User's Guide

KT-9 Kappameter

Rev. 1

EXPLORANIUM
RADIATION DETECTION SYSTEMS

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Preface

General information

Introduction

Congratulations on purchasing the KT-9 KAPPAMETER, the most advanced, easiest-to-use hand-held susceptibility meter available today.

This manual provides both instructional and reference material to help you get the most from your KT-9.

Getting help
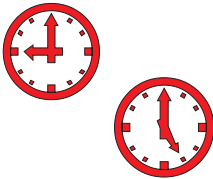
If you should encounter a problem with either the KT-9, the optional external sensors, the applications software or applying the instrument to a particular problem, please contact **EXPLORANIUM** technical support, Monday to Friday from *0900* to *1700* (Eastern Standard Time) at the following numbers:
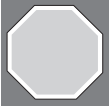
Telephone: **(905) 712-3100**

Fax: **(905) 712-3105**

Conventions

To help you quickly find information, the KT-9 documentation follows these conventions:

Symbols

Symbol	Meaning
i NOTE	Indicates a note of interest, a default or special condition, or specific critical information.
☞ TIP	Indicates a tip, helpful hint or an alternate way of doing a task.
⚠ CAUTION	Indicates a cautionary note. You should pay attention to this and proceed appropriately.
🚫 DON´T	Indicates things you should not do with, or to, the equipment. Pay special attention to these items.
⬭ STOP	You *must* read this item. It indicates a critical condition. Please follow the advice listed.
🪛 MAINT.	Indicates a maintenance tip or how to fix a problem.

Instrument control buttons

The KT-9 has two control buttons on either side and a removable push-pin button on the sensor face. The side control buttons are referred to as the RIGHT or LEFT buttons when you are looking at the display screen with the sensor facing upwards.

One of the features of the KT-9 allows you to re-assign the functions of the buttons depending upon whether you prefer to hold the instrument in your right or left hand. All the operations will be described from the point of view of right-handed use. However, the following special icons will show when a function is available in the re-mapped modes.

Symbol	Meaning
L	Indicates the physical LEFT button at all times.
R	Indicates the physical RIGHT button at all times.
P	Indicates the removable PIN on the sensor face.
LR	Indicates the LEFT button when the KT-9 is in the right-hand mode (solid character). Alternatively, this button can be re-mapped to be the RIGHT button in the left-hand mode (outline character).
RL	Indicates the RIGHT button when the KT-9 is in the right-hand mode (solid character). Alternatively, this button can be re-mapped to be the LEFT button in the left-hand mode (outline character).

Instrument display screen

The KT-9 display screen is a five character liquid-crystal display (LCD). When an action or instructional sequence is being described, the appropriate display from the instrument will be shown. A sample screen looks like this:

$$^{LoBAT}\ 1\,8\!:\!8\,8\,8$$
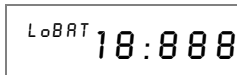
Type styles

Style	Meaning
Italics	1. A new term is being introduced. 2. An item of importance is being emphasized.
Bold	An action that you are required to perform.
SMALL CAPS	Descriptive or proper name for a mode, instrument, etc.
Monospaced	A filename, environment variable, directory, menu selection, or any computer command entered through a keyboard.
KeyCaps ▫▫	The keys you are required to press while running an optional computer program. If these key symbols are not separated by commas, you must press all the keys simultaneously.

The KT-9 Kappameter

The KT-9 KAPPAMETER is the state-of-the-art, hand-held field magnetic susceptibility meter for obtaining accurate and precise measurements from outcropping rocks, drill cores and rock samples. Special design features make the KT-9 superior in measuring uneven rock surfaces and well suited to automated drill-core logging with digital recording.

Figure 1   The KT-9 Kappameter

Features

The KT-9 has many unique features over it's predecessor (the KT-5 — see also "KT-5 vs. KT-9 operational differences" on page 71), as well as other commercially available units. These features include:

Easy to use – A special *measuring pin* protrudes from the centre of the measuring head. In order to take a reading, you simply press the pin against the sample to be measured. When you remove the KT-9, it automatically displays the true measured susceptibility of the sample in SI units.

Hi-sensitivity – The *maximum* sensitivity of the KT-9 (in common with the KT-5) is 1×10^{-5} SI units. The largest value that can be read is 999×10^{-3} SI units. The autoranging capability of the unit gives it the best sensitivity range available.

True susceptibility – Unlike all other current commercial instruments, which measure the **APPARENT** susceptibility, the KT-9's automated correcting routines display the **TRUE** susceptibility. In older instruments, the measured apparent susceptibility differs significantly from the real susceptibility in the higher ranges. Users of these instruments would then have to *manually* correct the measured data to obtain a true value.

Long battery life – The special power saving techniques used by the KT-9 allows you to take up to 10,000 readings (under normal conditions) using a single 9-volt battery.

Uneven samples – The measurement of magnetic susceptibility is dependent upon the volume of material being sampled. The presence of an *uneven* surface (as is the case in most practical situations) creates air space gaps due to the sensor sitting up on bumps. This causes *serious* errors in the measured susceptibility of all other currently available commercial units.

The KT-9 *overcomes* this problem by spacing the sensor a fixed distance away from the sample by means of a **PIN**. The *average* of repeated measurements (placing the pin in different locations) averages the errors due to the bumps to provide the *true* reading of the magnetic susceptibility.

There is *no reduction in the effective sensitivity* of the KT-9 due to the air gap, because of the automatic compensation built into the unit.

Drill-core samples – Similar to the problem for uneven samples, the curvature of the drill-core samples creates large geometric errors to the measured susceptibility in older instruments. You would have to correct the data manually using special tables calculated for various drill-core diameters.

The KT-9 *automatically* corrects the reading since you select the appropriate core *diameter* prior to taking measurements.

Fast scanning – The KT-9 has an automatic SCAN mode to allow larger areas to be scanned quickly for changes in susceptibility. The scan rate is three readings per second—that's three times faster than the KT-5!

Variable audio – In the scan mode, the KT-9 has a variable audio tone that is directly *proportional* to the measured susceptibility—the higher the tone, the greater the susceptibility. This allows you to quickly scan a rock surface and visually correlate areas of varying susceptibility.

Data storage – Up to 10 readings can be stored in the KT-9's internal memory. This data is retained e*ven if the unit is powered off*!

Data averaging – The average of up to the 10 stored readings can also be displayed. This allows for very accurate measurement of uneven surfaces while in the PIN mode, as well as improved data quality for smoother surfaces while in the NO-PIN mode.

External sensors – The design of the KT-9 permits the connection of various external sensors to the unit via a special connector. When an external sensor is connected, then the internal sensor is automatically disconnected.

Digital output to a computer – The KT-9 can be connected to a computer via the serial port and a special cable. The KT-9 can then be completely controlled from the computer in a special REMOTE mode. In this mode, the computer can start the KT-9 and store the measured values in a file. This permits *core logging*

operations to produce a complete profile of the core in the SCAN mode.

Soil monitoring – A special *stick* with the an external sensor can be connected to the KT-9 to facilitate ground level suscepti-bility measurement of soils and rocks without you having to continuously crouch or bend over.

Design

The KT-9 was specially designed to be an easy to use, one-handed, rugged field instrument.

Rain and dust proof – To this end, the slim instrument case consists of two isolated compartments. The front compartment (containing all the electronics, the measuring coil, touch switches and display) is rainproof and dustproof. The measuring pin used in the PIN mode, is covered with a rubber shield. When the pin is removed for the NO-PIN mode, a replacement stud is installed that maintains the moisture and dust seal to the upper compartment.

The rear compartment contains the battery and connectors for the external sensors and computer. The connectors are protected with special rubber plugs to prevent dirt and water damage.

Simple one-handed operation – The KT-9 is totally con-trolled by only two touch switches conveniently located on the right and left side of the unit. This allows you to use either your thumb or fore-finger to control the measurements while com-fortably holding the unit in the palm of your hand. Further, the KT-9 can be configured to reverse the functionality of the switches to accommodate both right and left-handed users.

Large LCD display and audio alerts – A simple 5 character liquid-crystal display with half-inch (12 mm) characters is used.

Simple beeps confirm operations when configuring the KT-9 for the various modes of operation.

In the scan mode, a continuous audio tone that is directly proportional to the measured susceptibility is heard. This facilitates heads-up operation.

Economical operation – By utilizing the latest technology CMOS VLSI circuitry, very low power consumption takes place in the KT-9. Consequently, a single 9-volt battery is usually sufficient for a full season (up to 10,000 readings under normal conditions).

Storage and transportation – A robust leather case is supplied with the KT-9. The case can be either carried over the shoulder on a strap or worn on a belt to facilitate transportation in the field. The case has a moulded bottom to accommodate the sensor head with the pin in order to prevent the KT-9 from sliding around. Consequently, the unit should be stored sensor down in the case when not in use.

There is also a small compartment under the lid of the carrying case for storing a spare battery and some accessories, such as a spare rubber PIN cover, a PIN assembly or a replacement stud.

i

NOTE

Even though the KT-9 has been designed to be a rugged instrument, it still can be damaged by severe impacts. Also, please note that the KT-9 is only moisture proof, not water proof. Consequently, total immersion in water (i.e. falling into a river, etc.) or long exposure in heavy rains is not advisable for either the instrument or the operator.

Controls

Figure 2 The controls and features of the KT-9.

TABLE 1: KT-9 controls and features

#	Item	Description
1	LCD Display	Up to 5 large characters can be displayed making it easy to read under a variety of conditions
2	Right Button	Multiple functions: – main control – mappable to LEFT function – ON switch – referred to by these icons:
3	Left Button	Multiple functions: – menu selections – mappable to RIGHT function - OFF switch, when pressed at the same time with the RIGHT – referred to by these icons:
4	Sensor Head	This is the *active* face of the instrument when using the internal sensor coil.

TABLE 1: KT-9 controls and features

#	Item	Description
5	Pin	This removable measuring pin is located in the centre of the top coil assembly. For ease of use, it behaves as the RIGHT button for taking readings. It is referred to by this icon:
6	Computer connector	The cable to a personal computer plugs into this connector.
7	Battery compartment screw	This screw secures the cover to the battery compartment.
8	External sensor connector	External sensors plug into this connector.
9	Battery connector	A standard 9-volt battery connector.
10	Battery extractor strip	A textile strip to facilitate battery removal from the case.

