not (depending also on how strong specimens are measured).
- If you switch to frequency F2 (F3) or change the calibration standard nominal value(s), the *Holder Correction* is reset to zero. If you switch back to frequency F1, the last saved holder values for F1 are recalled from configuration file SAFYR.SAV.

Function AuxKey 5 **Field****Set Field**

Set the field from 2 A/m to maximum field, (depending on current frequency and properties of pick-up coils) in step of 1 A/m. The nominal maximum fields are as follows:

F1 976 Hz 700 A/m peak value

F2 3904 Hz 350 A/m peak value

F3 15616 Hz 200 A/m peak value

The real maximum field may be slightly higher than nominal maximum field. The real maximum value is displayed at enter field prompt. Set Field is not available during AMS measurement in individual positions.

Function AuxKey 6 **ActVol****Actual Volume**

Set the actual specimen volume, which is used for bulk susceptibility calculation. This key is active if the *Volume Mode* is selected (see AuxKey2 **ACmd** <Vol>).

Function AuxKey 6 **Mass****Actual Mass**

Set the actual specimen mass, which is used for mass susceptibility calculation. This key is active if the *Mass Mode* is selected (see AuxKey2 **ACmd** <Mass>).

Function AuxKey 7 **Help****Help Page**

Pressing this key invokes the list of help page. To quit help page press ESC key.

Function AuxKey 8 *Freq****Set Frequency***

F1 976 Hz 200 A/m peak

F2 3904 Hz 200 A/m peak

F3 15616 Hz 200 A/m peak

This routine allows to select one of three available frequencies (FA and FB options). If the frequency is changed the field is set to default 200 A/m. In case of F2 and F3 the holder correction values are zeroed. If you return to F1 the holder values are restored from configuration file, where they were saved during last holder correction procedure. Program then waits 10 min to eliminate coil drift caused by frequency change. The time can be reduced by the user by pressing <Esc> key. This is not recommended in case of measuring weak specimens and/or using low fields.

Function AuxKey 9 *Kill*

The program breaks the current activities and clears current specimen data.

Function AuxKey 10 *Main*

Return from AUXILIARY menu to the MAIN menu.

Appendices

This chapter covers the following topics

- List of Magnetic Anisotropy Factors.
- Structures of Data File.
- Selection of Coordinate Systems.
- Geological Locality Data.

List of Magnetic Anisotropy Factors

<i>Factor No.</i>	<i>Mathematical expression</i>	<i>Usual Abbreviation</i>
1.	$(15/2)[(k_1-k)^2+(k_2-k)^2+(k_3-k)^2]/(3*k)^2$	
2.	$\Leftrightarrow \exp\{\sqrt{2((n_1-n)^2+(n_2-n)^2+(n_3-n)^2)}\}$	P'
3.	$\sqrt{2[(n_1-n)^2+(n_2-n)^2+(n_3-n)^2]}$	ln P'
4.	$\Leftrightarrow k_1/k_3$	P
5.	$\ln(k_1/k_3)$	ln P
6.	$100(k_1-k_3)/k_1$	
7.	$(k_1-k_3)/k_2$	
8.	$(k_1-k_3)/k$	
9.	$\Leftrightarrow k_1/k_2$	L
10.	$\ln(k_1/k_2)$	ln L
11.	$(k_1-k_2)/k$	
12.	$2k_1/(k_2+k_3)$	
13.	$\Leftrightarrow k_2/k_3$	F
14.	$\ln(k_2/k_3)$	ln F
15.	$(k_1+k_2)/(2k_3)$	
16.	$(k_1+k_3)/(2k_2)$	
17.	$2k_2/(k_1+k_3)$	
18.	$1-k_3/k_2$	
19.	$(2k_1-k_2-k_3)/(k_1-k_3)$	
20.	$(k_1+k_2)/2-k_3]/k$	
21.	$(k_2-k_3)/k$	
22.	$k_1/\sqrt{k_2*k_3}$	
23.	$(k_1*k_3)/(k_2^2)$	
24.	$\Leftrightarrow (k_1-k_2)/[(k_1+k_2)/2-k_3]$	Q
25.	$(k_1-k_2)/(k_2-k_3)$	
26.	$(k_2-k_3)/(k_1-k_2)$	
27.	$\arcsin\{\sqrt{[(k_2-k_3)/(k_1-k_3)]}\}$	
28.	$\Leftrightarrow (k_2^2)/(k_1*k_3)$	E
29.	$k_2(k_1-k_2)/[k_1(k_2-k_3)]$	
30.	$(k_2/k_3-1)/(k_1/k_2-1)$	
31.	$\Leftrightarrow (2n_2-n_1-n_3)/(n_1-n_3)$	T
32.	$\Leftrightarrow (2k_2-k_1-k_3)/(k_1-k_3)$	U
33.	$(k_1+k_2-2k_3)/(k_1-k_2)$	
34.	$\sqrt{[(k_1-k)^2+(k_2-k)^2+(k_3-k)^2]/3}/k$	R
35.	$(k_1*k_2*k_3)^{(1/3)}$	
36.	$k_3(k_1-k_2)/[k_1(k_2-k_3)]$	
37.	$k_3(k_1-k_2)/(k_2^2-k_1*k_3)$	
38.	$(k_1-k_2)(2k_1-k_2-k_3)/[(k_2-k_3)(k_1+k_2-2k_3)]$	

