Field Rock Magnetic Susceptibility Meter

KAPPAMETER

KT- 6

2007

Instruction Manual

TABLE OF CONTENTS

1. GENERAL INFORMATION 2
   - 1.1 Applications 2
   - 1.2 Specifications 2

2. DESCRIPTION 3
   - 2.1 Operating Principle 3
   - 2.2 Design 3

3. OPERATION 3
   - 3.1 Battery Instalation 3
   - 3.2 Power ON/OFF 3
   - 3.3 Measurement 3
   - 3.4 Data Memory 4
   - 3.5 Scan Mode 5
   - 3.6 Low Battery Indication 5
   - 3.7 Date and Time Set 5
   - 3.8 Miscellaneous 6

4. MEASURING METHODS 6
   - 4.1 Measured Value and Corrections 6
   - 4.2 Instructions for Measurement 7

5. ERROR MESSAGES 7

6. MAINTENANCE 7

7. Warranty 8

8. Connectors Wiring 8

1. GENERAL INFORMATION

1.1 Applications

The pocket susceptibility meter KT-6 is designed for quick field measurements of magnetic susceptibility of outcropping rocks, drill cores and larger pieces of rocks. The use of KT-6 is especially advantageous for selecting of suitable specimens for further precise laboratory studies of magnetic properties.

1.2 Specifications

Sensitivity:	$1x10^{-5}$ SI units
Measuring ranges:	from -999 to 9999 x 10^{-3} SI units with automatically switched accuracy (9.99, 99.9, 999)
Operating frequency:	10 kHz
Display:	4 digit LCD, 13 mm hig.
Data memory:	up to 100 measurements
Controls:	two touch switches: Clear/Measure [C/M], Recall [RCL]
Serial interface RS-232C:	Baud rate: 9600Bd. Format: 10 bits (1 start, 8 data, 1 stop), no parity
Power consumption:	10 mA (average)
Battery:	9 V alkaline, IEC standard type 6LF22
Ambient operating temperature:	from -10^{O}C to $+55^{O}$C
Dimensions (diameter x length):	65 x 187 mm
Weight :	0.35 kg (including battery)
Accessories:	leather case, instruction manual, RS-232C cable, disk- communication program