TIP

The RIGHT and LEFT buttons must be pressed *slowly* (at least a one half-second [0.5 sec] push) for proper operation. The KT-9 is programmed to reject *fast* button activation as a means to prevent accidental activation.

Displays

The characters that the KT-9 displays are summarized as follows

Character(s)	Meaning	Description
$A:$	Access:	Indicates the mode of measurement can be set
$C:$	Control:	Indicates that you can change from *right-handed* to *left-handed* operation
$Cor:$	Core:	The measurement mode is set for CORE samples
$Cdd:$	Core Diameter:	Core sample measurement set for a diameter of " dd " cm
$d:$	Diameter:	Core diameter in centimetres
$EC:$	External Coil	An external coil is connected and will be used
$ErrX$	Error:	Error number "X" occurred. See "Error messages" on page 38.
$F:$	Full:	The data memory is *full*, i.e. ten readings have been stored
$o:$	Average:	The displayed value is the *average* of all the data in memory
$P:$	Pin:	The measurement mode is set for the PIN mode
$nP:$	No-Pin:	The measurement mode is set for operation without the pin in place

Operating principle and Theory

Theory

Magnetic susceptibility is defined as the degree to which a substance can be magnetized. In mathematical terms, this the ratio **κ** of the intensity of the magnetization **I** to the magnetic field **H** that is responsible for the magnetization, i.e.

$$kH \ = \ I$$

From Ampere's law, it is known that a current (i.e. a moving electrical charge) generates a magnetic field. The inverse corollary to this is that a magnetic field can also influence a moving electrical charge. Therefore, put in simple terms, an oscillating EM field will be influenced to varying degrees by magnetically susceptible material.

Operating principle

The KT-9 uses a 10 kHz LC oscillator and an inductive coil to measure the susceptibility. The sequence required to obtain a measurement of susceptibility is:

1. The frequency of the oscillator is measured in free space.

2. The oscillator frequency is next measured when the coil is placed on the material for which the susceptibility is required.

3. The frequency difference is directly proportional to the materials susceptibility.

4. The susceptibility is calculated from this frequency difference and takes into account geometric corrections to determine the true susceptibility.

Using the KT-9

Battery installation

The KT-9 is powered by a single 9-volt alkaline battery (type 6F22, IEC standard). The battery compartment is accessed from the bottom of the instrument by removing the single screw. The battery compartment is shown in the following figure.

Figure 3 KT-9 battery compartment

Procedure:

1 Remove the screw from the bottom cover.

2 Remove the bottom cover lid.

3 Pull on the fabric tab to free the old battery from the case.

4 Detach the old battery from connector

5 Attach new battery to connector (the design of the connector allows only the correct orientation).

6 Insert the new battery into the cavity, ensuring that the fabric pull tab is behind the battery (for easy removal next time).

7 Replace the cover.

8 Insert and tighten the screw.

CAUTION

If you are going to store your KT-9 for a longer term (over thirty days), please remove the battery from the unit to prevent damage from electrolyte leakage. It is also recommended that you visually inspect the battery after any long storage interval.

Power ON or OFF

The RIGHT and LEFT buttons are used to turn the KT-9 ON or OFF.

Power ON

| R |

1 Press the RIGHT button.

When the KT-9 powers on, the following test display is shown for about a second:

$$\text{LoBAT} \quad 18:888$$

After this the display will change to *last* mode that was used. This convenience allows you to immediately continue operations where you left off.

Power OFF

R L

1 Press the RIGHT and LEFT buttons *simultaneously.* A beep will be heard to indicate that the unit is powering off. All of your data and the current configuration will be saved and immediately available when you power back on.

i

NOTE

The KT-9 turns off automatically after five minutes of inactivity to conserve battery power.

Menus

The KT-9 has two main menus and one sub-menu that control the various configurations and modes. The displayed menu items are as follows and their relationships are shown in Figure 4 on page 14

A:XXX

Access menu for operating mode

A: nP   NO-PIN operation

A: P   PIN operation

A:Cor   CORE logging operation

C: XX

Configuration menu for right or left hand

C: LH   LEFT-HAND operation

C: rH   RIGHT-HAND operation

d :XXXX

Diameter selection for core

You will be able to toggle between the following core diameters (in units of centimetres):

3, 4, 5, 6, 7, 8, 9, 10, 11, 12

The following value is used to represent a **1** inch diameter core:

2.54
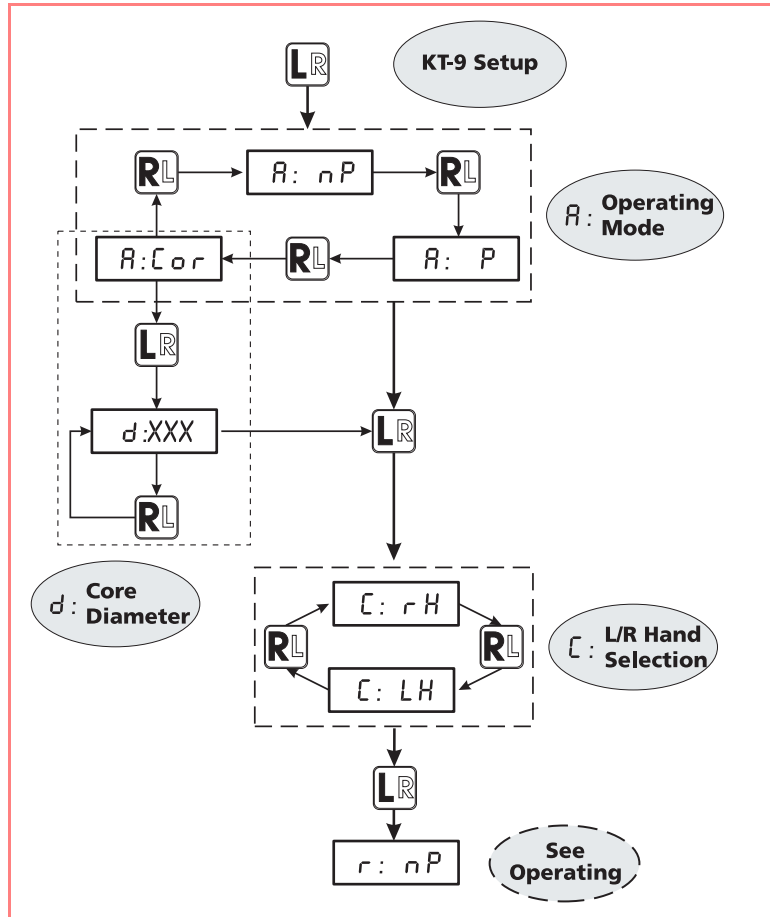
Figure 4   KT-9 Menus flow chart

Configuring for right or left-handed use

To make the KT-9 fully adaptable to your way of working in the field, it can be set to operate in either a *right* or *left*-handed mode. This means that the main measurement functions, i.e. the button you would press most often, can be re-mapped to be activated on either the right or left *side* of the KT-9.

Whenever a re-mappable button is referred to in the following documentation, it will be described from a *right-handed* operations point of view, unless specified otherwise. The special icons shown in the margins will be used to highlight a *right* or *left* re-mapped button respectively.

To change from right to left-handed usage:

1 The display in the measurement mode will have a r : as the first character, e.g.

$$r : n\,P$$

2 Press the LEFT button twice to get to the C : menu. Please also refer to Figure 4 on page 14 to see the flow of events.

3 Press the RIGHT button once to toggle to the left-handed mode. You should now see the following display:

$$C : \; L\,H$$

4 Press the LEFT button again to get back to the measurement mode.

To change from left to right-handed usage:

The steps in the previous description need to be repeated, except that you will be pressing the opposite button.

1 The display in the measurement mode will have a L: as the first character, e.g.

L: n P
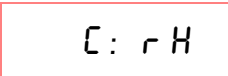
2 Press the RIGHT button twice to get to the C: menu. Please also refer to Figure 4 on page 14 to see the flow of events.

3 Press the LEFT button once to toggle to the right-handed mode. You should now see the following display:

C: r H

4 Press the RIGHT button again to get back to the measure-ment mode.

TIP

The mode of operation can only be changed when the data memory is empty. See "Clearing the memory" on page 37 for details on how to clear the memory.

Selecting mode of operation

The KT-9 has four modes of operation:

PIN – In this mode, measurements are activated by the special pin located at the top of the KT-9. This permits easier operation and achieves much higher accuracy when used for samples with irregular surfaces. This unique *simple* mode of operation auto-matically finds the zero-reference level *after* the reading has been taken. Please refer to "PIN mode" on page 21 for a detailed description on the use of this mode.

NO-PIN – In this mode, the KT-9 is operated as a conventional unit, requiring you to manually zero the unit and take the reading as done with the older KT-5. Please refer to "NO-PIN mode" on page 24 for a detailed description on the use of this mode.

CORE – In this mode, you can take measurements of selected core diameters and have the KT-9 *automatically* apply geometric correction calculations to give a true reading. Please refer to "CORE mode" on page 27 for a detailed description on the use of this mode.

SCAN – In this special sub-mode of the NO-PIN or CORE modes, the KT-9 continuously samples at a rate of 3 times per second. The unit also emits an audio tone that is directly proportional to the measured susceptibility. This mode may also be used for core logging with optional digital recording, as required. Please refer to "SCAN mode" on page 31 for a detailed description on the use of this mode.

To select operating mode

To select the mode you wish to take measurements in, you will need to activate the A: (ACCESS) menu and toggle between the three modes. The ACCESS menu is only available when the data memory is empty, so you may have to clear your stored readings. Please also refer to Figure 4 on page 14, which schematically shows the KT-9 configuration sequence.

1 Press the RIGHT button.

2 Make sure that there is no data in memory. If the display shows C: 0, then the memory is empty. Otherwise you will have to clear the memory as described on page 37.

3 Wait 10 seconds and the system will return to:

```
r : n P
```

L R

4 Press the Left button until the A: (ACCESS) menu is displayed, e.g.

$$A:\ nP$$

R L

5 Press the RIGHT button to toggle to the desired mode, e.g.

$$A:Cor$$

L R

6 Press the LEFT button. If you have selected the CORE mode, you will be presented with the d: menu for core diameter selection. You will have to use the RIGHT button to toggle to the desired diameter.