$k_1 > k_2 > k_3$ are principal normed susceptibilities and n_1, n_2, n_3 are their respective natural logarithms, the symbol

\Leftrightarrow means default set of AGICO (stored in PAFA.SAV configuration file of a new instrument)

Structures of Data Files

The program SAFYR works with the following data and configuration files :

- The following notation is used for variables denotation :
 - $n\$$ n bytes string variable
 - 2I two bytes integer variable
 - 4R four bytes real variable

- The classical sequential ASCII file with extension **.ASC** contains the printable output results of measured specimen(s), in the same form as on the screen.
- The Standard Anisotropy File (AMS) contains the results of the anisotropy measurement in binary form and has extension **.RAN**
- The Geological Data File contains only the geological data (orientations of specimens and of mesoscopic fabric elements), its extension is **.GED**
- File **Pafa.SAV** contains current set of orientation parameters and anisotropy factors.
- Files **Safyr.SAV** contains serial port number, calibration standard values, instrument configuration parameters, instrument gain and phase coefficients calculated during calibration procedure for field 200 A/m peak, holder components measured during holder correction routine and actual current volume or mass of specimen.
- File **Aniso.TMP** contains the screen contents results of AMS measuring of the last specimen measured.
- File **Bulk.TMP** contains the screen contents in measuring bulk susceptibility using routine **Bulk** invoked by function AuxKey 1. This file can be saved as **xxx.MFK** for future post processing.
- File **Safyr.HLP** contains the Help page.
- File **MFK.VAR** contains predefined fields for field variation measurement.
- File **Safyr.MON** contains information useful for service diagnostics, this file is appended each program run.
- File **Safyr.TMP** contains current day information useful for service diagnostics, this file is overwritten in each program run.

Structure of Standard AMS File

The STANDARD ANISOTROPY FILE is a random access file with the length of the record being 64 bytes.

Structure of the First Line (Record)

2I	16\$	7\$	7\$	4\$	4\$	4\$	4\$	4x3\$	4\$
N+2	LOCALITY	LONGI	LATI	ROCK	STRATI	LITHO	REGIO	ORIENT.P.	EOL

- The first record contains the locality data:

N+2	number of specimens in the file+2,
LOCALITY	name of locality,
LONGI	geographical longitude of the locality,
LATI	geographical latitude of the locality,
ROCK	rock type,
STRATI	stratigraphical position,
LITHO	lithostratigraphy,
REGIO	regional position,
ORIENT	orientation parameters P1, P2, P3, P4,
EOL	end of line sequence.

