METROLAB Instruments SA

THM 7025

3-AXIS HALL MAGNETOMETER

User's Manual

Version 2.01

(Revision 1.4)

September 1997

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Conventions

This manual uses the following conventions:

<HOLD> : name of a keyboard button.

[ENQ] : a RS 232c command.

"BAT" : an indication in the display.

'1' : a parameter or option.

200 : a string of characters returned by the THM 7025.

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1.   GENERAL DESCRIPTION

The METRO*LAB* 3-axis Hall Teslameter "THM 7025" is an instrument using HALL elements to measure magnetic fields. The main feature of the THM 7025 is the simultaneous measurement of the 3 axis, X, Y, Z, which are set at 90° angle, allowing a direct measurement of the magnetic field intensity, **without a particular orientation of the sensor (isotropic).**

The THM 7025 calculates and displays the modulus of the magnetic field as per the equation :

$$B = \sqrt{Bx^2 + By^2 + Bz^2}$$

The magnetic field value is displayed in (mT) on a 3½ digits Liquid Crystal Display.

The THM 7025 and its probe provide a portable magnetic field measuring system. The keyboard gives the operator complete control over the different measurement modes as well as over the zeroing of the probe.

All the functions of the THM 7025 (controls and measurements) can be accessible to a computer (supplied by the user) via a RS 232c serial interface.

Figure 1 : The THM 7025
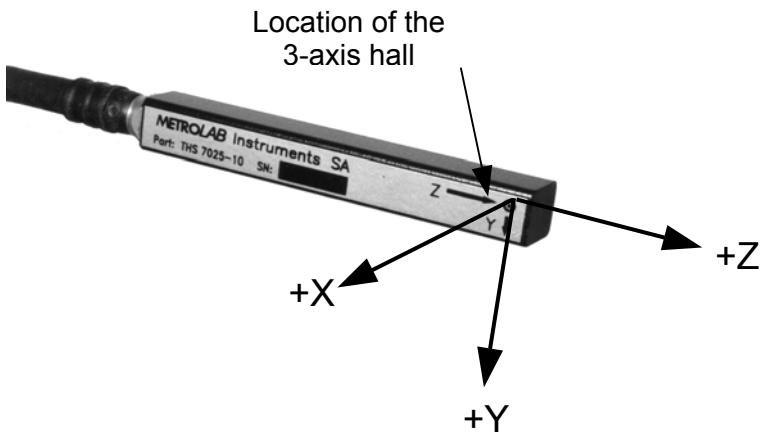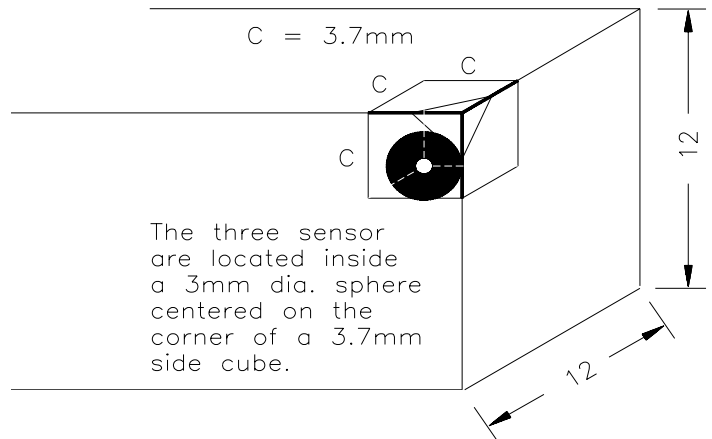

Figure 2 : The 3 axis sensor and the axis direction

C = 3.7mm

The three sensor are located inside a 3mm dia. sphere centered on the corner of a 3.7mm side cube.

Figure 3 : Hall sensor position

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2.   SPECIFICATIONS

Ranges:	19.99 mT, 199.9 mT, 1999 mT "DC" full scale ranges. Automatic or manual ranging.
Resolution:	0.01 mT, 0.1mT, 1mT.
Accuracy:	±2 % of reading or ±3 digits.
Temperature coefficient of the gain:	±0.05% / °C (from 25°C).
Display:	3 ½ Digits LCD, mTesla units.
Update rate:	0.4 sec or hold.
Measurement mode:	3-axis or one axis, i.e. Bz (or Bx, By).
Operating - temperature:	0°C to +40°C.
- magnetic field:	Main unit only: 0.1T (1.5T when battery is removed).
Storage temperature:	-20°C to +60°C.
Size - main unit:	160 x 80 x 30 mm.
- sensor:	12 x 12 x 100 mm.
Weight:	250 g.
Interface:	RS 232c.
Battery:	9 Volt, type SLM9V, Lithium, 22h duration (display reads "BAT" when battery is low). If connected with RS 232c to computer, duration of battery is much less.

