Limited Warranty

Images SI, Inc. warrants this product to the original retail purchaser to be free from defects in materials and workmanship for a period of 90 days of purchase. The Geiger Muller tube is very fragile and is not included in this warranty.

This warranty may be extended to a period of 1 year by registering the product on our website at:

http://www.imagesco.com/reg.html

Registration must occur within 30 days of delivery.

Images SI, Inc. will, at its own discretion, repair or replace the Geiger counter if it fails to operate properly within the warranty period provided that it has not been subjected to misuse, abuse, or neglect. Modification or repair by anyone other than Images SI, Inc. voids the warranty.

Repairs/Replacements will only be made when the customer properly packages and returns the unit to our facility with prior authorization.

Contamination of the Geiger counter with radioactive materials voids the

Images Scientific Instruments, Inc.

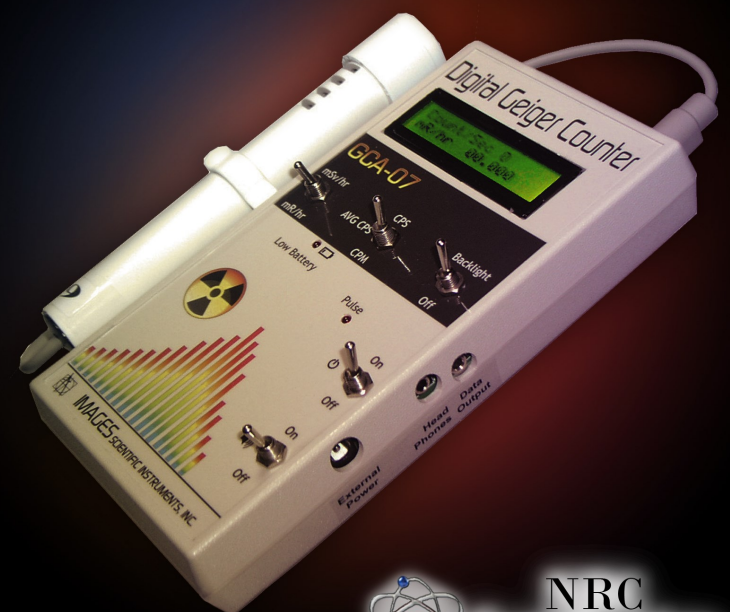
sales@imagesco.com 800-230-4535

Phone: 718-966-3694 Fax: 718-966-3695

www.imagesco.com

GCA-07 Series Geiger Counter

MANUAL & USER GUIDE



NRC Certification Available

Images Scientific Instruments Inc.

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Digital Geiger Counter Technical Specifications

Radiation Detected	Alpha, Beta, X-Ray, and Gamma
Detector Type	Geiger Muller tube Ne + Halogen filled: Mica end window has a .38" effective diameter , with a density of 1.5-2.0 mg/cm^2
Detector Sensitivity	Alpha above 3.0 MeV Beta above 50 KeV Gamma above 7 KeV
Countable Pulse Resolution Range	1 Count Per Minute (CPM) - 5000 Counts Per Second (CPS)
Radiation Resolution & Range	1.0uR/hr - 1000 mR/hr .01uSv/hr - 10 mSv/hr

To Change / Install Battery

Battery compartment is located on the lower back of the Geiger Counter case.

Turn Geiger Counter off. Slide battery compartment lid open. Attach 9 Volt battery to battery clip. Install 9 Volt battery into battery compartment. Slide cover back into place. It is important to note that when using the external power supply, there is no need for a 9V battery.

1. Introduction

The model GCA-07 has an internal Geiger Mueller tube. The model GCA-07W uses an external wand that houses the Geiger Mueller tube.

Scientific Instrument & Industrial Tool

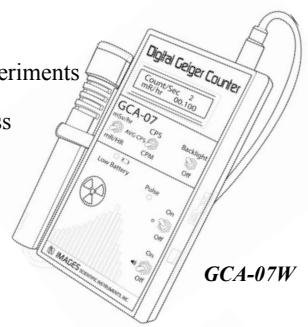
Our Digital Geiger counters have been calibrated and certified accurate in reading radiation levels to within 5% from background radiation to 1000 mR/hr.
NRC Certification available at additional cost.

Perfect for schools and industry. In the laboratory the Digital Geiger Counter may be used to conduct nuclear experiments and measurements. Free Windows 7 graphing programs. Graphic Files may be exported to Excel spreadsheets.

Communication specifications are provided for users to read the output of the Geiger Counter and write their own programs.