Structure of the Other Lines (Records)

12\$	4R	4R	6x4R	2\$	2x2I	2x2I	2\$	2x2I	2x2I
SPEC	CHAR	NORM	K11 to K33	C1	FOLI1	LINE1	C2	FOLI2	LINE2

- The second and the following records contain the specimen data. Each record contains:

SPEC	<i>name of the specimen,</i>
CHAR	<i>mean susceptibility in the order of 10^{-6} SI,</i>
NORM	<i>Freq *1000 + Field,</i>
K11, K22, K33, K12, K23, K13	<i>components of normed AMS tensor in the geographic system,</i>
C1	<i>code for the 1st pair of mesoscopic foliation and lineation,</i>
FOLI1	<i>azimuth of dip and dip of the 1st foliation,</i>
LINE1	<i>trend and plunge of the 1st lineation,</i>
C2	<i>code for the 2nd pair of mesoscopic foliation and lineation,</i>
FOLI2	<i>azimuth of dip and dip of the 2nd foliation,</i>
LINE2	<i>trend and plunge of the 2nd lineation.</i>

Structure of Geological Data File

The GEOLOGICAL DATA FILE is a random access file with the length of the record being 64 bytes. The numerical data are for practical reasons recorded as strings so that they can be directly checked.

Structure of the First Line (Record)

4\$	16\$	7\$	7\$	4\$	4\$	4\$	4\$	4x3\$	2\$
N+2	LOCALITY	LONGI	LATI	ROCK	STRATI	LITHO	REGIO	ORIENT.P.	EOL

- The first record contains the locality data:

N+2	number of specimens in the file+2,
LOCALITY	name of locality,
LONGI	geographical longitude of the locality,
LATI	geographical latitude of the locality,
ROCK	rock type,
STRATI	stratigraphical position,
LITHO	lithostratigraphy,
REGIO	regional position,
ORIENT	orientation parameters P1, P2, P3, P4,
EOL	end of line sequence.

Structure of the Other Lines (Records)

12\$	2x4\$	4\$	2x4\$	2x4\$	4\$	2x4\$	2x4\$
SPEC	ORIENTATION	CODE1	FOLI1	LINE1	CODE2	FOLI2	LINE2

- The second record and the following records contain the specimen data. Each record contains:

SPEC	<i>name</i> of the specimen,
ORIENTATION	<i>azimuth</i> ¹ and <i>dip</i> ² of the fiducial mark orienting the specimen,
CODE1	<i>code</i> ^A for the 1 st pair of mesoscopic foliation and lineation,
FOLI1	<i>azimuth of dip</i> and <i>dip</i> ³ of the 1 st foliation,
LINE1	<i>trend</i> and <i>plunge</i> of the 1 st lineation,
CODE2	<i>code</i> for the 2 nd pair of mesoscopic foliation and lineation,
FOLI2	<i>azimuth of dip</i> and <i>dip</i> of the 2 nd foliation,
LINE2	<i>trend</i> and <i>plunge</i> of the 2 nd lineation,
FREE	four characters free string.

Note : The orientation of mesoscopic foliation should be measured in terms of azimuth of dip and dip or strike and dip and this is indicated by the orientation parameter P4 (see the section *Orientation Parameters*). The azimuth of dip or strike should be measured as angles ranging from 0 to 360 degrees (not from zero to 180 degrees) and they are recorded in the geological data file as measured.

¹ values from 0 degrees to 360 degrees

² values from 0 degrees to 180 degrees

^A for the reason of compatibility with the AMS file only 2 characters are used

³ values from 0 degrees to 90 degrees

Selection of Coordinate Systems

The orientations of magnetic foliation and magnetic lineation can be presented not only in the standard geographical coordinate system, but also in the so-called palaeogeographical system (after rotation of the mesoscopic foliation under consideration into the horizontal position about the corresponding lineation) or in the so-called tectonic coordinate system (mesoscopic lineation and foliation are the coordinate axes). The program can work with up to 2 pairs of mesoscopic foliation and lineation which are described by a two-character code. The first character of the code describes the foliation, while the second character describes the lineation (for the proposal of the codes see the enclosed table). For example, the code characterizing the existence of metamorphic schistosity and mineral alignment lineation is SA. If only the foliation and no lineation exist, the second character in the code is zero. For example, the system characterized by the bedding only has the code B0 (zero).

Codes characterizing mesoscopic foliations and lineations :

<i>Code</i>	<i>Foliation</i>	<i>Code</i>	<i>Lineation</i>
B	bedding	A	mineral alignment
C	cleavage	D	bedding/cleavage intersection
K	cataclastic schistosity	F	fold axis
S	metamorphic schistosity	R	striation
J	joint	W	wave hinge lineation
G	igneous banding	P	current direction
E	fluidal foliation	M	beta axis
H	schlieren foliation	L	lava flow lineation
N	lava flow foliation	O	schlieren lineation

Geological Locality Data

The inputting of the locality data is not compulsory. The **ANISOFT** package of programs for advanced AMS data processing does not work with the locality data. These data serve only for storing the locality geological characteristics on the disk.