A THM 7025 system is supplied in its own hard-side plastic carry case, with one piece of each following item:

- Hand held instrument.
- 3-axis sensor (model THS7025-10) with its 1.5 meters shielded cable.
- 9 Volt Lithium battery.
- 110V or 220V plug-in power supply (model HPS7025-10).
- Zero field chamber (model ZFC7025-16).
- 3 meters serial interface cable with Sub-D 9 poles IBM-PC type connector (model SC7025-13).
- User's manual.

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3.   SAFETY

The THM 7025 can measure magnetic field up to 2 Tesla.

We strongly **WARN and URGE** the user to take into consideration the **effects** of such strong magnetic fields.

The THM 7025 unit is powered by a 9 Volt battery which is partly made out of iron. Meaning that strong mechanical forces are applied to the battery and therefore to the THM 7025 unit.

The main unit, WITH THE BATTERY INSIDE, should not be exposed to magnetic field stronger than <u>0.1 Tesla</u>.

<u>By neglecting this warning, the THM 7025 might be pulled away from the hands'user.</u>

EVEN WHEN BATTERY IS REMOVED, the main unit should not be exposed to magnetic fields stronger than <u>1.5 Tesla</u>.

The operation and the accuracy of the THM 7025 cannot be guaranteed as long as it remains in the magnetic field. Without excluding that permanent damage can occur to the instrument.

When battery is removed and the plug-in power supply is being used, be aware of the similar danger, since the transformer of the power supply contains a mass of iron. Therefore the plug-in power supply should never by exposed to magnetic field stronger than 0.1 Tesla.

METROLAB Instrument SA cannot be hold responsible for any accident occurred by the misuse of the THM 7025 or by none-respect of the present warning.

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4. PRINCIPLE OF OPERATIONS

4.1. Operating procedure

- Slide the battery door at the back of the unit. Install the 9V battery and replace the battery door.

- Plug the sensor into the connector at the top of the unit.

- Turn on the THM 7025 by pressing the ON/OFF switch for at least 1 sec.

The THM 7025 is being manually operated by 5 switches.
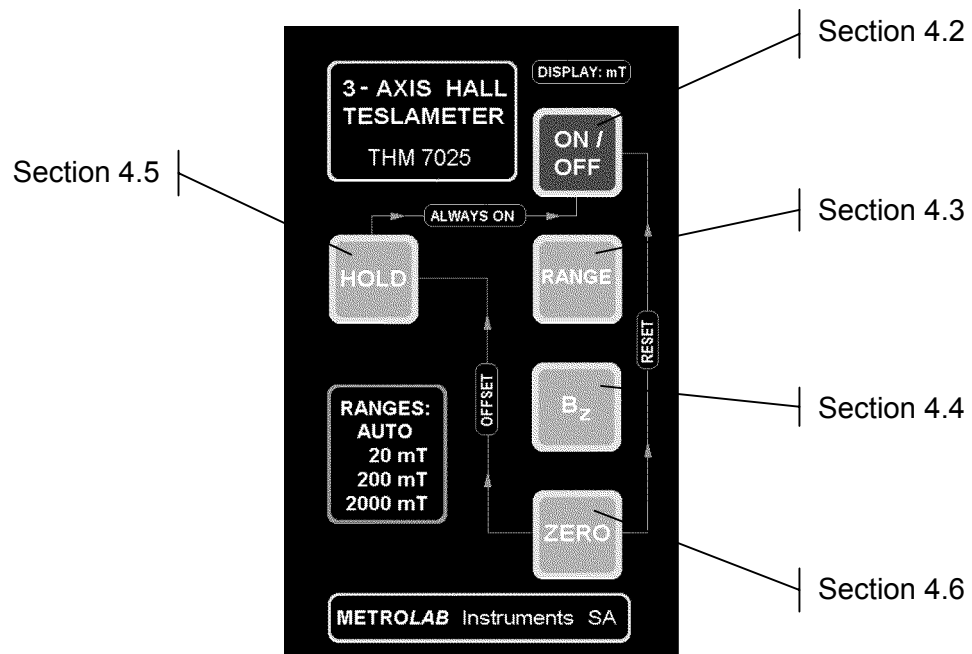
Figure 4 : keyboard view

4.2. ON/OFF

On and Off switch.

