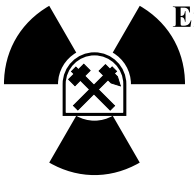

Environmental Instruments Canada Inc.

TM372B Sample Counter User's Manual

Contents

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Chapter 1

Overview of Device

1.1 Introduction

The TM372B is an ALPHA counter equipped with a foil type open zinc sulphide detector. This type of detector is inexpensive, readily obtainable and is easily replaced. The instrument uses a photomultiplier tube to count the number of scintillations from the alpha particles that strike the zinc sulphide.

A sample tray opens near the bottom of the instrument into which a sample holder may be placed. The sample holders can accommodate membrane filter samples of 25mm, 37mm, or 47mm diameter.

The following sections describe the device itself as well as the procedures required to determine detector efficiency and measure the activity of a sample.

1.2 Specifications

ALPHA COUNTING DETECTOR	2” (50mm) diameter zinc sulphide open foil.
PHOTOMULTIPLIER	B38B01W
BATTERY SUPPLY	Five size AA NiMH rechargeable batteries.
BATTERY LIFE (per charge)	Aproximately 35 hours, depending on number of digits displayed.
BATTERY CHARGER	9V 660mA externally connected charger, CSA approved. 16 hours charging time. Batteries should be charged once a month if left idle. Only use the charger supplied with this instrument.
TIME BASE	Crystal controlled clock oscillator.
HIGH VOLTAGE	Nominally 450-1000V. Adjustable.
DIMENSIONS	Basic instrument: 21.6 cm (8.5”)w x 10.8 cm (4.25”)d x 19 cm (7.5”) h With leather case: 24.8 cm (9.75”)w x 11.4 cm (4.5”)d x 20.3 cm (8”) h
WEIGHT	Basic instrument: 2.2 kg(5 lbs) With leather case: 3.2 kg(7 lbs)

Chapter 2

Components

2.1 Controls and Display

An overview of the front face plate controls is given in Figure 2.1.

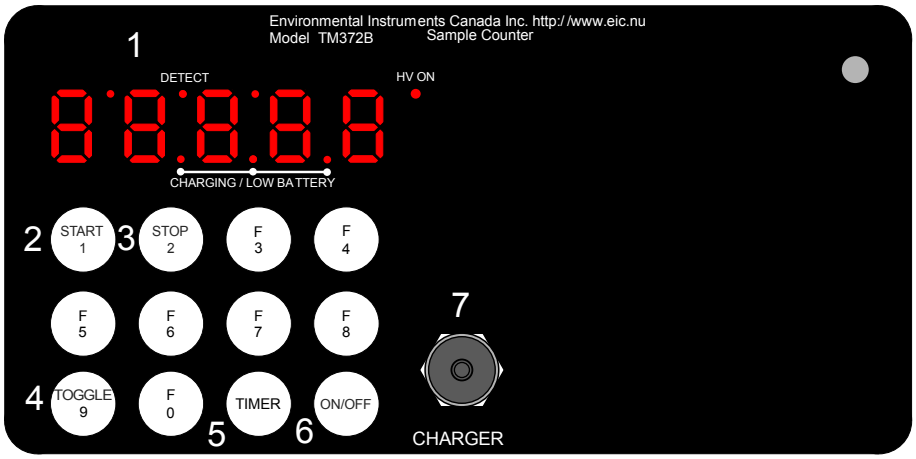

Figure 2.1: Front Plate Controls

1. Main Display
2. Start Button
3. Stop Button
4. Toggle Button
5. Timer Button
6. On/Off Button
7. Charger Jack and Cover

Main Display: A five digit L.E.D. display where the gross counts or the elapsed time is displayed. An overview is given in section 2.4.

Start Button: This button begins the count from zero. The display shows the number of counts until either the pre-set time is reached or the stop button is pressed.

Stop Button: Stops the count.

Toggle Button: Used to briefly toggle the display to show either the pre-set time that the user has entered or the time remaining on the count, depending on whether or not the device is counting at the moment the button is pressed.