In inputting the locality geological data, the following data are asked for.

- NAME OF LOCALITY (max. 16 characters, ENTER means no data)

This is the literary name of the locality, it serves only as a note characterizing the locality location, etc.

- LOCALITY GEOGRAPHICAL LONGITUDE (DECADICAL EXPRESSION)
- LOCALITY GEOGRAPHICAL LATITUDE (DECADICAL EXPRESSION)

Both in the format xxxx.xx. These data are input as decadical expressions, not using minutes and seconds.

- ROCK TYPE (max. 4 characters)
- STRATIGRAPHY (max. 4 characters)
- LITHOSTRATIGRAPHY (max. 4 characters)
- REGIONAL (max. 4 characters)

These data are recommended to be input as 3 character codes; their purpose is to characterize geologically the locality investigated, they are not used in further calculations.

- ORIENTATION PARAMETER P1
- ORIENTATION PARAMETER P2
- ORIENTATION PARAMETER P3
- ORIENTATION PARAMETER P4

(See also Appendix - Selection of Coordinate System)

Maintenance

Cleaning the Holders and Rotator

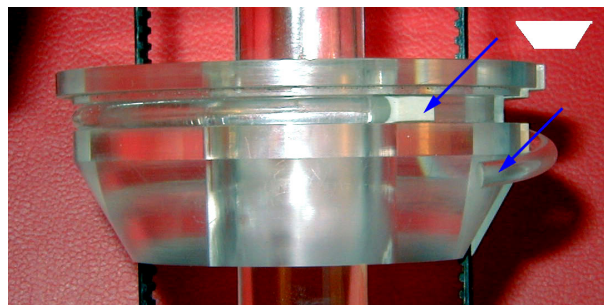
It is recommended to clean the specimen holders regularly, especially if you continue with measurement of relatively weak specimens after measuring strong ones. For cleaning use pure water with a small amount of detergent and soft brush. **Do not use alcohol for cleaning** (may cause damaging due to heat of vaporization).

Cleaning the Rotator and Belt – MFK versions FA and A

It is necessary to clean the shell in which the specimen is fixed and the other part of the rotator if rotator makes suspicious noise during spinning and/or if the “belt strain” value (see below) is higher than 1750.



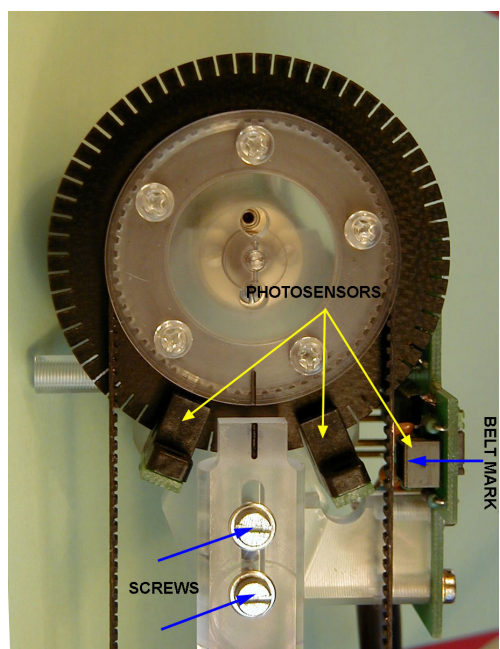
4.1 Unscrew three plastic screws and washers and remove the cover of the motor carefully by pulling it up,



4.2 release gently the ring, pay attention to the position and trapezoid shape of rubber washer,