L R

7 Press the LEFT button *two times* to get back to measure-ment mode. You will pass through the C: menu in this step.

To select Scan mode

The scan mode can only be activated when the KT-9 is set to the NO-PIN or CORE modes, i.e. the display should show either of the following when in right-handed mode:
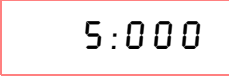
$$r:\ nP$$ $$r:C\ X$$

R L

1 Press the RIGHT button to check if the data memory is empty. If the display does not show $C:\ 0$, then you will have to clear the data memory as described in page 37.

2 The display should now show:

$$C:\ 0$$

L R

3 Press the LEFT button, while C: 0 is still displayed. The sensor head should be kept at least 30 cm from any metallic objects at this point to ensure a proper zero or free-air reading.

4 The display changes to the following and a pulsing audio tone can be heard:

$$5:000$$

5 To *turn off* the SCAN mode, either the RIGHT or LEFT button can be pushed.

TIP

The mode of operation can only be changed when the data memory is empty. See "Clearing the memory" on page 37 for details on how to clear the memory.

Taking measurements

The KT-9 remembers the last mode of operation that was set. Therefore, for everyday use when the unit is turned on, it is ready to go. Depending upon what mode you have selected for operation, there are slight variations in the procedures to obtain precise and accurate true susceptibility readings. The various procedures are described in the following sections. Figure 5 shows the relationships of the various measuring modes.
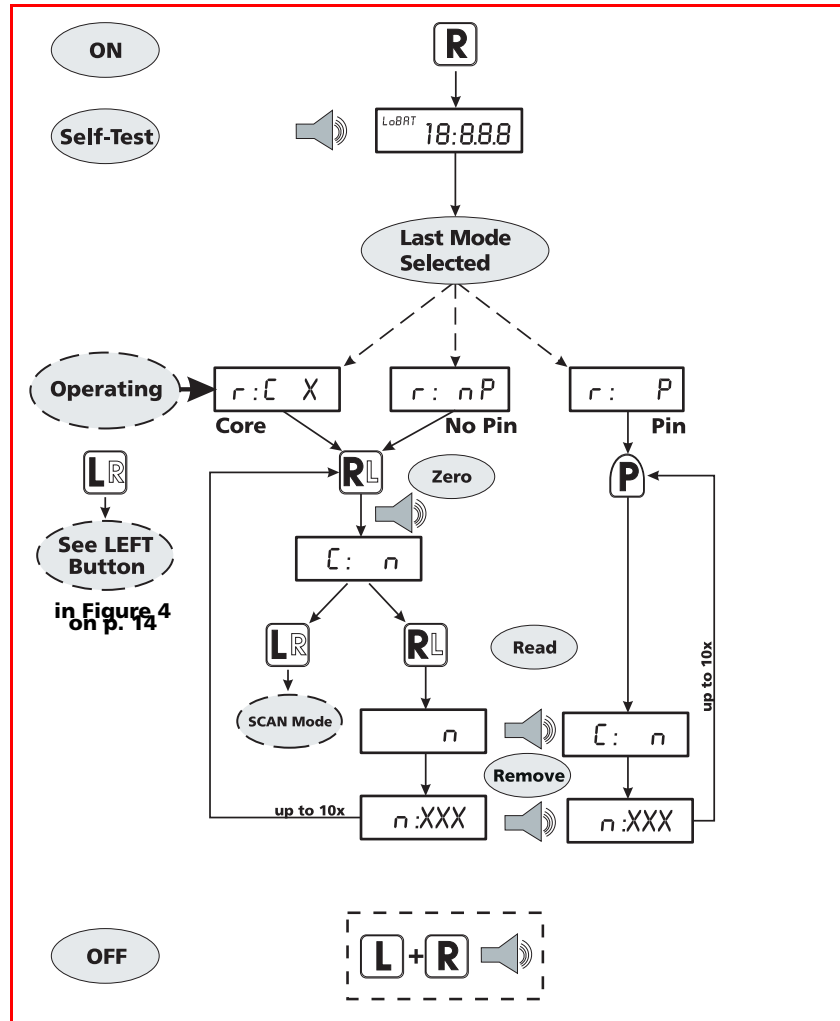
Figure 5   KT-9 measuring modes

Data Units – The KT-9 unit of measurement is in SI Units rang-
ing from 0.01×10^{-3} to 999×10^{-3}, with a sensitivity of 0.01×10^{-3} SI
Units.

PIN mode

This is the recommended mode of operation for the KT-9, and is sometimes referred to as the *read-zero* method. You may need to replace the STUD in the centre of sensor head with the PIN. These items, found in the lid compartment of the storage case (as shown in Figure 12 on page 42), can be seen in the following figure.

Figure 6   PIN and STUD components for sensor

Installing the PIN

MAINT.

1 Unscrew the STUD from the sensor and place it in the lid storage compartment.

2 Screw the PIN into the hole on the front sensor until it is finger tight.

3 Push in the PIN with your finger tip. You should feel some tactile feedback and hear a clicking sound if it is installed correctly.

Taking a reading

Please also refer to the flowchart in Figure 5 on page 20. You are ready to take a reading, if your display shows the following screens. Otherwise please select PIN mode as shown on page 17:

| r :   P | **or** | L :   P |

1 Press the PIN firmly against the sample as shown in the adjacent illustration.

2 The display will show:

C :   0

If the value is not 0, then you have old data in memory that should be cleared. Please refer to "Clearing the memory" on page 37 on how to clear the memory.
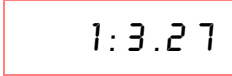
3 The internal buzzer will *beep*.

4 Remove the KT-9 from the sample (and at least 30 cm away from any other magnetically susceptible material) to get the zero or free-air value.

5 After a 1 to 2 second interval, a *beep* will sound to indicate that the measurement is complete and the value will be displayed.

For example, after the first reading the display may show:

$$1:3.27$$

This means that sample number **1** has a value of 3.27×10^{-3} SI Units. Remember that the display is always in 10^{-3} SI Units. Therefore, a value of $0.01 = 0.01 \times 10^{-3}$ SI Units $= 1 \times 10^{-5}$ SI Units, which is the limit of sensitivity for the KT-9.

Additional readings

1 To take additional measurements, the above steps **1** to **5** are repeated.

2 Each new measurement is *automatically* stored in memory when you press the PIN for the next reading. The digit after the $C:$ will change to reflect the current sample number.
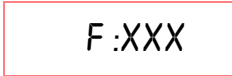
> ### NOTE
> If you do not wish to store a particular measurement, then you must press the LEFT button before taking the next reading.

3 Up to **10** samples can be stored in memory. When the eleventh sample is taken, the display will show:

$$F:XXX$$

The XXX represents the value of the reading and the F indicates that the memory is now full.

4 If you continue taking additional readings after the tenth, the eleventh sample is moved into memory location ten. All the other samples are moved down one memory location, resulting in the first sample being lost.

Summary

Taking a reading in the PIN mode (*read-zero* method) is a simple three step procedure:

(P)

1 Press the PIN against the sample.

2 Remove the KT-9 after the beep (it is measuring the *zero*).

3 The result is displayed after the second beep.

NO-PIN mode

The NO-PIN mode (sometimes referred to as the *zero-read-zero* method) requires that the measuring pin be replaced by the STUD in order to allow the sensor to come in direct contact with the samples. The STUD should be located in the lid compartment of the storage case (as shown in Figure 12 on page 42) can be seen in the following figure.

Figure 7 Pin and stud components for sensor

Installing the STUD

MAINT.

1 Unscrew the PIN from the sensor and place it in the lid storage compartment of the carrying case.

2 Screw the STUD snugly into the hole on the front of the sensor. You may need a small screwdriver for this operation.

Taking the reading

Please refer also to the flowchart shown in Figure 5 on page 20.

1 You are ready to take a reading, if your display shows either:

r : n P	**or**	L : n P

2 Press the RIGHT button to *zero* the instrument while holding it at least 30 cm away from any magnetically susceptible material. The KT-9 will *beep* when the button is pressed.

3 The display will show:

$$C : \; 0$$

If the value is not 0, then you have old data in memory that should be cleared. Please refer to "Clearing the memory" on page 37 for further instructions.

4 Place the sensor firmly against the sample.

5 Press the RIGHT button again to start the measurement sequence. The KT-9 will beep. Hold the unit on the sample for about half a second.

6   Remove the KT-9 at least 30 cm away from the sample.

7   After one second, the KT-9 will *beep again*, and the true measured value will be displayed.

8   Press the RIGHT button to store this reading in memory. The KT-9 is also now ready to take the next measurement. This is indicated by the incremented value on the display, i.e.:

$$C: \quad 1$$

Additional readings

1   To take additional measurements, the above steps **2** to **8** are repeated.

2   Up to **10** samples can be stored in memory. The display, after the eleventh sample is taken, will show:

$$F:XXX$$

The *XXX* represents the value of the reading and the *F* indicates that the memory is now full.

3   If you continue to take additional readings after the tenth, the eleventh sample is moved into memory location ten. All the other samples are moved down one memory location, resulting in the first sample being lost.

Summary

Taking a reading in the No-Pin mode (*zero-read-zero* method) is a simple four step procedure:

R L

1 Take a zero reading in free-space.

R L

2 Place the sensor head against the sample and press the RIGHT button again.

3 Remove the KT-9 after the beep (it is checking *zero* again).

4 The result is displayed after the second beep.

CORE mode

The CORE mode (also referred to as a *zero-read-zero* method) requires that the measuring pin be replaced by the STUD in order to allow the sensor to come in direct contact with the core. The STUD should be located in the lid compartment of the storage case (as shown in Figure 12 on page 42) can be seen in the following figure.

Figure 8   Pin and stud components for sensor

Installing the STUD

MAINT.

1 Unscrew the PIN from the sensor and place it in the lid storage compartment of the carrying case.

2 Screw the STUD snugly into the hole on the front of the sensor. You may need a small screwdriver for this operation.

Selecting core diameter

You will need to specify the core diameter in order to get a correct reading, as this diameter is critical to the geometric correction that the KT-9 performs. You will be automatically presented with the $d:$ (DIAMETER) menu when the CORE mode is selected from the $A:$ (ACCESS) operating menu. This is shown in Figure 4 on page 14.

The core diameters are specified in 1 centimetre increments from **3** to **12** centimetres. A special value of 2.54 is used to specify a **1** inch diameter core.