Press once for at least 1 sec :   instrument is On.
Press again :   instrument is Off.

If the <ON/OFF> switch of the THM 7025 is not being used or if no RS 232c command is sent, the THM 7025 switches off automatically after ~ 3 minutes.

To disable the automatic switch Off, press the button <HOLD>, hold it and then press <ON/OFF>. The display shows "On" for about 0.4s to indicate that the instruments is now On until you turn it Off by using the <ON/OFF> button.

This function is recalled on the keyboard by [ALWAYS ON]

The [OFF] command can cancel or enable the automatic switch Off.(See section 5.11, page 18.)

Also, when the battery is too low, the display indicates "BAT" and a few minutes later, the THM 7025 switches Off by itself.

4.3.   RANGE

The values of measurement are displayed in three ranges :

1. 19.99 mT
2. 199.9 mT
3. 1999 mT.

When the THM 7025 is switched On, it is set on autoranging mode and it displays the measurement in the most appropriate range. By pressing <RANGE>, it switches from Autoranging to 1999, by second pressing to 199.9, by third pressing to 19.99 and then switches back to autoranging mode. Before displaying the value of the magnetic field, the THM 7025 displays the selected range for a **half second**. Refer to the following chart:

Pressure on <RANGE>	Range of measurement	Range indication in the display
When switched On	*Autoranging*	
1st	*up to 1999*	**0**
2nd	*up to 199.9*	**0.0**
3rd	*up to 19.99*	**0.00**
4th	*Autoranging*	**Aut.**
. . .		

4.4.   Bz (B on Z axis)

The <Bz> button toggles between 3 and single axis measurements. To distinguish between these two modes, the sign "**+**" or "**-**" is displayed with the magnetic field value in single axis mode. Otherwise no sign is displayed.

By default, the chosen axis is '**Z**'. The access to another axis is possible via the RS 232c command [BZA] (see section 5.7, page 15).

When switched On :	3 Axis measurement
Press once :	measurement of a single axis (Z) (display of "+" or "-")
Press again :	comes back to 3 Axis measurement

4.5. <u>**HOLD**</u>

As long as the button <HOLD> is pressed down, **the display of the measured value is held.** The sign " ▲ " comes in the display. By releasing <HOLD>, the THM 7025 continues its measurement and gives new values.
This is the **normal** operation of the button.

When switched On :	running mode
Press :	displayed value is held (display of " ▲ ")
Release:	running mode

If user prefers to handle the button <HOLD> in the toggle way, he can do so via an RS 232c interface Command (see section 5.4, page 14).
This is the **toggle** operation of the button.
Button <HOLD> will be used as follows :

Press :	displayed value is held (display of " ▲ ")
Release:	displayed value is still held (display of " ▲ ")
Press :	go back to running mode
Release	still in running mode

<u>Note:</u>   when pressing the button <HOLD>, holding it and then pressing <ON/OFF>, the automatic switch Off will be disabled (see section 4.2, page 9).

4.6. <u>**ZERO**</u>

This button supplies **three functions** : Clearing of an error, User's Offset and System Offset.

A) While using the THM 7025 an error may occur. Display reads "Er.n", where 'n' indicates the error number (error description list is in section 5.15, page 18). The button <ZERO> clears the error and its indication.

   Press <ZERO> once :   clear the error

B) The offsets of the Hall sensors are calibrated at the factory. They are called System Offset.

   If the user of the THM 7025 needs to readjust the Offsets, he has to **place the probe in the zero field chamber**, then press button <ZERO>, hold it and press button <HOLD>. The Offsets is then measured and memorized. The new set of Offsets remains after switching off the THM 7025. Even if the THM 7025 is in single axis mode, the offset measurement is performed on the 3 axis.

   Press <ZERO>, hold it, press <HOLD> :   User's Offset

   The User's Offsets is recalled on the keyboard by ⌈ OFFSET ⌉

Warning: because the THM 7025 is an instrument measuring 3 axis, the User's Offset **cannot** be used to offset the display when the sensor is in a given magnetic field (i.e. relative measurements) otherwise the measurements will be dependent on the sensor orientation !