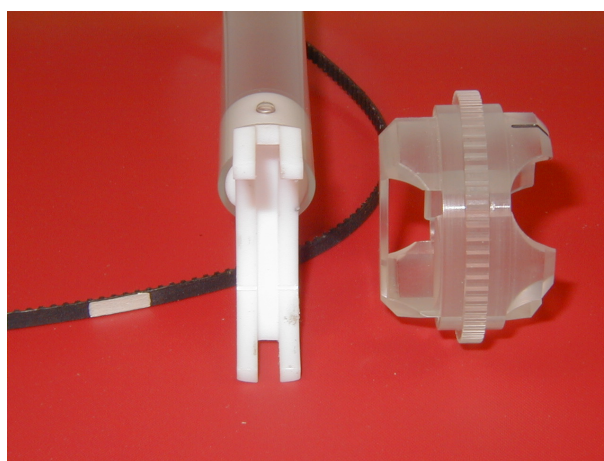


4.3 and remove the perspex ring,



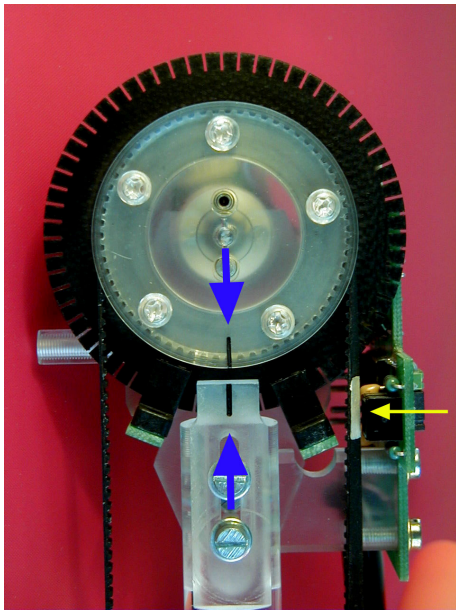
4.4 check the belt strain to set it later in the same level and remember the belt mark position, loosen a little bit (do not remove them) two screws, after that the strain of the tooth belt eases and the specimen shell can be removed from its bearing, and remove the belt

Clean the black wheel with 64 notches, optocouples and photosensor from dust using soft dry brush. Check if all 64 notches are transparent.



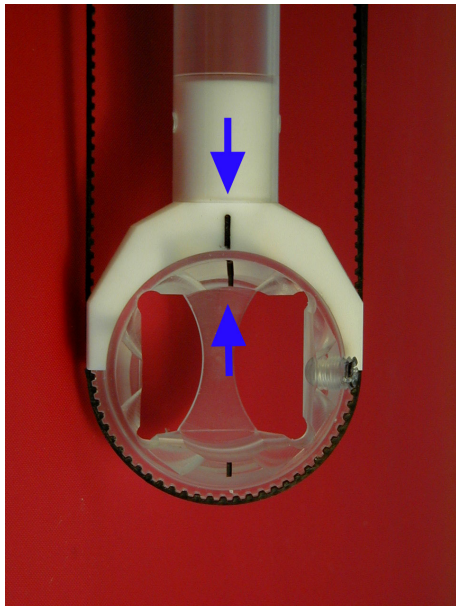
4.5 Clean the shell, the belt and the bearing, use pure water with a small amount of non-powdered detergent and soft brush. Check if the belt mark is clear white. Before assembling dry up everything properly.
Do not use alcohol for cleaning!

Rotator assembling – MFK versions FA and A



During assembling pay attention to the following three points:

- the strips on the upper wheel are in the same line
- the white belt mark is approximately in the centre of the photosensor
- the strips on specimen shell are in the same line



If all three conditions are met adjust the proper belt strain by picking-up slightly the part with motor and fixing the two screws.