To select the core diameter:

1 Press the LEFT button when the CORE mode is displayed from the $A:$ menu, i.e.

$$A:Cor$$

2 The first choice of the $d:$ (DIAMETER) menu is displayed, e.g.

$$d:2.54$$

R L

3 Press the RIGHT button to toggle to the desired diameter. If you accidently pass it, you will have to cycle all the way around to the value again.

$$d: \quad 4$$

L R

4 Press the LEFT button to set the diameter.

L R

5 Press the LEFT button again to pass through the C: menu and get back to the measurement mode.

Taking the reading

Please refer also to the flowchart shown in Figure 5 on page 20.

1 You are ready to take a reading, if your display shows either:

$$r:C \quad X$$ **or** $$L:C \quad X$$

i NOTE — This example is illustrated with the KT-9 set for the LEFT button.

2 Press the LEFT button to *zero* the instrument while holding it at least 30 cm away from any magnetically susceptible material. The KT-9 will *beep* when the button is pressed.

L R

3 The display will show:

$$C: \quad 0$$

If the value is not 0, then you have old data in memory that should be cleared. Please refer to "Clearing the memory" on page 37 for further instructions.

4 Place the sensor snugly against the core.

5 Press the LEFT button again to start the measurement sequence.The KT-9 will beep. Hold the unit on the sample for about half a second.

6 Remove the KT-9 at least 30 cm away from the sample.

7 After one second, the KT-9 will *beep again*, and the true measured value will be displayed.

8 Press the LEFT button to store this read-ing in memory. The KT-9 is also now ready to take the next measurement. This is indicated by the incremented value on the display, i.e.:

$$C:\ 1$$

If a reading is not taken within 10 sec-onds, then the instrument will re-set to indicate the current operating mode.

Additional readings

1 To take additional measurements, the above steps **2** to **8** are repeated.

2 Up to **10** samples can be stored in memory. The display, after the eleventh sample is taken, will show:

$$F : XXX$$

The *XXX* represents the value of the reading and the *F* indicates that the memory is now full.

3 If you continue taking additional readings after the tenth, the eleventh sample is moved into memory location ten. All the other samples are moved down one memory location, resulting in the first sample being lost.

Summary

Taking a reading in the CORE mode (*zero-read-zero* method) is a simple four step procedure:

1 Take a zero reading in free-space.

2 Place the sensor head against the core sample and press the RIGHT button again.

3 Remove the KT-9 after the beep (it is checking *zero* again).

4 The result is displayed after the second beep.

SCAN mode

This is a special sub-mode of the NO-PIN and CORE modes. Please refer to Figure 5 on page 20 to see where it is activated. In this mode, the KT-9 continuously samples at a rate of 3 times per second (i.e. 0.333 sec/sample). The unit also emits an audio tone that is directly proportional to the measured susceptibility.

The SCAN mode allows for rapid examination of rock faces and lengths of core. The variable audio allows you to rapidly correlate visually the various lithologies being examined. This mode may also be used for detailed core logging with optional digital recording.

The procedure for selecting the SCAN mode is described in detail on page 18 and is shown schematically in the following figure:
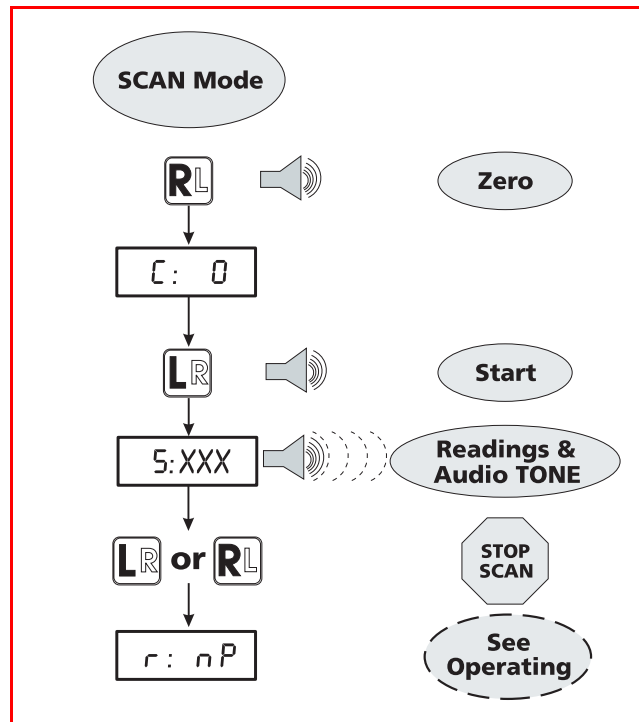
Figure 9   SCAN mode flowchart

Taking readings

1 The display should show either of the following when in right-handed mode:

$$r : n\,P \qquad r : C \; X$$

2 Press the RIGHT button to check if the data memory is empty. If the display does not show $C : 0$, then you will have to clear the data memory as described in "Clearing the memory" on page 37.

3 The display should now show:

$$C : \quad 0$$

4 Press the LEFT button, while $C : 0$ is still displayed. The sensor head should be kept at least 30 cm from any magnetic sources at this point to ensure a proper zero or *free-air* reading.

5 The display changes to the following and a pulsing audio tone can be heard:

$$5 : 0\,0\,0$$

6 To *turn off* the SCAN mode, either the RIGHT or LEFT button can be pressed.

.

> 1 In the SCAN mode, the displayed data are not stored in memory.
>
> 2 Beware of temperature dependent drift in SCAN mode! Since only one measurement of the free-space frequency is used for calculating all the susceptibilities, there is a possibility that you may experience a gradual decrease in the accuracy of the readings over a period of time. You should occasionally stop and restart the SCAN mode.
>
> 3 The SCAN mode is not suitable for precise measurements of low susceptibility material.

CAUTION

Summary

Taking a reading in the SCAN mode (*zero-rea*d method) is a simple three step procedure:

1 Clear the memory so that no data are stored.

2 Press the RIGHT button while holding the sensor at least 30 cm from any magnetically susceptible bodies for a free-space reading (i.e. zero the instrument).

3 Press the LEFT button to start the SCAN mode.

4 A pulsing audio tone indicates that the SCAN mode is active. Move the sensor slowly along the sample to measure.

Data handling and memory

The KT-9 has convenient features for storing, recalling and averaging up to 10 readings in its memory stack.

Storing a measurement

R⃞L⃞

1 Press the RIGHT button after a reading is complete (usually, the second beep) to store the reading in memory. In the PIN mode, this is automatically done by taking the next reading.

L⃞R⃞

2 If you do not wish to store a particular reading, you must press the LEFT button, before proceeding to take further readings.

The KT-9 can store up to **10** samples in its memory stack. The display after the eleventh sample is taken will show:.

$$F:XXX$$

The *XXX* represents the value of the reading and the *F* indicates that the memory is now full.

If you continue to taking additional readings after the tenth, the eleventh sample is moved into memory location ten. All the other samples are moved down one memory location resulting in the first sample being lost.

Retrieving a measurement

You can retrieve prior readings in last to first order from the KT-9. The data recall procedure is schematically shown in the following figure:
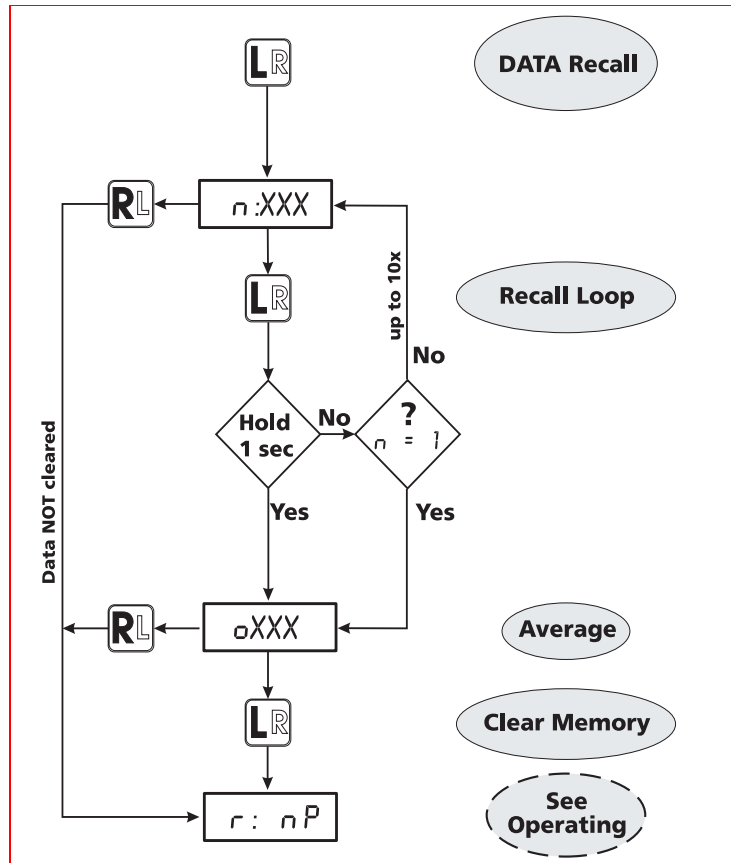
Figure 10 Data recall and averaging flowchart

1 When there is more than one reading in memory, pressing the LEFT button recalls prior readings in a last to first order, i.e. popping values off a stack.

2 To continue recording data *without* averaging or clearing the stack, press the RIGHT button before or when you reach the average.

Automatic averaging

Please refer to Figure 10 on page 36 to see where the averaging operation takes place.

Lℝ **1** If you hold the LEFT button for 1 second, it will trigger the averaging operation and display the average of all the values in memory, e.g.

$$o:12.7$$

Lℝ **2** Alternatively, if you are scrolling down through the stack of stored readings, after the first stored reading has been displayed, pressing the LEFT button one more time will also display the average of all the values in memory.

R𝕃 **3** Pressing the RIGHT button returns you to the measurement mode without clearing the memory stack.

Clearing the memory

Please refer to Figure 10 on page 36 to see where the clearing operation takes place.

Lℝ **1** After obtaining the average of the readings stored in memory, i.e. the display is in o : mode, pressing the LEFT button one more time will clear the memory.