C) To restore the System Offset defined at the factory, the user will press <ZERO>, hold the button and press <ON/OFF>. This action resets the default parameters, including that the Z axis will be the default axis when pressing the <Bz> button.

Press <ZERO>, hold it, press <ON/OFF> :   System Offset

The System Offset is recalled on the keyboard by ⎡ RESET ⎤

5. INTERFACE RS 232c COMMANDS

5.1. INTRODUCTION

Ensure the instrument is Off before connecting the supplied RS 232c cable from the THM 7025 to the serial port of the computer.

Set the computer with the following RS 232c parameters :

9600 bauds, 8 bits, no parity, 1 stop bit, No XON/OFF.

The control of the THM 7025 through the serial interface is made with a set of commands. Every command consist of a string of ASCII characters using the following syntax: a root of 3 mnemonic characters then one or zero parameters, then the characters 'carriage-return' (ASCII 13) and 'Line-feed' (ASCII 10).
The root and the parameter are separated by a comma.

Note: the characters 'carriage-return' - 'line-feed' are **mandatory for any command**, as well as they are returned at the end of any string of characters sent by the THM 7025. However, to clarify the text, they have been omitted in the command description.

Some commands are 'read only' (ex: [ENQ]), or 'write only' (ex: [CLE]). The others are 'read and write' commands. They are used to set a parameter or an option. In 'write' mode these commands include the parameter (ex: [RNG,2]) and in 'read' mode these commands have no parameter (ex: [RNG]) and the present parameter value is returned by the THM 7025.

The set of commands is described in the following sections.

5.2. ENQ (ENQuire displayed value)

The [ENQ] Command returns the value of the magnetic field.

The returned string of characters corresponds to the display. This command will return the field value presently displayed. If the THM 7025 is overloaded, the [ENQ] Command will return: ***O.L.***
If the [ENQ] Command is sent when the THM 7025 is changing the range of measurement (display reads " ‾ ‾ ‾ "), the returned string of characters will be: ***!***

The [ENQ,n] Command gives the value of the magnetic field of the individual axis, where :

n = 1 for X Axis
n = 2 for Y Axis
n = 3 for Z Axis

Note: if the THM 7025 is in single axis mode, [ENQ] will return the magnetic field value of this axis only. Whereas [ENQ,n] will return 0 if 'n' refers to one of the none-selected axis.

5.3.   RNG (RaNGe)

The [RNG,n] Command modifies the ranges of measurement where :

    n = 1   or   20   sets 19.99 mT range
    n = 2   or   200   sets 199.9 mT range
    n = 3   or   2000   sets 1999. mT range
    n = 0   sets in autoranging mode.

The [RNG] Command returns the current status of range in a string of characters which has the following meaning :

    0   for the autoranging mode
    20   for the 19.99 mT range
    200   for the 199.9 mT range
    2000   for the 1999. mT range.

5.4.   HLD (HoLD)

The [HLD,n] Command holds or releases the display where :

    n = 1,   display is held
    n = 0,   display is running.

The [HLD] Command returns the current status of Hold mode.

The [HLD,n] Command alternates normal and toggle operation of the button, where :

    n = 2,   button <HOLD> is in toggle operation
    n = 3,   button <HOLD> is in normal operation.

(see section 4.5 at page 11 on how to use button <HOLD>).

Note : The selected operation, normal or toggle, is memorised. The chosen
        operation remains after switching off the THM 7025.

5.5.   MAP

The [MAP,n] Command sends to RS 232c the displayed value where :

    n = 1,   at each press of button <HOLD> the displayed value is sent to
              RS 232c
    n = 0,   release MAP function.

Note : Thanks to the RS 232c interface, the mapping of a field is very convenient.
        The THM 7025 is positioned where a measurement of the field has to be
        taken. When the user is pressing the button <HOLD>, the displayed value
        is sent to the computer, thus allowing easy acquisition of magnetic field
        values.

5.6.   STZ (Set To Zero)

The [STZ,n] Command deals with the sensor offsets, where:

n = 1,   measures and memorizes the User's Offset on the three axis.