Applications

* Education - Classroom demonstrations and experiments
* Emergency Services and Domestic Preparedness
* HAZMAT and Compliance Verification
* Dirty Bomb Screening and EMT's



GCA-07W

Nuclear Experiments Online

Images Scientific Instruments publishes a number of nuclear experiments you can perform with you digital Geiger counter. Experiments are suitable for schools, teachers and students. Visit our website at:

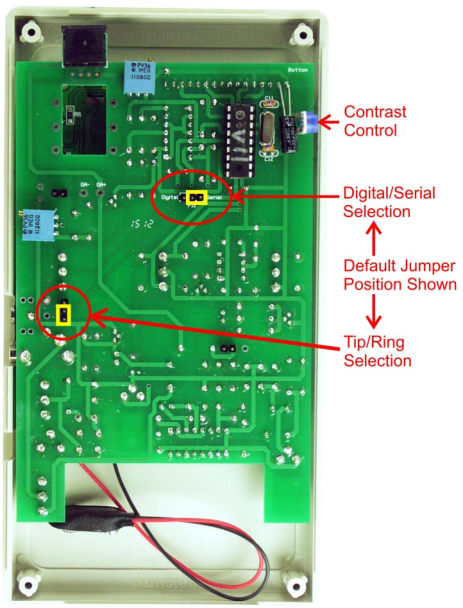
GCA-07

http://www.imagesco.com/geiger/nuclear_experiments/experiment1.html

4. Appendix

Setting the Back Jumpers and Contrast Control

If it becomes necessary to adjust contrast control or to set internal jumpers: Remove back cover of the GCA-07.



Contrast Control: The contrast control has been optimized for the best viewing of the LCD screen. However, it may be changed using a small Philips screwdriver to adjust the potentiometer shown in picture to left.

TTL Serial / TTL Pulse: The default setting is for the micro-controller to output serial data for the PC Graphing Program. In some experiments you may want the raw TTL pulses outputted for each radioactive particle detected. As one would need for a Gamma Ray telescope experiment, coincidence detectors, or random number generator. Jumpers: To change Serial Output to TTL pulses (or vice versa,) set labeled jumper to TTL or Serial as shown in Picture to the left.

Tip/Ring Adjustment : If one is using a different USB to TTL Serial cabled adaper , it may be necessary to change the data output to the tip and ring of the stereo plug. Data output to the stereo 3.5 MM jack may be changed to Tip/Ring using labeled jumper shown in Picture to left.

The picture shows the default settings for these jumpers.

www.imagesco.com/geiger/shields.html

Features

Radiation Detected

Alpha, Beta, Gamma and X-Rays.

Detector

Geiger-Muller tube Ne + Halogen filled with a .38" effective diameter 1.5-2.0 mg/cm2 mica end window.

Detector Sensitivity

- Alpha above 3.0 MeV
- Beta above 50 KeV
- Gamma above 7 KeV

Countable Pulse Range 1 (CPM) - 10000 + counts per second (CPS)

Converted Radiation Range .05 mR/hr - 1000 mR/hr (Imperial)

.0005 mSv/hr - 10.0 mSv/hr (SI Metric)

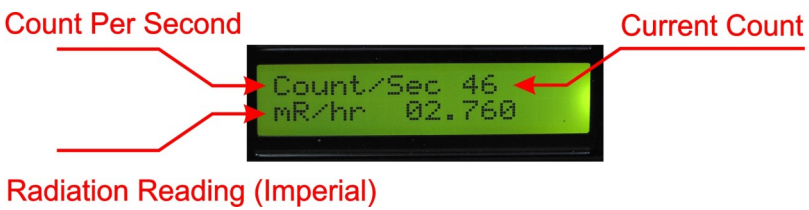
The Liquid Crystal Display (LCD) is 16 character by 2 line that provides an easy to read output, see image to right. LCD has an on-off backlight switch . LCD display continuously updates counts per second (or counts per minute) on line one while displaying con-

verted radiation level second line.

Backlight Switch turns on and off the LCD backlight.

The LED marked **Low Battery** will turn on when the battery power drops to approximately 7 Volts to alert the user to change battery. Readings taken when low battery indicator is on may not be accurate.

The LED marked **Pulse**—is a secondary radioactive particle indicator it blinks each time a radioactive particle is detected by the Geiger Counter.



The **Power Switch** turns power on or off to the GCA-07.

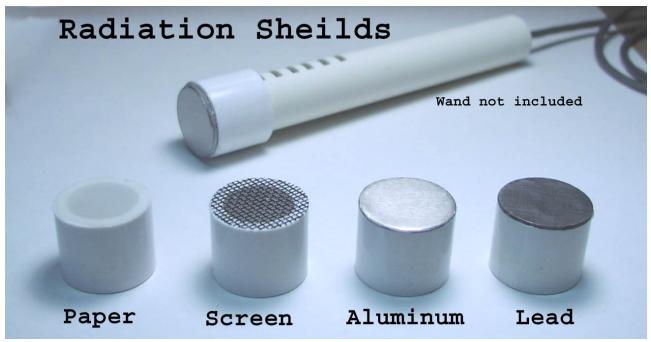
The **Speaker Switch** turns the sound on or off to the internal speaker. The speaker is a secondary radioactive particle indicator. It clicks each time a radioactive particle is detected. Note: Plugging a headphone in the headphone jack will automatically turn off the internal speaker.

Headphone jack is a standard 3.5mm for private listening. Using a headphone automatically turns off the internal speaker of the Geiger counter.