If something goes wrong

The KT-9 has very sophisticated error checking capabilities. It can display a variety of error messages when it detects an incorrect function or fault. These error messages are:

Table 2: Error messages

Display	Meaning	Action
Err 1	Battery charge is *below* 5.3V	Replace the battery.
Err 2	Internal memory error	If this message persists, the unit must be returned for repair.
Err 3	Wrong button pushed.	Usually this means the PIN has been depressed while in the NO-PIN mode.
Err 4	PIN not depressed long enough.	Repeat the measurement.
Err 5	Susceptibility is *below* -0.99×10^{-3}	Take a measurement against a known sample or calibration standard to verify that the KT-9 is operating properly.
Err 6	Susceptibility is *above* 999×10^{-3}	See above for Err 5
Err 7	Mode error: PIN used for NO-PIN or CORE setting	Check that the mode of operation is properly set.
Err 8	Communication error with external computer during calibration.	1. Check cable and connectors. 2. Contact EXPLORANIUM.
Err 9	Time-out error: no data from external computer	1. Check cable and connectors. 2. Ignore, if no computer used.

Chapter 3

External sensors, maintenance and options

The KT-9 has specially designed external sensors available to enhance the functionality and versatility of the instrument. Currently, there are two sensors with accessories available.

External sensors

KT-9-SC Remote Coil

The remote coil was specially designed to overcome certain problems encountered in core scanning. The internal two-inch diameter sensor has problems with adjacent core when measuring samples in a typical corebox, where the core is stored in lengths side-by-side. Smaller diameters of core samples (1½ in or less) when in a core-box, allow the sensor to see adjacent core on either side, resulting in unreliable data. Another inconvenience is that unless the Scan mode is used, it can be very cumbersome to

- zero the KT-9 in free-space
- place the KT-9 on the core
- take a reading
- remove the KT-9 to get another zero reading
- examine the results, and so on.

To solve these application problems, a rectangular (2 x 1 inch) remote coil was designed and built. The shape of the coil now permits scanning of smaller diameter cores (when the long axis of the sensor is along the core axis) without interference from adjacent cores in a core-box. This remote coil has a built-in preamplifier with the sensor so that the cable length to the KT-9 would not become a serious limitation. The remote coil is shown in Figure 11 on page 40.

Stick attachment

If you need to take ground level data of rocks, soils or even scanning a series of core boxes, you will soon realize that it is quite laborious with the KT-9 alone. You are always crouching or bending over to take the readings.

To solve this problem, EXPLORANIUM developed an ergonomic STICK shown in Figure 11. This attachment was specially designed to accommodate either the remote coil or the KT-9 itself. You can now use the STICK to place the REMOTE COIL on whatever is of interest and a reading is conveniently taken.
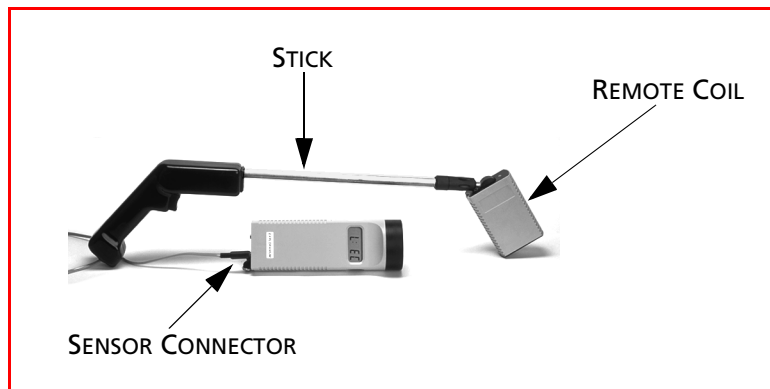
Figure 11 KT-9 with the REMOTE COIL attached to the STICK.

Using external sensors

Calibrating

Before an external sensor can be used for the first time, the KT-9 must be calibrated for the particular external sensor. Each external sensor is always shipped with a diskette containing a specific calibration program for it.

The calibration procedure is as follows (for more details, please see page 54):

1 Connect the supplied cable (Part no. 97945) to the KT-9 computer port located on the bottom panel covering the battery compartment.

2 Connect the other end of the cable to the COM1: serial port of your computer. Please note that this is a DB-9 connector. If you have an older computer, you may require a DB-9 to DB-25 adaptor.

3 Run the supplied CALIB program and follow the instructions on the screen.

4 When the program ends with the message: "Calibration successful," you are ready to use the external sensor.

Taking readings

1 Connect the sensor to the SENSOR connector located on the bottom panel covering the battery compartment.

2 Turn on the KT-9 by pressing the button on the right side.

3 The KT-9 automatically recognizes that an external sensor has been connected and shows either of the following displays, depending upon which hand mode (right or left) was last selected:

r: EC **or** L: EC

4 You should clear the memory if there is any old data stored. See "Clearing the memory" on page 37 for more details.

5 Taking readings with an external sensor uses the same *zero-read-zero* method as with the NO-PIN and CORE modes. See "Taking the reading" on page 25 for more details.

6 To switch back to the internal coil, simply remove the external coil connector and clear the data memory.

Maintenance and handling

Storing and transporting the KT-9

A robust leather case is provided for storing and transporting the KT-9. The case can be worn on a belt or carried over your shoulder using the provided strap. You should always store the instrument in the supplied case to prevent accidental damage.

The interior of the case is designed to accept the KT-9 in a face down manner as shown in Figure 12. The bottom is designed to accommodate PIN and this orientation is also easier to remove from the case.

Figure 12 KT-9 orientation for storage. Note the compartment in the lid for storing a spare battery, studs and pins.

The Stick, Remote Coil and computer cable are supplied in a larger case as illustrated in Figure 13.
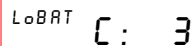

Figure 13 Carrying case for REMOTE COIL and STICK assembly

Batteries and maintenance

The KT-9 utilizes special power saving techniques, so a single 9V battery typically allows 10,000 readings under normal conditions. However, using external sensors increases power consumption and you will not get as many readings from one battery.

If the battery voltage drops below 6V, you will see a low battery warning ($LoBAT$) displayed in the upper left corner of the display, e.g.

$$LoBAT \quad C: \quad 3$$

⚠ **CAUTION**

When the $LoBAT$ warning appears, you have enough power left for only 100 readings (at normal temperatures).

If the battery voltage drops below 5.3V, then the KT-9 will not allow any more readings, since proper operation cannot be

guaranteed. You will then see the following message on the display and will have to replace the battery to continue.:

$$Err1$$

NOTE

All configuration settings and stored data are in flash memory. You will not lose any data when you remove the battery.

The KT-9 is powered by a single 9-volt alkaline battery (type 6F22, IEC standard). The battery compartment is accessed from the bottom of the instrument by removing the single screw. The battery compartment is shown in Figure 14.
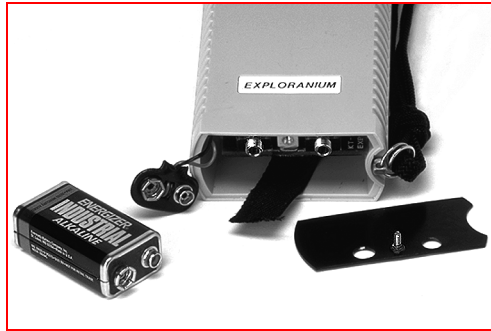
Figure 14 KT-9 battery compartment

Battery installation

MAINT.

1 Remove the screw from the bottom cover.

2 Remove the bottom cover lid.

3 Pull on the fabric tab to free the old battery from the case.

4 Detach the old battery from connector

5 Attach new battery to connector (the design of the connector allows only the correct orientation).

6 Insert the new battery into the cavity, ensuring that the fabric pull tab is behind the battery (for easy removal next time).

7 Replace the cover.

8 Insert and tighten the screw.

Long-term storage

CAUTION

If you are going to store your KT-9 for a longer term (over thirty days), please remove the battery from the unit to prevent damage from electrolyte leakage. It is also recommended that you visually inspect the battery after any long storage interval.

Chapter 4

Technical reference

Specifications

Item	Description
Sensitivity	1×10^{-5} SI Units
Measuring ranges	9.99, 99.9 x10^{-3}, 999. x10^{-3} SI Units autoranging
Operating frequency	10 kiloHertz
Display	4½ character LCD, 12mm high
Data memory	up to 10 measurements
Controls	2 touch buttons & measuring pin
Connectors	Sensor (external) & Computer (RS-232)
Battery	9V alkaline, IEC standard, type 6F22
Battery life	10,000 readings at 20°C (typically)
Ambient operating temperature	from -10°C to +55°C
Dimensions	Length: 187 mm (without PIN) Diameter: 65 mm
Weight	0.35 kg (including battery)

Parts list and accessories

Standard items

Description	Part no.
User's Manual	97901
Leather Case	97955
9V Alkaline battery	40-404-009
Pin assembly (mounted on the unit)	97935
Blind STUD	97960
Spare rubber shield for the PIN	97961
Spare connector sealing	25-700-007

Options

Code	Description	Part no.
KT-9-RS	RS-232C cable	97945
KT-9-ST	Adjustable STICK with trigger and clamp	97985
KT-9-ST	Adjustable STICK with trigger, cable and REMOTE COIL	97940
KT-9-SC	REMOTE COIL (In-Box) 2.6"x1.4" external sensor	97980
KT-9-SW	Software	97925

Display symbols

The characters that the KT-9 displays are summarized as follows:

Character(s)	Meaning	Description
A :	Access:	Indicates the mode of measurement can be set
C :	Control:	Indicates that you can change from *right-handed* to *left-handed* operation
C o r :	Core:	Indicates that the measurement mode is set for CORE samples
C d d :	Core Diameter:	CORE sample measurement set for a diameter of " *d d*" cm
d :	Diameter:	The core diameter in cm
E C :	External Coil	An external coil is connected and will be used
E r r X	Error:	Error number "*X*" occurred. See "Error messages" on page 50.
F :	Full:	The data memory is *full*, i.e. ten readings have been stored
o :	Average:	The displayed value is the *average* of all the data in memory
P :	Pin:	The measurement mode is set for the PIN mode
n P :	No-Pin:	The measurement mode is set for operation without the pin in place

Error messages

Display	Meaning	Action
$Err\ 1$	Battery charge is *below* 5.3V	Replace the battery.
$Err\ 2$	Internal memory error	If this message persists, the unit must be returned for repair.
$Err\ 3$	Wrong button pushed.	Usually this means the PIN has been depressed while in the NO-PIN mode.
$Err\ 4$	PIN not depressed long enough.	Repeat the measurement.
$Err\ 5$	Susceptibility is *below* -0.99×10^{-3}	Take a measurement against a known sample or calibration standard to verify that the KT-9 is operating properly.
$Err\ 6$	Susceptibility is *above* 999×10^{-3}	See above for $Err\ 5$
$Err\ 7$	Mode error: PIN used for NO-PIN or CORE setting	Check that the mode of operation is properly set.
$Err\ 8$	Communication error with external computer during calibration.	1. Check cable and connectors. 2. Contact EXPLORANIUM.
$Err\ 9$	Time-out error: no data from external computer	1. Check cable and connectors. 2. Ignore, if no computer used.