This Command has the same result as by pressing down the buttons <ZERO> and <HOLD> (See section 4.6, page 11)

WARNING : to measure the User's Offset, the user has to place the probe in the zero field chamber which itself must be in a magnetic environment below 0.15 mT (1.5 Gauss or about ~3 time the Earth magnetic field strength).

n = 0,   reverts to System Offset.

This Command has the same result as by pressing down the buttons <ZERO> and <ON/OFF>. (See section 4.6, page 11)

The [STZ] Command returns *0* if THM 7025 is being used with System Offset or returns *1* if it is being used with User's Offset.

5.7.   BZA (B on single Axis)

This command allows the user to select any of the three single axis or the 3 axis mode.

The [BZA,n] Command sets the Axis mode where :

n = 1,   for the X axis
n = 2,   for the Y axis
n = 3,   for the Z axis
n = 0,   for the 3 axis mode.

Note: by pressing the <Bz> button, the display indicates the magnetic field measured with the last single axis selected by the [BZA] Command.

The [BZA] Command returns the current status of the axis mode.

5.8.   VER (firmware VERsion)

The [VER] Command returns the firmware version in the following string of characters.

METROLAB SA, THM 7025, Ver X.XX

5.9.   ST1 (STatus register 1)

The [ST1] Command returns the Status Register 1

The Status Register 1 is returned in a string of 8 ASCII characters *0* or *1* followed by 'CR' 'LF'; the **first** character received is the **most** significant bit (bit 7).

The [ST1,n] Command clears the bits of the Status Register 1

Where 'n' is a decimal value from 0 to 255 which allows to write zeroes in Status Register 1: i.e. '0' clears all bits of the Status Register 1; '255' doesn't clear any bits of the Status Register 1; '9' clears all bits except the bits 3 and 0 of the Status Register 1.

Meaning of the status register 1:

7	6	5	4	3	2	1	0
Reset or power on	0	0	EEPROM R/W Error	Battery low	Overload	Command or Com. Error	Data ready

Bit 7: reset or power on
This bit is set to 1 at power on or by a reset of the instrument using the [RST] Command.

Bit 6: always 0

Bit 5: always 0

Bit 4: EEPROM Read/Write error
This bit is set to 1 to indicate that there is an error in reading or writing parameters in the none-volatile memory (EEPROM). This is a fatal error which cannot be cleared. The instrument needs to be repaired.

Bit 3: Battery low
This bit is set to 1 to indicate that the battery level is too low and thus the battery needs to be changed. The display reads "BAT".

Bit 2: Overload
This bit is set to 1 to indicate that the range is overloaded. The display reads "O.L." . The user can select a higher range, if it is possible.

Bit 1: Command or communication error
This bit is set to 1 to indicate that the syntax of a command was wrong. The last command which gave the error is returned by the [ERR] Command.
This bit is also set in case of an error in the communication with the RS 232c interface.

Bit 0: Data ready
This bit is set to 1 to indicate that a value is available for reading. The update interval is about 0.4 sec.

5.10. ST2 (STatus register 2)

The [ST2] Command returns the Status Register 2.

The Status Register 2 is returned in a string of 8 ASCII characters *0* or *1* followed by 'CR' 'LF'; the **first** character is the **most** significant bit (bit 7). The bit of the Status Register 2 indicate the state of the instrument at the moment of the reading. They cannot be cleared by the user.

Meaning of the status register 2:

7	6	5	4	3	2	1	0
Reserved	0 or 1	Local LockOut	User's Offset is used	Hold	Single Axis	Range (h)	Range (l)

Bit 7: Reserved

Bit 6: 0 or 1
Can be 0 or 1. Information used at the factory only (test and diagnostic purposes).

Bit 5: Local LockOut
This bit is set to 1 when the keyboard is locked.
It is cleared to 0 when it is in operation.

Bit 4: User's Offset
This bit is set to 1 when the THM 7025 is used with the User's Offset.
It is cleared to 0 when it is used with the System Offset.

Bit 3: Hold
This bit is set to 1 when the display is held.
It is cleared to 0 when the display is running.

Bit 2: Single axis
This bit is set to 1 when the THM 7025 is used in single axis mode.
It is cleared to 0 when the 3 axis mode is activated.

Bits 1 and 0: Ranges
These bit indicate the range:

Bit 1	Bit 0	RANGE
0	0	not available *
0	1	20.00 mT
1	0	200.0 mT
1	1	2000. mT

* Combination of 0 and 0 cannot occur.