Timer Button: Used to enter a time for which the TM372B will count.

On/Off Button: Turns the device on or off. NOTE: This button must be held for two seconds in order to turn the power off.

Charger Jack and Cover: The TM372B runs off of internal rechargeable batteries. The batteries may be recharged by connecting the supplied charger to this jack. See section 2.5 for more information.

2.2 Sample Tray

The sample tray is located on the back of the device near the bottom. The sample is held in the sample holder, which drops into the recess in the sample tray. To count a sample, withdraw the tray, insert the sample as outlined in section 3.1, close the tray, and start the counting cycle.

2.3 Sample Holders

Three 2 part sample holders are supplied with the TM372B for membrane filter samples of 25 mm, 37 mm, and 47 mm diameter. Alpha emitting calibration sources are calibrated for either 2π or 4π geometry, and the active diameter is usually less than the diameter of the disc.

When the membrane filter sample is inserted in the 2 piece holder assembly it is secured around the edge, masking a portion of the filter from alpha particle activity. The region that is masked is a ring of about 1 mm thickness around the outside edge of the sample. This means, for example, that the active area of a 25 mm diameter sample would be the area within a 23 mm diameter. This, however, will not adversely affect the activity reading because the outer edge is essentially inactive.

2.4 Display Overview

The display shows either the gross number of counts or time, in mmm:ss format. For how to change between the two displays, see section section 3.2.

While counting, a value will be displayed using either five digits or three digits and an exponent. For numbers less than 100 000, five digits are used; see Figure 2.2. For numbers greater than 99 999, three digits and an exponent are used; see Figure 2.3.

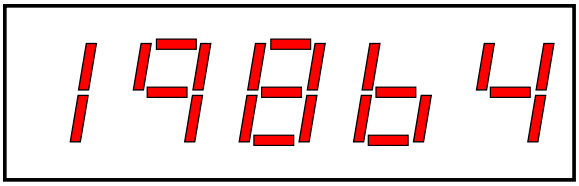

Figure 2.2: An example of the display reading 19864

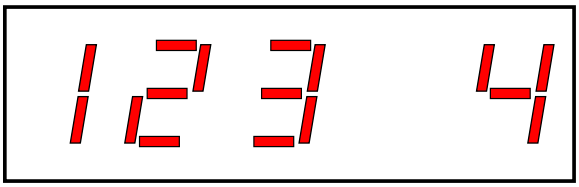

Figure 2.3: An example of the display reading 123×10^4

When the device detects an alpha particle, an LED at the top of the display will briefly illuminate to show that it has registered a count, as shown in Figure 2.4.

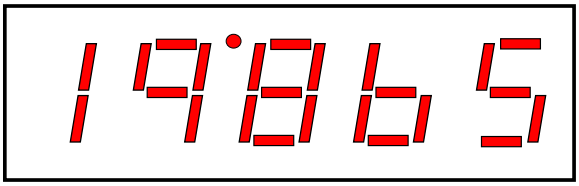

Figure 2.4: Registering a Count

When the batteries are starting to run low the three decimal points in the center of the display will flash; see Figure 2.5. When the batteries are charging the three decimal points in the center of the display will be illuminated; see Figure 2.6.

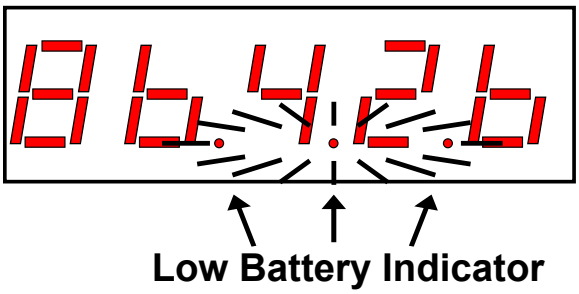

Figure 2.5: Low Battery Indicator

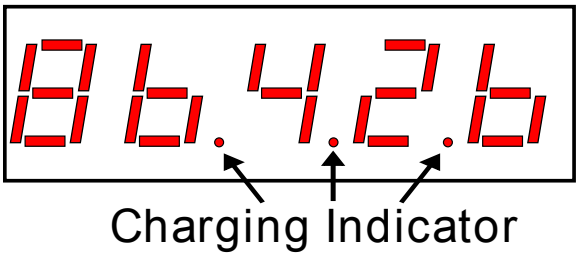

Figure 2.6: Charging Indicator

2.5 Batteries

The instrument is equipped with 5 size AA NiMH rechargeable batteries, located inside the instrument. These batteries should not need to be replaced during normal operation.