Warranty and repair

Warranty terms

All EXPLORANIUM equipment, except for consumable items, is warranted against defects in materials and workmanship for a period of one year from the date of shipment from our plant. Should you discover any defects under *normal* use during the warranty, EXPLORANIUM will make the necessary repairs (free of charge).

This warranty does not cover damage due to misuse or accident and may be voided if the instrument is disassembled or tampered with by persons not authorized by EXPLORANIUM.

Repair

When to ship the unit

Please do not ship your KT-9 for repair until you have contacted EXPLORANIUM and explained the problem. Certain simple tests or steps for you to do may be suggested. These may solve your problem without the time and expense incurred in shipping the instrument for repair. If the problem still can not be resolved at this point, then you will be requested to return the KT-9 for the necessary repairs.

Description of the problem

Please include the following information when describing your problem with the KT-9:

- the serial number
- the symptoms of the problem
- how and when the problem started
- is the problem constant, intermittent or repeatable
- if constant, under what conditions does it occur
- the software version (if known)

Shipping instructions

Instruments will not be accepted for repair unless they are shipped *prepaid*. After repairs, the instrument will be returned *collect* unless other arrangements have been made with EXPLORANIUM.

Please include the instrument's serial number in all communications regarding equipment that is leased or purchased from EXPLORANIUM.

Instruments shipped for repair from outside Canada

EXPLORANIUM instruments are manufactured in Canada, consequently there is no customer duty payable in Canada. It is advisable to state on the customs documents:

- "**Canadian Goods Returned to Canada for Repair**"
- name of the equipment
- value
- serial number
- reason for return
- packaging and weight

Instruments should be shipped to:

Exploranium G.S. Limited
264 Watline Avenue
Mississauga, ON L4Z 1P4
CANADA

DON´T

Please do not ship the KT-9 with the batteries installed. Further damage may result!

Operating the KT-9 from a computer

There are optional packages available from EXPLORANIUM that allow you to run the KT-9 under computer control. The packages contain software which can be used to test the KT-9 hardware or provides you with a digital logging tool.

The source code for the software (written in either GWBASIC or Microsoft C) is also optionally available to let you prepare your own custom software package for controlling the KT-9.

Further, if you choose to use any of the external sensor options, you may also need to run the KT-9 under computer control to set the calibration constant for your KT-9.

The various computer programs are revised on a periodic basis. The discussions of these programs in this chapter will be of a general nature. You should refer to the information that accompanies the software for more current details. The current version (August 1997) of the software disk is labelled: "KT-9 Support Software — KT9–002".

TIP

When the KT-9 is used in a remote mode from a computer, it consumes more power. It is therefore highly recommended to immediately change the KT-9's battery whenever the $LoBAT$ message appears.

CALIB—calibration program

Before using an external sensor, it must be specifically calibrated for your KT-9. Every external sensor is shipped with

- a diskette that contains specific calibration data for the particular sensor and a copy of the calibration program CALIB
- a calibration standard sample
- a serial port connector cable (Part no. 97945).

The calibration procedure is as follows:

1 Connect the supplied cable (Part no. 97945) to the KT-9 computer port located on the bottom panel (covering the battery compartment).

2 Connect the other end of the cable to the COM1: serial port of your computer. Please note that the cable has a DB-9 connector. If your computer has a 25-pin port, you will either need a DB-9 to DB-25 adaptor or ask EXPLORANIUM for a special DB-25 version of the connector cable.

3 Run the CALIB program on your computer. A typical session follows and is shown in Figure 15:

```
G:\XPLRANUM>calib

 *** CALIBRATION OF KAPPAMETER KT-9 ***

 PRINT RESULTS - 'Y'-Yes, 'N'-No N

 OPERATOR:      John Smith

 kappa OF STANDARD [E-3 SI units]  1.00
      APPARENT kappa OF STANDARD   1.00

 CONNECT KT-9 TO COM1 OF PC-COMPUTER
 SWITCH  KT-9 ON
 SELECT MEASURING MODE FOR CALIBRATION - press ENTER

 SERIAL NUMBER: 4510

 TYPE COMMAND: 'G' -> Get old calibration from KT-9
               'M' -> Measurement of standard
               'S' -> Save new calibration in KT-9
               'N' -> New standard for calibration
               'E' -> Exit program & DISABLE COM1 output ?
```

Figure 15 Sample calibration session using CALIB

a) You will be prompted if you want the results of the session printed or not. You must enter either a ⊡ for yes or a ⊡ for no.

b) You will now be prompted for specific information that you must enter before calibration can proceed:

    i The name of the operator.

    ii The *kappa* value of the standard as supplied—it is on the data sheet with the standard.

    iii The *apparent* kappa value of the standard.

    iv The serial number of your KT-9—located on the tag on the back of the instrument

c) You will then be reminded to make sure that the KT-9 is connected to the computer and is turned on. You will then have to select a measuring mode (NO-PIN, PIN or EXTERNAL COIL) on the KT-9 for the calibration procedure.

d) Press the ⊡Enter⊡ key to continue when you are ready.

e) You will now be shown a menu from which to choose an action:

    i `'G' -> Get old calibration data from KT-9`

    Pressing ⊡G⊡ will retrieve the current calibration value in the KT-9 and re-display the menu.

    ii `'M' -> Measurement of standard`

    Pressing ⊡M⊡ will begin the calibration process.

    ⊡RL⊡ •A message:" `PRESS C/M ON KT-9` " will appear. You will have to press the RIGHT button on the KT-9 to get a free-space reading for the *zero* value. Please ensure that the external sensor is well away from any susceptible material.

    •Next, you will be asked to measure the standard with the prompt: " `MEASURE STANDARD` "

    •The resulting kappa and *new* calibration values will then be displayed, followed by the menu.

iii 'S' -> Save new calibration in KT-9

Pressing ⓢ will save the newly established calibration value in the KT-9's memory for this particular external sensor.

---

i **NOTE**

When switching to a different external sensor, the calibration routine will have to be re-run every time.

---

iv 'N' -> Next KT-9 for calibration

This option allows you calibrate another KT-9.

v 'E' -> Exit program & DISABLE COM1 output

Pressing ⒠ will stop the program, close the communications link and return full manual control to the KT-9.

The particular external sensor is now calibrated and ready to use. This calibration remains in the KT-9's memory until a new calibration for a different sensor is performed. When you disconnect the external sensor, the KT-9 *automatically* switches back to it's internal sensor but remembers the external sensor's calibration for use when it is reconnected.

---

i **NOTE**

The KT-9 uses flash memory. Consequently, it will not lose the calibration value (or any data) when the batteries are removed.

KAPPA1—simple data transfer

This is a simple program that demonstrates how data is transferred from the KT-9 to the computer.

There is no remote control of the KT-9 from the computer in this program.

The data are displayed on the computer screen only and not stored.

SCAN7C—PC recording of data from a manually operated KT-9

This program allows you to digitally record the data on a PC from a manually operated KT-9. The KT-9 may be operated in either the PIN or NO-PIN modes.

SCAN7C has detailed on-screen instructions to guide you, starting from the connection of the KT-9 to the RS-232 port all the way through to the opening and closing of the data files. A brief overview of the process is as follows.

1 Connect the supplied cable (Part no. 97945) to the KT-9 computer port located on the bottom panel (covering the battery compartment).

2 Connect the other end of the cable to the COM1: serial port of your computer. Please note that the cable has a DB-9 connector. If your computer has a 25-pin port, you will either need a DB-9 to DB-25 adaptor or ask EXPLORANIUM for a special DB-25 version of the connector cable.

3 Run the SCAN7C program on your computer.

4 The display prompts ask you to:

- power the KT-9 on
- use any mode of operation
- ensure that any data in memory is erased (see "Clearing the memory" on page 37)

5 Press the ⏎Enter key to continue when you are ready.

6 You will be prompted to provide a filename where the collected data will be stored:

    Enter the name of file...

7 You will then be prompted to take a measurement with the KT-9 (see "Taking measurements" on page 19).

8 Press the F10 key to exit the program.

9 Press the C key on the computer. This opens a memory buffer in the PC.

    DISPLAY OF KT-9 MUST BE 'C   0'
    PRESS 'R' ON PC TO START SCAN MODE >>

You now have 10 seconds to begin the scan, otherwise the computer will time out and display:

    End of 10 sec TIMEOUT

You will then be presented with the clear prompt and have to start again:

    Press "C" ON PC TO CLEAR >>

10 Place the sensor against the object to be scanned.

11 To begin scanning, press the R key. The KT-9 should now be beeping and the data is displayed on the PC screen as it is being stored in memory.

12 To stop recording, press the C key.

13 Your data will be stored as ASCII text in the filename that you specified in step 6.

SCAN7—remote control & data storage

The SCAN7 program allows you to collect a continuous stream of data from either core samples or rock faces for later analysis. This program puts the KT-9 into the SCAN mode, transfers the measured data to the computer and stores the data into a file. The KT-9 is completely controlled from the computer in this configuration. You can also annotate individual profiles or data segments before they are stored in the data file.

The procedure for running the scanning program is as follows:

1 Connect the supplied cable (Part no. 97945) to the KT-9 computer port located on the bottom panel (covering the battery compartment).

2 Connect the other end of the cable to the COM1: serial port of your computer. Please note that the cable has a DB-9 connector. If your computer has a 25-pin ports you will either need a DB-9 to DB-25 adaptor or ask EXPLORANIUM for a special DB-25 version of the connector cable.