5.11.   OFF (auto OFF)

The [OFF,n] Command controls the automatic switch Off function:

n = 0,   mode auto-OFF is canceled. The THM 7025 is On until it is switched Off by using the button <ON/OFF> or the [OFF,2] Command. The display reads " On " for ~0.4 sec.

n = 1,   mode auto-OFF is enabled, meaning that the THM 7025 will be automatically switched Off by itself after 3 minutes when unused. The display reads " OFF " for ~0.4 sec.

n = 2,   the THM 7025 is switched Off !

5.12.   BAT (BATtery Level)

The [BAT] Command returns the current battery level in 1/10 of Volts.

Example : *92* indicates 9.2 V

5.13.   RST (ReSeT)

The [RST] Command resets the THM 7025.

The THM 7025 returns to the same status as when it has been switched On.

5.14.   LLO (Local LockOut)

The [LLO,n] Command blocks or releases the keyboard.

It presents a safety if the user does not want to loose the parameters which he has modified, by touching accidentally the keyboard of the unit.

n = 1,   the keyboard is locked
n = 0,   the keyboard is in operation.

5.15.   ERR (ERRor)

The [ERR] Command returns the first 3 digits of the last command which gave a syntax error.

The syntax error is indicated by bit 1 of status register 1.

5.16.   <u>CLE (CLear Error)</u>

<u>The [CLE] Command clears an eventual error.</u>

i.e. : when the display reads "Er.2" or "Er.3"

<u>Errors description:</u>

If a fault is detected, the Display or the returned string of characters of the [ENQ] command indicates "Er.n", where :

n = 1,   This is an error in reading or writing the parameters in the none-volatile memory (EEPROM).
                This is a fatal error which cannot be cleared and the instrument needs to be repaired.

n = 2,   This error arises when there is a fault in the RS 232c communication or the reading of the keyboard.
                This error can be cleared by either pressing button <ZERO> or by using the [CLE] Command.

n = 3,   This error occurs either during a User's Offset measurement, when the residual magnetic field is too high to be nulled.
                The error 3 can be cleared by either pressing button <ZERO> or by using the [CLE] Command.

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6.   APPENDIX A: THM 7025's display

This symbol is lit when the measurement is held.

The "±" sign is used only when the THM 7025 is in single axis mode.

The "BAT" symbol indicates that the battery must be replaced.
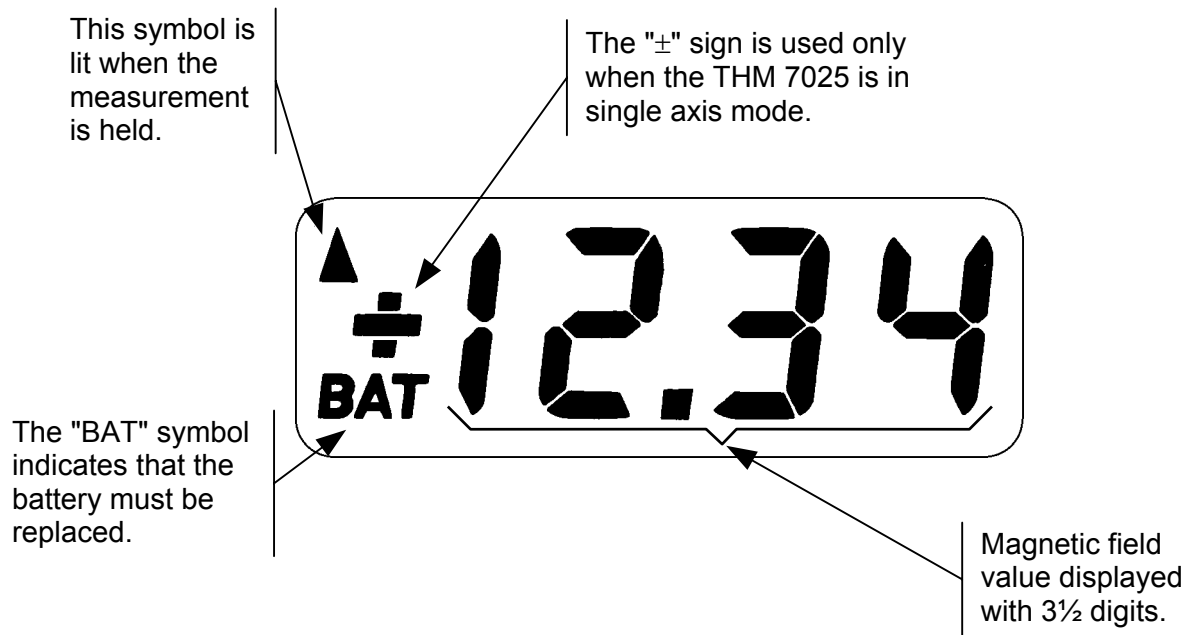
Magnetic field value displayed with 3½ digits.