Connect the rotator, switch MFK on, run SAFYR program, select AUX menu and check the number following the message “ROTATOR is Enabled”. This value is proportional to the mechanical resistance (belt strain) and should be in the range 1550 to 1700. If necessary adjust the belt strain, than disable and enable the rotator by commands <T> and <E> to update the “belt strain” value. Switch MFK off and finally set the motor cover and fix it by screws, install the perspex ring and check the proper position of trapezoid rubber washer.

```

AUX      200 A/m F1  ** END OF ZEROING

Enter Command:

<u>  up           Exec.time: 3.35 [s]
<d>  down        Exec.time: 3.24 [s]
<i>  init rotator

<E>  U/D disable  U/D is Enabled
<T>  Rotator Disable  ROTATOR is Enabled 1675

<z>  zeroing     Exec.time: 2.20 [s]

<C>  Calibration Standard
<O>  Orientation Parameters
<A>  Anisotropy Factors

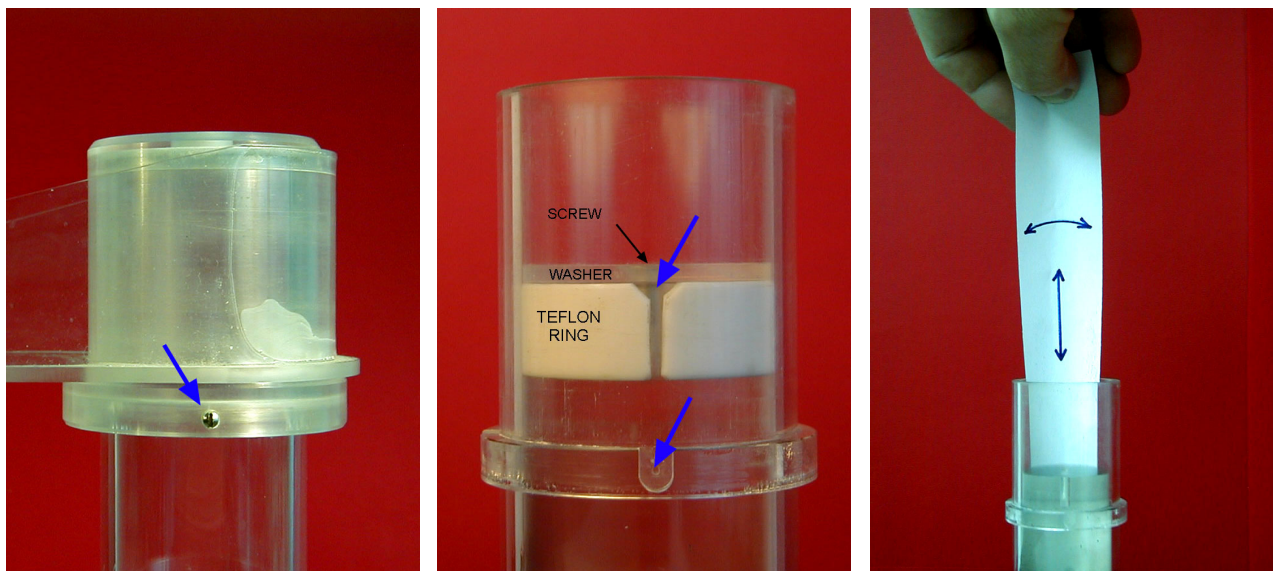
<M>  Mass node   VOLUME is ON: Vol = 10.00 ccn
<S>  Signa Test
<L>  List of Parameters

<Esc> Escape
  
```


Cleaning the Up/Down Mechanism

The Up/Down Mechanism should be cleaned in case the mechanism makes suspicious noise during movement and/or if the time of the movement of the holder from lower to upper position is longer than 3.6s and/or if the massive linear white contamination trace (from teflon) is present on the inner surface of the cylinder. The Up/Down execution time can be checked using *AuxKey 2* in Auxiliary Menu of SAFYR program.

Set the Up/Down Mechanism to down position (*AuxKey 2 <down>*) and switch off the instrument.



- After loosening the small screw remove the arm of the holder. Check the position of the white teflon ring to reinstall it later into the same position and angle orientation. Then remove the screw and the washer and, at last, the white teflon ring.
- You can remove the rear panel of the Pick-Up Unit (only for the reason to see inside).
- Using cleaning paper clean the space inside the cylinder. Insert the paper into the gap between the inner cylinder and outer tube and clean the inner cylinder space by moving papers along inner surface of the cylinder and simultaneously by moving them a little bit up and down.
- Clean the ring also and reinstall it, checking its proper position and angle orientation inside the cylinder. Tighten the screw fixing the washer gently.
- For easier manipulation it is recommended to use the following size and shape of cleaning paper. Paper strip about 30 cm in length of trapezoid shape, with bases 5 and 2 cm, thickness of about 0.1 mm (standard office paper).
- Do not lubricate the inner cylinder by any lubricant. **Do not use alcohol for cleaning** (may cause damaging of cylinder due to evaporated heat). In case the cleaning does not fix the problem, do not try to solve it yourself, contact the manufacturer.