3 Turn on the KT-9.

4 Select either the NO-PIN (n P) or CORE (C o r) measuring modes.

5 Erase all old data in the KT-9's memory.

6 Run the SCAN7 program on your computer.

A typical session follows and is shown in Figure 16:

```
G:\XPLRANUM>scan7

 *** SCAN MODE OF KAPPAMETER KT-9 ***

 CONNECT KT-9 TO COM1 OF PC-COMPUTER
 SWITCH  KT-9 ON
 SELECT MEASURING MODE 'nP' OR 'Cor'
 ERASE ALL DATA FROM MEMORY OF KT-9 - press ENTER on PC

 *** KT-9 READY ***

 Enter name of file DEV:FILENAME.EXT  mydata.dat
 File mydata.dat opened for input

 Enter HEADER of measurement  FIRST Measurement
```

Figure 16 Sample session using SCAN7

a) You will be reminded to connect the KT-9 to the computer, turn on the KT-9, select either the NO-PIN or CORE measuring modes and to erase all old data from the KT-9's memory.

b) When you are ready to proceed, press the ⌨Enter key on the computer.

c) You should then see: `*** KT-9 READY ***`

This messages indicates that the computer is properly talking to the KT-9 and there are no problems.

d) You will now be asked where you want to store the data that the KT-9 will be sending:

`Enter name of file DEV:FILENAME.EXT`

e) Enter a proper DOS filename with the full path, for example: `D:\KT9DATA\SAMPLE1.DAT`, and press ⌨Enter.

Remember that DOS only accepts a filename consisting of 8 characters and 3 extent characters. Also, if no drive or directory is specified, then the current drive and directory that you were in (when you started the SCAN7 program) will contain your data file.

f) You should then see:

`File sample1.dat opened for input`

This message indicates that the file has been properly opened and you can proceed.

> **TIP**
>
> The output file is in ASCII format to allow you to import the data into a variety of programs for plotting, analysis, etc.

g) You will now be asked to enter some identifying information in the file header:

`Enter HEADER of measurement`

Enter up to 20 characters identifying the file, e.g. a date, location, drill-hole, core box number, etc.), and press Enter.

h) You should then see:

`Press "C" ON PC TO CLEAR >>`

This indicates that the program is ready to start the measurement process. For the process to begin, the KT-9 needs to get a zero reading of free space. Therefore, please make sure that the sensor is at least 30 cm away from any magnetically susceptible material at this point.

This action will also clear the data buffers.

i) Press the c key while holding the sensor at least 30cm away from any magnetically susceptible material.

> **CAUTION**
>
> If the sensor is closer than 30 cm to a magnetically susceptible body when you zero (measure free space), you may contaminate all the readings in the subsequent scan.

j) You should then see:

```
DISPLAY OF KT-9 MUST BE 'C   0'
PRESS 'R' ON PC TO START SCAN MODE >>
```

You now have 10 seconds to begin the scan, otherwise the computer will time out and display:

```
End of 10 sec TIMEOUT
```

You will then be presented with the clear prompt and have to start again:

```
Press "C" ON PC TO CLEAR >>
```

```
G:\XPLRANUM>scan7

 *** SCAN MODE OF KAPPAMETER KT-9 ***

 CONNECT KT-9 TO COM1 OF PC-COMPUTER
 SWITCH  KT-9 ON
 SELECT MEASURING MODE 'nP' OR 'Cor'
 ERASE ALL DATA FROM MEMORY OF KT-9 - press ENTER on PC

 *** KT-9 READY ***

 Enter name of file DEV:FILENAME.EXT  mydata.dat
 File mydata.dat opened for input

 Enter HEADER of measurement  FIRST Measurement

 PRESS 'C' ON PC TO CLEAR >> C

 DISPLAY OF KT-9 MUST BE 'C   0'
 PRESS 'R' ON PC TO START SCAN MODE >>
 End of 10 sec TIMEOUT

 PRESS 'C' ON PC TO CLEAR >>
```

Figure 17 SCAN7 showing a time-out after a free-space measurement

k) Place the sensor against the object to be scanned.

l) Press the ⌨R key to begin scanning.

m) If everything is OK, the KT-9 should be beeping with the display showing:

n) As you scan along your sample, the PC display will be showing each reading as it comes in:

```
*** SCAN MODE ***
PRESS 'C' ON PC TO  S T O P

kappa =  -0.57 [E-3 SI units]
kappa =  -0.37 [E-3 SI units]
kappa =  -0.40 [E-3 SI units]
kappa =  -0.50 [E-3 SI units]
kappa =   0.10 [E-3 SI units]
kappa =  48.18 [E-3 SI units]
kappa =  15.41 [E-3 SI units]
kappa =  44.72 [E-3 SI units]
kappa =  13.74 [E-3 SI units]
kappa =  10.50 [E-3 SI units]
kappa = 214.00 [E-3 SI units]
kappa =  68.14 [E-3 SI units]
kappa =  90.90 [E-3 SI units]
kappa =  50.14 [E-3 SI units]
kappa =  -0.37 [E-3 SI units]
kappa =  18.13 [E-3 SI units]
kappa =  35.69 [E-3 SI units]
kappa =  76.62 [E-3 SI units]
kappa = 135.55 [E-3 SI units]
kappa =  66.51 [E-3 SI units]
kappa =  -0.37 [E-3 SI units]
```

Figure 18 SCAN7 showing the sample measurements

o) Press the c key at anytime to stop data acquisition:

You will now see:

```
PRESS 'C' TO CONTINUE
PRESS 'E' TO EXIT PROGRAM
```

```
kappa =   0.17 [E-3 SI units]
kappa =   0.19 [E-3 SI units]
kappa =   0.64 [E-3 SI units]
kappa =   0.93 [E-3 SI units]
kappa =   0.02 [E-3 SI units]
kappa =   0.21 [E-3 SI units]
kappa =   3.72 [E-3 SI units]
kappa =   0.34 [E-3 SI units]
kappa =  -0.65 [E-3 SI units]
kappa =  36.33 [E-3 SI units]
kappa =  21.43 [E-3 SI units]
kappa =   4.09 [E-3 SI units]
kappa =   1.28 [E-3 SI units]
kappa =   3.89 [E-3 SI units]
kappa =   2.93 [E-3 SI units]
kappa =   2.56 [E-3 SI units]
kappa =   2.84 [E-3 SI units]
kappa =   6.16 [E-3 SI units]
kappa =   4.73 [E-3 SI units]
kappa =   6.46 [E-3 SI units]
kappa =   0.38 [E-3 SI units]
kappa =   0.90 [E-3 SI units]

PRESS 'C' TO CONTINUE
PRESS 'E' TO EXIT PROGRAM >>
```

Figure 19 SCAN7 after data acquisition stopped

p) Pressing the ⃞C key allows you to enter a new header and continue scanning more data into the same file, starting from Step **g)** on page 61.

You can keep adding as many sub-sections to your file as you like. Each will be separated by the header.

An example where this may be use is when you change to the next core box in the hole you are scanning.

q) Pressing the ⃞E key stops the program, closes the data file on the computer and returns control to the KT-9.

STICK — scan control from STICK device

This program is similar to SCAN7, except that the start and stop measuring commands are controlled by the trigger button on the STICK device. You can also specify a speed at which you will be moving the stick in order to provide distance/length data along with the susceptibility data. This does require reasonably steady and constant movement of the sensor on your part, in order to minimize positional error.
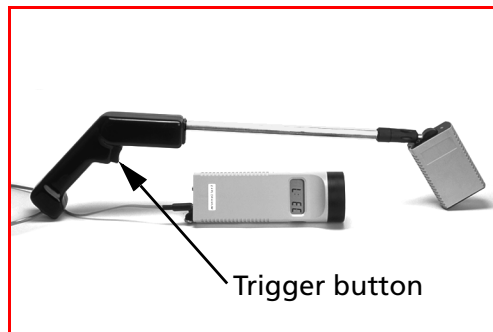
Trigger button

Figure 20 STICK and trigger button.

The procedure for running the STICK program is as follows:

1 Connect the supplied cable (Part no. 97945) to the KT-9 computer port located on the bottom panel (covering the battery compartment).

2 Connect the other end of the cable to the COM1: serial port of your computer. Please note that the cable has a DB-9 connector. If your computer has the older 25-pin ports you will either need a DB-9 to DB-25 adaptor or ask EXPLO-RANIUM for a special DB-25 version of the connector cable.

3 Turn on the KT-9.

4 Select either the NO-PIN (n P) or CORE (C o r) measuring modes.

5 Erase all old data in the KT-9's memory.

6 Run the STICK program on your computer. A typical session follows and is shown in Figure 21:

```
G:\XPLRANUM>scan7

 *** SCAN MODE OF KAPPAMETER KT-9 ***

CONNECT KT-9 TO COM1 OF PC-COMPUTER
SWITCH  KT-9 ON
SELECT MEASURING MODE 'nP' OR 'Cor'
ERASE ALL DATA FROM MEMORY OF KT-9 - press ENTER on PC

 *** KT-9 READY ***

 Enter name of file DEV:FILENAME.EXT  mydata.dat
 File mydata.dat opened for input

 Enter HEADER of measurement  FIRST Measurement
```

Figure 21 Sample session using the STICK program

a) You will be reminded to connect the KT-9 to the computer, turn on the KT-9, select either the NO-PIN or CORE

measuring modes and to erase all old data from the KT-9's memory.

b) When you are ready to proceed, press the `Enter` key on the computer or *click* (quickly press and release) the trigger button on the stick.

c) You should then see: `*** KT-9 READY ***`

This messages indicates that the computer is properly talking to the KT-9 and there are no problems.

d) You will now be asked where you want to store the data that the KT-9 will be sending:

`Enter name of file DEV:FILENAME.EXT`

e) Enter a proper DOS filename with the full path, for example: `D:\KT9DATA\SAMPLE1.DAT`, and press `Enter`.

Remember that DOS only accepts a filename consisting of 8 characters and 3 extent characters. Also, if no drive or directory is specified, then the current drive and directory that you were in (when you started the SCAN7 program) will contain your data file.

f) You should then see: `File sample1.dat opened for input`

This message indicates that the file has been properly opened and you can proceed.

i

NOTE

The output file is in ASCII format to allow you to import the data into a variety of programs for plotting, analysis, etc.

g) You will now be asked to enter some identifying information in the file header:

`Enter HEADER of measurement`

Enter up to 20 characters identifying the file, e.g. a date, location, drill-hole, core box number, etc.), and press `Enter`.

h) You should then see:

```
Press TRIGGER ON STICK TO CLEAR >>
```

This indicates that the program is ready to start the measurement process. For the process to begin, the KT-9 needs to get a zero reading of free space. Therefore, please make sure that the sensor is at least 30 cm away from any magnetically susceptible material at this point.