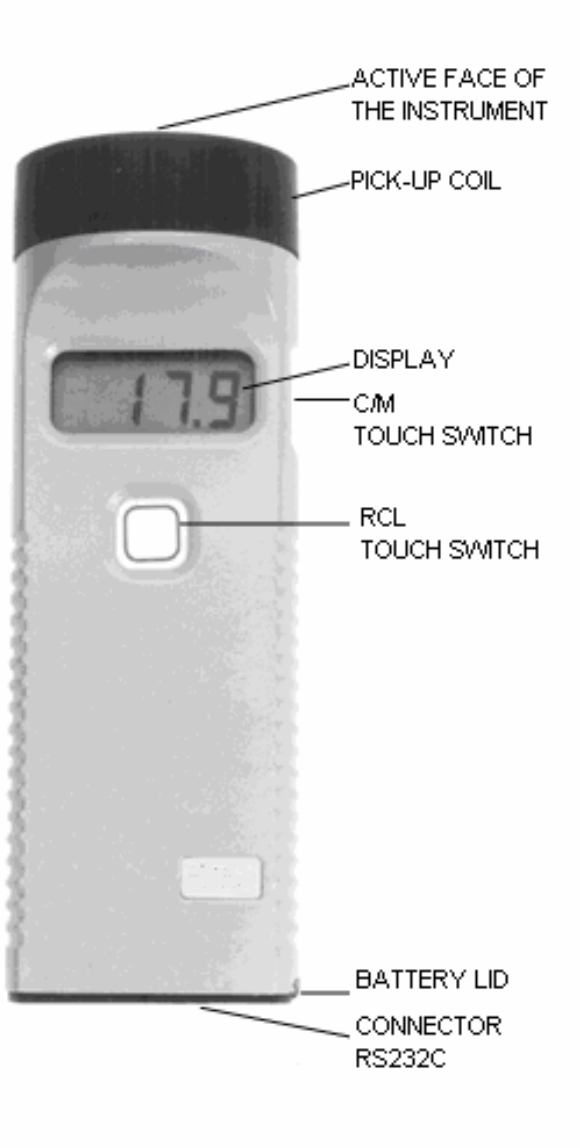

Fig. 1. Principal elements of KT-6

2. DESCRIPTION OF THE INSTRUMENT

2.1 Operating Principle

The fundamental part of the instrument is an LC oscillator of 10 kHz, the inductivity of which is embodied by a flat measuring coil situated at the active face of the instrument. The susceptibility measurement is performed in two steps.
The frequency of the oscillator is measured with the coil at some distance from the rock (free space measurement) and then with the coil applied to the rock surface. From the frequency difference the true susceptibility is computed by the built-in microcomputer and then displayed. For the details see *section 4. Measuring methods*.

2.2 Design

The KT-6 is designed for one-hand operation.
A robust leather case, which can be either carried on a strap over the shoulder or worn on a waist-belt, facilitates the KT-6 field manipulation.
The instrument case consist of two hermetically insulated compartments. The water- and dust-proof front compartment contains all electronics together with the measuring coil, touch switches and display. The battery and the set switch are housed in the rear compartment covered with a lid - see Fig.1.

3. OPERATION

3.1 Battery Instalation

The instrument is powered by one 9 V battery type 6LF22 IEC standard. The battery is housed in the rear compartment of the instrument. The covering lid can be removed by unscrewing the fixing screw. The battery is then removed by pulling out the textile strip. A new battery is then connected, the textile strip inserted and the battery put in.

Caution:

- ***The battery compartment is not waterproof. If the interior gets wet, the compartment must be dried to prevent the contacts from corroding.***
- ***If long-term storage of the KT-6 is anticipated, remove the battery from the instrument to prevent damage from electrolytic leakage. After long storage always inspect the battery.***

If a standard dry battery is used, the operation time will exceed 100 hours. The instrument can also be powered by a rechargeable battery. The operating time is then shorter, approximately 30 hours. It is necessary to recharge the battery outside the instrument using the charger.

3.2 Power ON/OFF

The instrument can be switched on by pressing any touch switch. The display shows all segments and immediatelly the current time.

Fig. 2

If the display does not show it and fails to do so even if the instrument is switched on and off several times, proceed according to *section 5*.
The instrument is switched off automatically 20 seconds after the last pressing a switch.

3.3 Measurement

Immediately after switching on the instrument is ready to measure. The measurement is carried out in two steps. By pressing the switch **[C/M]** on the side of the instrument (see Fig. 1) for the **first** time, the instrument is **cleared** (zeroed); by pressing this switch for the **second** time, the susceptibility of the specimen is **measured**.
To be cleared properly, the instrument must be removed from the measured rock and from other magnetic or conductive objects to a distance of at least 30 cm. The clearing cycle takes about 0.3 s. At the end of the cycle the display shows:

Fig. 3

The character '**C**' indicates that the instrument is cleared. The digits give the number of readings stored in the memory - see *section 3.4*.

The measurement must then be completed within 10 s, otherwise the instrument reverts to the stand-by status and the display shows the time. This is audibly indicated. In this case clear must be repeated. During the measuring interval the active face of the KT-6 must be pressed lightly against the surface of the rock measured. When the **[C/M]** switch is pressed for the second time, the measuring cycle is started. It takes approx. 0.3 s. At the end of this cycle the true susceptibility of the rock (in 10^{-3} SI units) is displayed.
The formats of the susceptibility display for the individual ranges are shown in Figs. 4 - 6.