Figure 5

Messages displayed:

A) Status messages **(They are displayed during half second)**:

This message indicates a restart of the measurement process. This happen when the THM 7025 is turned On, when it is reset or when the single/3 axis mode is changed.

This message is displayed when the automatic Off function is disabled.

This message is displayed when the automatic Off function is again enabled.

Autoranging is selected.

The range is moving to the higher range. (Taking ~0.4 sec.)

0	The range 1999 mT is selected.
0.0	The range 199.9 mT is selected.
0.00	The range 19.99 mT is selected.
.0.	The THM 7025 returns to the System Offset.
Au.0	The User's Offset is being measured and memorized.

<u>B) Error messages</u> **(They are displayed until the error condition is cleared)**:

O.L.	The range is overloaded, the user can select the higher range, if it is possible.
Er.1	This is an error in reading or writing the parameters in the none-volatile memory (EEPROM). **This is a fatal error which cannot be cleared and the instrument needs to be repaired.**
Er.2	This error arises when there is a fault in the RS 232 communication or the reading of the keyboard. It can be cleared by either pressing button <ZERO> or by using the command [CLE].
Er.3	This error occurs either during a User's Offset measurement, when the residual magnetic field is too high to be nulled, or during regular measurements, when the internal memory is saturated. However, the latter should never occur in normal operation. This error can be cleared by either pressing button <ZERO> or by using the [CLE] Command.

7. APPENDIX B: WARRANTY

METROLAB Instruments SA warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this warranty is limited to servicing or adjusting free of charge any THM 7025 system returned to our factory for that purpose. This warranty covers the THM 7025 and its accessories which, within one year after delivery to the original purchaser, shall be returned with transportation charges prepaid by the original purchaser, and which upon examination shall disclose to our satisfaction to be defective. If it is determined that the defect has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost after submitting an estimate to the purchaser.

METROLAB Instruments SA reserves the right to make changes in design at any time without incurring any obligations to install same changes on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of METROLAB Instruments SA, and METROLAB Instruments SA neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of the THM 7025.

DAMAGE IN SHIPMENT:

The instrument should be examined and tested as soon as it is received. If it does not operate properly, or is damaged in any way, immediately file a claim with the carrier. The claim agent will provide report forms. A copy of the completed form should be forwarded to us. We will then make necessary arrangements for repair or replacement.

8.   APPENDIX C: Summary of the RS 232c commands

Command	Description	Min/Max	Read/Write	Pages
ENQ	Measured value in mT	---	R	13
ENQ,n	Measured value in mT on a single axis	1/3	R	13
RNG	Select the measurement range	0/3;20-200-2000	R/W	14
BZA	Select the single / 3 axis mode	0/3	R/W	15
HLD	Hold the measurement	0/1	R/W	14
STZ	Set to zero (User's Offset; System Offset)	0/1	R/W	15
OFF	Disable / Enable the auto-Off	0/2	R/W	18
ST1	Status Register 1	0/255	R/W	15
ST2	Status Register 2	---	R	17
ERR	Returns the command which gave the last syntax error	---	R	18
VER	Returns the THM 7025 firmware version	---	R	15
RST	Reset the THM 7025	---	W	18
CLE	Clear an error condition	---	W	18
LLO	Lock / Unlock the THM 7025 keyboard	0/1	R/W	18
BAT	Returns the battery level in 1/10 Volt	---	R	18

Status Register	bit 7	6	5	4	3	2	1	0
	hex 80	40	20	10	8	4	2	1
1	Reset or power on	0	0	EEPROM R/W Error	Battery low	Overload	Command or Comm. Error	Data ready
2	Reserved	0	Local LockOut	User Offset is used	Hold	Single Axis	Range (h)	Range (l)