This action will also clear the data buffers.

i) Click the trigger on the stick, while holding the sensor at least 30cm away from any magnetically susceptible material.

CAUTION

If the sensor is closer than 30 cm to a magnetically susceptible body when you zero (measure free space), you may contaminate all the readings in the subsequent scan.

j) You should then see:

```
DISPLAY OF KT-9 MUST BE 'C   0'
PRESS and HOLD TRIGGER ON STICK TO START SCAN MODE >>
```

You now have 10 seconds to begin the scan. If you do not start within this time, the computer will time out and display:

```
End of 10 sec TIMEOUT
```

You will then be presented with the clear prompt and have to start again:

```
Press TRIGGER ON STICK TO CLEAR >>
```

```
G:\XPLRANUM>scan7

 *** SCAN MODE OF KAPPAMETER KT-9 ***

 CONNECT KT-9 TO COM1 OF PC-COMPUTER
 SWITCH   KT-9 ON
 SELECT MEASURING MODE 'nP' OR 'Cor'
 ERASE ALL DATA FROM MEMORY OF KT-9 - press ENTER on PC

 *** KT-9 READY ***

 Enter name of file DEV:FILENAME.EXT  mydata.dat
 File mydata.dat opened for input

 Enter HEADER of measurement  FIRST Measurement

 PRESS 'C' ON PC TO CLEAR >> C

 DISPLAY OF KT-9 MUST BE 'C   0'
 PRESS 'R' ON PC TO START SCAN MODE >>
 End of 10 sec TIMEOUT

 PRESS 'C' ON PC TO CLEAR >>
```

Figure 22 STICK program showing a time-out after a free-space measurement

    k) Place the sensor firmly at the beginning of the core or profile to be scanned.

    l) Press and *hold* the trigger on the STICK to begin scanning.

    m) If everything is OK, the KT-9 should be beeping with the display showing:

$$5:000$$

Start moving the sensor along the core or profile. The PC display will be showing each reading as it comes in:

```
*** SCAN MODE ***
PRESS 'C' ON PC TO  S T O P

kappa =   -0.57 [E-3 SI units]
kappa =   -0.37 [E-3 SI units]
kappa =   -0.40 [E-3 SI units]
kappa =   -0.50 [E-3 SI units]
kappa =    0.10 [E-3 SI units]
kappa =   48.18 [E-3 SI units]
kappa =   15.41 [E-3 SI units]
kappa =   44.72 [E-3 SI units]
kappa =   13.74 [E-3 SI units]
kappa =   10.50 [E-3 SI units]
kappa =  214.00 [E-3 SI units]
kappa =   68.14 [E-3 SI units]
kappa =   90.90 [E-3 SI units]
kappa =   50.14 [E-3 SI units]
kappa =   -0.37 [E-3 SI units]
kappa =   18.13 [E-3 SI units]
kappa =   35.69 [E-3 SI units]
kappa =   76.62 [E-3 SI units]
kappa =  135.55 [E-3 SI units]
kappa =   66.51 [E-3 SI units]
kappa =   -0.37 [E-3 SI units]
```

Figure 23 SCAN7 showing the sample measurements

n) To stop data acquisition, *release* the trigger.

You will now see:

```
PRESS 'C' TO CONTINUE
PRESS 'E' TO EXIT PROGRAM
```

```
kappa =    0.17 [E-3 SI units]
kappa =    0.19 [E-3 SI units]
kappa =    0.64 [E-3 SI units]
kappa =    0.93 [E-3 SI units]
kappa =    0.02 [E-3 SI units]
kappa =    0.21 [E-3 SI units]
kappa =    3.72 [E-3 SI units]
kappa =    0.34 [E-3 SI units]
kappa =   -0.65 [E-3 SI units]
kappa =   36.33 [E-3 SI units]
kappa =   21.43 [E-3 SI units]
kappa =    4.09 [E-3 SI units]
kappa =    1.28 [E-3 SI units]
kappa =    3.89 [E-3 SI units]
kappa =    2.93 [E-3 SI units]
kappa =    2.56 [E-3 SI units]
kappa =    2.84 [E-3 SI units]
kappa =    6.16 [E-3 SI units]
kappa =    4.73 [E-3 SI units]
kappa =    6.46 [E-3 SI units]
kappa =    0.38 [E-3 SI units]
kappa =    0.90 [E-3 SI units]

PRESS 'C' TO CONTINUE
PRESS 'E' TO EXIT PROGRAM >>
```

Figure 24 SCAN7 after data acquisition stopped

o) Pressing the ⒸＣ key or clicking the trigger allows you to enter a new header and continue scanning more data into the same file, starting from Step **g)** on page 66.

You can keep adding as many sub-sections to your file as you like. Each will be separated by the header.

An example where this may be use is when you change to the next core box in the hole you are scanning.

p) Pressing the ⒺＥ key stops the program, closes the data file on the computer and returns control to the KT-9.

Appendix A

Technical Notes

KT-5 vs. KT-9 operational differences

In 1994 Exploranium released the KT-9 Susceptibility Meter. The KT-9 is a major advance over the already sensitive and accurate KT-5 unit, as it offers many new features. However, field experience has shown that some users, already familiar with the KT-5, experience difficulties in correctly using the KT-9. Some of the major differences are briefly explained in this section.

Zero level

KT-5	KT-9
The current ZERO level is measured *BEFORE* the sample is measured.	For ease of operation, the ZERO level is automatically computed *AFTER* the sample is measured.

Measurement procedures

	KT-5	KT-9
1.	Push the C/M button in free air to zero the KT-5.	*Assumes RIGHT button operation in the NO-PIN mode for a direct comparison with the KT-5.(See also page 25)* Zero the KT-9 in free air by pressing the RIGHT button. The display should show $C:0$ (or $1, 2... 10$, if data is in memory)
2.	Place the head of the instrument against the sample.	
3.	Push the C/M button once more to make the measurement.	Push the RIGHT button (the KT-9 should beep). NOTE: Do not wait more than 10 seconds after zeroing before taking the reading or else you will have to re-zero.
4.	**Leave the KT-5 head against the sample until the result is displayed.**	**Immediately remove the KT-9 away from the sample after the beep.** *The maximum recommended time of the head against the sample is two seconds (the measurement may be incorrect if held longer). After a bit of practise, this half- to two second dwell time becomes very natural and you get quickly accustomed to it.* The correct reading will be displayed after the second beep.
5.	To make a new measurement, repeat steps 1-4.	

Data accuracy

KT-5	KT-9
	Use the NO-PIN mode to obtain the highest sample data accuracy ("PIN vs. NO-PIN modes — comments" on page 74).

Susceptibility

KT-5	KT-9
The KT-5 was designed to measure the APPARENT susceptibility. At low susceptibility values, the differences between APPARENT and TRUE are relatively low. Above values of 100 x 10^{-3} SI units, you must correct the readings to TRUE. The correction data and procedure is shown in Figure 15 on page 13 of the KT-5 manual.	The KT-9 automatically computes the TRUE susceptibility.

PIN VS. NO-PIN modes — comments

The KT-9 permits the use of the NO-PIN mode (same as the older KT-5 unit) or the newly developed PIN mode. Feedback from users in the field indicates that many do not clearly understand the benefits of using the PIN mode and revert back to the NO-PIN mode under the false impression that it gives better quality data. The following information shows the very significant benefits of using the PIN mode.

Data Accuracy

On a flat rock

PIN Mode	NO-PIN Mode
Some errors can occur due to the possibility of variable pressure of the pin against the sample. This causes slight compression of the rubber cover, which slightly changes the coil-to-sample spacing. This in turn affects the result. Another source of error comes when the KT-9 is slightly tilted with respect to the surface being measured. this places a portion of the coil closer to the sample and affects the reading.	There is no rubber to compress and it is easier to hold the unit perpendicular to the sample surface. Consequently, any errors due to misalignment and positioning are minimal.
The absolute accuracy is estimated to be ±3%.	The accuracy is estimated to be ±1%.

In the field

In most field conditions, rock samples being measured have uneven surfaces. In this case, the PIN mode has distinct advantages.

PIN Mode	NO-PIN Mode
Uneven surfaces	
Field experience has shown that effects due to surface unevenness is minimized in the PIN mode.	With the sensor being in direct contact to the surface, a correction factor must be applied to the readings.
By taking a series of measure-ments (5 minimum) over vari-ous portions of the rock sample, and using the KT-9's averaging ability, the truest value of the samples suscepti-bility is obtained. This is due to the pin sometimes being placed on a peak or valley of the surface.	The correction factor is based upon the *maximum* elevation difference of the peaks and valleys of the sample surface in the area being measured. Some correction factors are: 1 mm = 1.07 5 mm = 1.41 10 mm = 1.96 The reading must always be *multiplied* by the correction factor, as the error always results in too low of a reading.

Weathering

In most cases the outer thin layer of the rock is oxidized (weathered) and the susceptibility value from this thin layer is *not representative* of the actual sample.

The KT-9 has an air-cored coil and 80% of the measured signal arises from a 20mm layer below the face of the coil.

PIN Mode	NO-PIN Mode
The pin spaces the coil away from the weathered surface and minimizes the effect of the weathered layer on the susceptibility measurement.	The largest influence is directly at the face of the coil and system *sensitivity* falls off away from the coil face.

Estimated Accuracy

For the reasons cited, which are common field problems, the *actual* KT-9 data accuracy is estimated to be:

PIN Mode	NO-PIN Mode
Typically ±10% of the actual laboratory measured value.	Up to ±100% of the actual laboratory measured value for a 10 mm unevenness of the sample.

Recommendations

PIN Mode	NO-PIN Mode
Use this mode for all measurements where an uneven surface and weathering are present — effectively all field samples.	Use this mode for all drillcore measurements, cut or polished rock samples or for relatively smooth rock faces (if weathering is not a problem).

CAUTION

When you have removed the pin from the KT-9 for the NO-PIN mode, the supplied plastic screw MUST be installed. This will prevent moisture from leaking into the unit and causing damage.

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