Fig. 4

Fig. 5

Fig. 6

If the susceptibility is lower than –999 x 10^{-3} SI units or higher than 9999 x 10^{-3} SI units, the instrument will display the error condition:

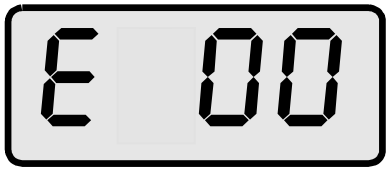

Fig. 7

A negative value of the susceptibility measured in the free space lower than -0.01 x 10^{-3} SI units may suggest that the instrument does not work properly.
If, after completion of the first measurement, the **[C/M]** switch is pressed again, the instrument will be cleared, the display shows:

Fig. 8

and the clear/measure sequence can proceed as described above.

3.4 Data Memory

Up to 100 measured susceptibility values with the date and time of the measurement can be stored in the data memory. The displayed value is automatically stored in the memory if the **[C/M]** switch is pressed again, i. e. during the next clearing period.
If, for some reason, it is not desirable to store the data just displayed, the **[RCL]** switch must be pressed before pressing the **[C/M]** switch.
When the 100th measurement is stored in the memory, the display shows:

Fig 9

From this moment all further measurements are flagged by the character '**F**' (full):

Fig. 10

Storing this data in the memory causes the first stored value to be pushed out, so that always the last 100 measurements are stored in the data memory (i.e. FIFO - first in first out).
The stored data can be recalled and displayed by pressing the **[RCL]** switch at any time. First the serial number of the measurement appears for about 0.5 s, e. g.

Fig. 11

followed by the respective susceptibility value. Measurements are displayed successively in the order reverse to the measurement sequence. In this way all the stored data can be surveyed.
After the oldest value the notice '**CL**' is displayed:

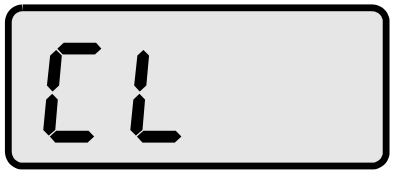

Fig. 12

warning the operator that another pressing of the **[RCL]** switch clears the whole memory and the instrument reverts to the stand-by status. If the **[C/M]** switch is pressed instead, the contents of the memory will be retained.

Note:

- ***The data stored in the memory are not lost when the KT-6 is switched off,***
- ***but they are lost when the battery is low or being replaced.***

The contents of the data memory can be sent to a computer via the RS-232C interface using the program ***KT.exe***. The program is supplied with the instrument. The program can be regularly installed or simply copied it to a desired directory on a hard disk. It is not recommended to run the program from the disk.The program ***KT.exe*** runs under Windows and allows the data to be transmitted from the kappameter to the computer and stored in a text file.

Instructions:

- Connect the serial output of KT-6 with the COM port of the computer.
- Switch on the KT-6.
- Start the program KT.exe.
- If necessary, select the COM1 or COM2 (item System – Set COM in the main menu),
- Select the item File - Receive in the main menu.
- Select the item File - Save as. The values of the susceptibility with respective dates and times are saved in a text file.

Note:

- ***The values of the susceptibility processed in the computer are displayed, printed or saved in SI units. The numbers are thousand times smaller than those displayed on the KT-6, where the 10^{-3} SI units are used.***

3.5 Scan Mode

The scan mode enables to get fast information on the distribution of susceptibility over a particular rock object. In this mode the measurements are repeated automatically in about half a second intervals. Each measurement is displayed but not stored in the memory. Each value is audibly indicated in the logarithmic scale relative to the first value.
The scan mode is achieved when the instrument is waiting for clearing. Press the **[C/M]** switch in free space, then place the instrument against a rock and press the **[RCL]** switch.
The scan mode stops when the **[C/M]** switch is kept pressed for about 0.5 s.