When the terminal voltage of the batteries drops below a certain threshold, the three low battery indicator lights will flash; see Figure 2.5. The instrument will continue to function for one or two hours after this level is reached without deterioration of performance, permitting the operator to conclude his/her tests.

Once depleted, the batteries will need to be charged for 16 hours to restore full charge. To charge the batteries, plug the supplied charger into an electrical outlet (Only the charger supplied with the instrument should be used), remove the cover from the charger jack, and insert the end of the charger (see Figure 2.1 for the location of the charger jack). When the batteries are charging the three center decimal points should be illuminated; see Figure 2.6. If the charger is plugged in before the batteries become low, the device will not charge the batteries until they do become low. The device will automatically stop charging after 16 hours have elapsed.

Chapter 3

Operation

This section describes the operation of the TM372B and the calibration of the instrument for counting radioactivity in a prepared sample.

For information on preparation of samples or interpretation of results, see reference section 5.1.

3.1 Inserting the Sample

To insert a sample in the 2 piece holder, remove the sample holder assembly from the tray. A hole in the tray facilitates this. Reinstall the base piece with its smaller diameter located in the hole in the tray. Center the filter sample on the base surface, place the ring over the top with the smooth surface facing up, and close the sample tray.

It is not usually necessary to switch the instrument off when changing samples. Some light may be reflected into the detector area when the tray is open, but the light seal will be restored when the tray is fully closed.

The effectiveness of this seal may be checked from time to time by counting for a period of time when no source or sample is installed in the instrument. A light leak will show up by causing many counts to be registered. Note, however, that the proper sensitivity settings must be established beforehand. A light leak should not be confused with luminescence of the detector after exposure to light or the background noise counts that may be 1 count per minute or less.

3.2 Counting

After inserting a sample into the sample tray, and if you have not already done so, turn the device on by pressing the **ON/OFF** button. To enter the time you would like to count for, press the **TIMER** button, enter the time (in mmm:ss format) using the number pad, then press the **TIMER** button again. If you made a mistake, you may repeat this same procedure to enter a new time. The maximum time that you may enter is 999:59.

To start the count, press the **START** button. An LED beside the digit on the far left of the display will illuminate indicating that the device is counting.

The count stops when either the preset time has elapsed or the **STOP** button is pressed.

By default, the gross counts are shown on the main display, but to briefly display the elapsed time press the **TOGGLE** button. The display will change to show the time remaining in mmm:ss format for a few seconds before automatically switching back to display the gross counts. This button may also be used before the count has started or after the count has finished to display the pre-set time that has been entered. An overview of the display is shown in Figure 3.1.

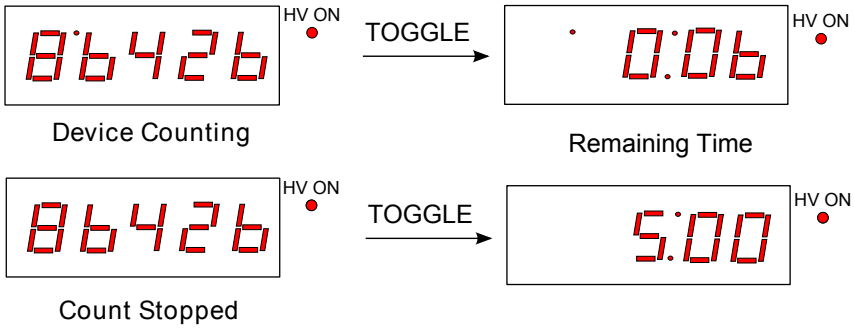

Figure 3.1: Counting Display Indicator

The Timer count mode has an upper display limit of $167 \times 10^5 counts$. Once this limit has been reached the display will read 167×10^5 and no further counts will be registered.

3.3 Calculating Detector Efficiency

This procedure should be carried out once per year, or as required by local regulations. With the standard source properly placed in the sample tray, count for a sufficiently long period of time to obtain at least 10,000 counts and then convert this to counts per minute (C.P.M.). By knowing the disintegrations per minute (D.P.M.) of the standard source, the detection efficiency may be calculated:

$$\%\, detection\, efficiency = \frac{100 \times C.P.M.\ (determined\ above)}{D.P.M.\ (as\ given\ for\ standard)}$$

This figure will vary slightly with the detector, but a typical value is approximately 43%.

The efficiency achieved is not as important as the accuracy and reproducibility of the efficiency value. This value will remain constant as long as the instrument settings are not changed or the detector damaged.

3.4 Daily Source Check

This procedure should be carried out at the beginning of each working day. Insert the check source into the sample changer. Count for 1 to 3 minutes. The result

should be within 20% of the nominal value of the source. Remove the source from the sample changer IMMEDIATELY after doing the source check.

3.5 Counting an Unknown Sample

The unknown sample may now be inserted in the 2 piece holder assembly as described in section 3.1.

Enter a suitable pre-set time, for example 3 minutes, and note the counts accumulated during the time period. Divide by the counting time to convert this to C.P.M. By knowing the detection efficiency, a D.P.M. figure for the unknown may be obtained:

$$D.P.M.\ (unknown) = \frac{100 \times C.P.M.\ (of\ unknown)}{\%\ detection\ efficiency}$$

Due to the random nature of radiation, a steady or constant rate of detection is not possible. The rate of occurrence will vary from the average by an amount equal to the square root of the counts, 65% of the time. Therefore, a count of 100 will be accurate to $\pm$ 10 counts, or 10%; a count of 1000 will be accurate to $\pm$ 33 counts, or 3%; and a count of 10,000 will give a 1% accuracy.

3.6 Resetting the Device

If, for any reason, the device becomes unresponsive, the following should be done to reset it:

1. Unscrew the cap on the charger jack.
2. Insert the reset key into the charger jack.
3. Wait 10 seconds, OR until the display goes black.
4. Remove the reset key.
5. Turn power back on.

If the device is still unresponsive, contact Environmental Instruments Canada for further assistance.

Chapter 4

Detector

4.1 Internal Detector

Do not work in an area where bare fluorescent tubes (without plastic cover) are used. Exposing the ZnS detector to UV light will cause the background reading to be elevated for about a day.

Detectors will need to be changed if they are damaged or become contaminated with radioactivity from the sample. Routine efficiency tests should indicate if the surface of the alpha detector has been scratched or damaged. High background readings will indicate surface contamination.

4.2 Circuit Functions

The TM372B is basically a Scintillation counter. The circuits used perform the following functions: The photomultiplier tube converts the light flashes (scintillations) from the detector into electrical pulses. These pulses are amplified and sent to a comparator. The comparator compares the pulses to a fixed reference voltage. If the amplitude of a pulse is greater than the reference voltage an output pulse will be generated. The pulses generated by the comparator are counted by the microcontroller. The microcontroller and related circuits handle pulse counting, timing, low battery detection, and display functions. The high voltage circuit is essentially a charge pump which converts the low voltage supply provided by the regulator into a high voltage supply suitable for driving the photomultiplier tube. The supply is adjustable from about 450 to 1000 volts.

Chapter 5

Reference

5.1 Reference

Radiation Protection in Uranium Mines.
(ANSI N 13.8 - 1973)

Available from:
The American National Standards Institute Inc.,
1430 Broadway,
New York, New York 10018

This is a very useful reference in itself, but it also includes an extensive list of related papers.