Note:

- ***Variations of the ambient temperature cause changes in the inductivity of the measuring coil and consequently changes in the oscillator frequency. In the normal measurement mode, these changes are eliminated because the free space frequency of the oscillator is measured in the clearing cycle prior to each measurement.***
- ***In the scan mode only one measurement of the free space frequency is used for calculating all the following susceptibility values. The temperature drift causes a gradual decrease of the accuracy of results. It is expedient to interrupt work in this mode from time to time and to clear the instrument again. Thus the influence of the temperature drift can be suppressed in this way.***
- ***The scan mode is not recommended for precise measurements of low susceptibility values.***

3.6 Low Battery Indication

If the battery voltage drops below 5.3 V, the character '**b**' appears at the most left position of the display. The battery condition is tested at switching the instrument on and each time the susceptibility value is displayed.

Fig. 13

When the warning '**b**' appears, the KT-6 will operate properly for several more hours. Nevertheless, it is recommended to replace the battery soon.

3.7 Date and Time Set

A setting mode is entered by pressing the **[C/M]** switch - see Fig. 1 and holding it for a few seconds. The blinking value (hours, minutes, year, month, day) can be modified by pressing **[RCL]** touch switch, the next item is achieved by pressing the **[C/M]** touch switch. Another pressing the **[C/M]** switch ends the setting mode and enters the measuring mode. After switching on the instrument is always in the measuring mode.

3.8 Miscellaneous

The instrument should be protected from heavy shocks and kept clean. Special attention should be paid to the condition of the battery contacts.
An unreliable contact can depreciate proper operation of the instrument.
Both touch switches are very sensible so that only moderate pressure is needed for switching. It is indicated by the buzzer or by change in the display.

4. MEASURING METHODS

4.1 Measured Value and Corrections

4.1.1 True and Apparent Susceptibility

The value measured with the KT-6 depends on the size and shape of the rock object.
The instrument KT-6 is calibrated for the idealized case in which the pick-up coil is attached to an absolutely smooth plane confining a half-space filled with magnetically homogeneous and isotropic medium.
Then the displayed value of the susceptibility is the true value. (The true value of susceptibility is computed in the microprocessor from the measured, so called apparent, susceptibility.)

4.1.2 Effect of the Gap between the Active Face of the Instrument and the Rock Surface

When the active face of the instrument is not close to the surface of the measured rock, the value indicated is lower than the true susceptibility.
In Fig. 14 the relative decrease of the displayed susceptibility value versus the distance between the active face and the rock surface is plotted.
The surface layer of the rock down to the depth of 20 mm contributes about 90% to the displayed value.

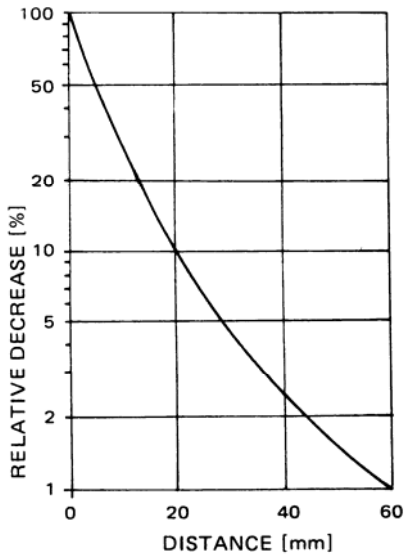

Fig. 14

4.1.3 Corrections for Surface Unevenness and for Finite Dimensions

Corrections for the surface can be derived from Fig. 14. The surface unevenness is the ‘peak-to-pit’ difference, i. e. the difference between the highest peak and the deepest pit in the area to which the KT-6 is attached during measurement. The unevenness is estimated by observing the gap. Table 1 lists the corrections for unevenness up to 10 mm. The corrected value is obtained by multiplying the measured value by the respective correction factor.

Table 1

Surface unevenness [mm]	**Correction factor**
1	1.07
2	1.15
3	1.23
4	1.32
5	1.41
6	1.51
7	1.61
8	1.72
9	1.84
10	1.96

Fig. 14 also indicates that the half space can be substituted with sufficient accuracy by a plate 50 mm thick. As for the surface plane area, infinite dimension is approximated with sufficient accuracy by a plane into which a circle can be inscribed with a diameter greater than 100 mm. It is ineffective to make measurements on surfaces with the diameter of the inscribed circle smaller than 60 mm.
The values measured on the surface with finite dimensions can be corrected using Table 2.
The value measured should be multiplied by the respective correction factor.

Table 2

Rock object size [mm]	**Correction factor**
60	1.19
70	1.11
80	1.05
90	1.03
100	1.01

4.1.4 Masurement on a Cylindrical Surface

In measuring drill cores, it is recommended to attach the pick-up coil to the side rather then to the head of the core, since the core side is an almost perfectly smooth cylindrical surface, while the head is uneven and usually of small diameter. The values measured on a cylindrical surface are systematically lower than those measured at the boundary of a smooth half-space and, therefore, they must be corrected.
The correction factors are given in Table 3; the value measured is to be multiplied by the correction factor.
It is essential that the cylinder measured be longer than 100 mm.

Table 3

Diameter of core [mm]	**Correction factor**
60	1.63
70	1.53
80	1.46
90	1.41
100	1.38
110	1.35
120	1.33

4.2 Instructions for Measurement

4.2.1 Measurement on Outcrops

In measuring on outcrops it is necessary to consider the degree of weathering of the surface which affects the results considerably.
The weathering effect can hardly be evaluated; therefore measuring on unweathered though less smooth surface is preferred.
For each measurement it is necessary to estimate the surface unevenness and to introduce the respective corrections - see Table 1. It is recommended not to measure on surfaces with peak-to-pit differences greater than 5 mm.

4.2.2 Piece Specimen Measurement

It is not recommended to measure samples less than 50 mm thick, with a surface smaller than the KT-6 face (60 mm). If the diameter of the circle approximating the measured surface is smaller than 100 mm, it is necessary to correct the measured value - see Table 2.

4.2.3 Drill Core Measurement

It is preferable to measure on the core side (on the cylindrical surface) rather than on the core head which is usually uneven and small.
The values measured are, however, systematically lower (by as much as 30%); it is therefore essential to correct them - see Table 3.
The measurement on the core side may be sufficiently accurate, since the surface is unweathered and usually smooth enough; the core must be longer than 100 mm.

5. ERROR MESSAGES

The instrument functions are checked.
The following messages indicating error conditions may be displayed.

E 00 Overflow of the display range
E 10 Data memory failure
E 11 Data format failure
E 51 Invalid PC command
E 55 Communication error (RS-232C)
E 81 The instrument cannot be switched off

E 10, **E11** and **E 81** are serious failures. It is necessary to ship the instrument for repair to the producer.

6. MAINTENANCE

Caution:

- ***The instrument can be damaged by a strong static charge.***

The KT-6 is a sophisticated measuring instrument. Trouble shooting is rather complicated and cannot be conducted without special electronic equipment. That is why the manufacture strongly recommends to all users to make no encroachments upon the KT-6 electronics.
If any operation described in this manual cannot be executed, check the battery, the cleanness and quality of the contacts that connect the battery with the electronics. If both the battery and the contacts are in a good condition, it is necessary to ship the instrument for repair to the producer *(see section 7*).

7. WARRANTY

All SatisGeo instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your distributor or SatisGeo representative.
All requests for repairs and replacement parts should be directed to the
SatisGeo, s.r.o.
Jecna 29a
621 00 Brno
Czech Republic
(info@satisgeo.com).
This will assure you the fastest possible service. Please include the instrument Type Number and Serial Number with all request for parts or service. Specifications and price change privileges reserved.

8. CONNECTORS WIRING

Connector on interface cable for PC connection:

C9 PIN NO.	EXPLANATION	KT-6 connect or (jack) PIN NO.
5	GND	case
2	Transmitted data	top
3	Received data	middle
4-6	*(two pins connected)*	
7-8	*(two pins connected)*	

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