External power jack is available for extended readings where battery operation may not be practical. Power jack is 2.5mm x 5.5mm. Power input is 9VDC or 9VAC @ 200mA min. current. **Mobile operation uses a 9V battery.**

TTL Serial output for PC available via 3.5MM stereo connector. Both the GCA-07 and GCA-07W output the counts per second.

Separating & Detecting

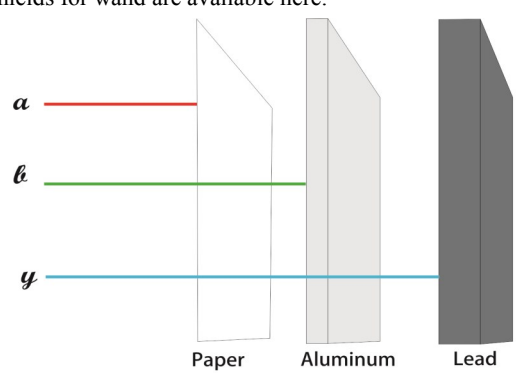


Alpha, Beta and Gamma

By placing shields of different materials in front of the GM tube we can filter out some radiation. For instance placing a paper shield in front of the GM tube will block all the Alpha radiation. The Geiger counter will now only detect beta and gamma radiations. If we place a thin metal shield in front of the GM tube that would effectively block the alpha and beta radiation, allowing the detection of only gamma radiation.

Radiation Shields for wand are available here:

https://



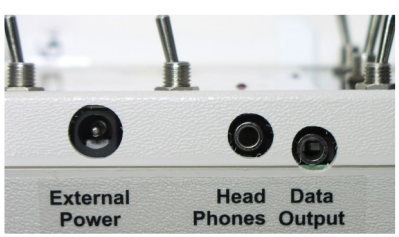
Penetration Power of Radiation

Common Radiation Exposure (General Population)

Background radiation consists of three sources; **Cosmic** radiation from the sun and stars. **Terrestrial** radiation from low levels of uranium, thorium, and their decay products in the soil, air and water.

Internal radiation from radioactive potassium-40, carbon-14, lead-210, and other isotopes found inside our bodies.

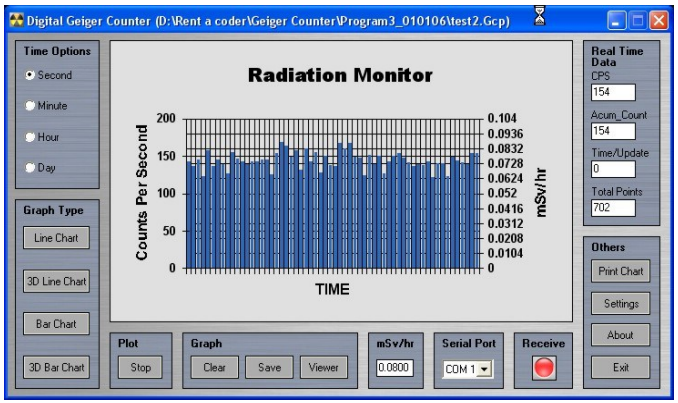
Because of the randomness of radioactivity, background radiation can vary from minute to minute and place to place. In my corner of the world I have a background radiation that triggers the counter 22-34 times a minute.



Main Panel Controls

The first panel switch starting from the left selects whether the radiation levels are shown in Systems International (SI) metric (mSv/hr) or imperial (mR/hr) measurements.

The middle switch labeled CPS, AVG CPS and CPM selects one of the three Survey Meter Modes:



CPS (Counts Per Second) is a one second counting mode. Real time radiation readings and displays the count/second and equivalent radiation level in either mR/hr or mSv/hr.

AVG CPS is a three second average of the CPS. AVG CPS performs a smoothing function similar to analog meter readings. Displays the 3 Second CPS and equivalent radiation level in either mR/hr or mSv/hr.

CPM (Counts Per Minute) is a one minute counting mode for measuring low levels of radioactivity and background radiation: Displays accumulated count and equivalent background radiation in either uR/hr or uSv/hr. If radiation level is significant radiation level is displayed either mR/hr or mSv/hr.

consider them the one and the same. Remember, the digital Geiger counters are calibrated using a Cs-137 radioactive source. Therefore the highest accuracy in reading radiation levels will be from Cs-137 sources.

System International (SI) of Units

The System International of unit for radiation measurements is now the official system of measurements. This system uses the "gray" (Gy) and "sivert" (Sv) for absorbed dose and equivalent dose respectively.

Exposure Source	Dose (conventional)	Dose (SI)
Flight from LA to NY	1.5 mrem	.015 mSv
Dental X-ray	9 mrem	.09 mSv
Chest X-ray	10 mrem	0.1 mSv
Mammogram	70 mrem	0.7 mSv
Background Radiation	620 mrem/year	6.2 mSv/year

The conversion from one system to another is simple:

How Much Radiation is Safe?

In the United States, the U.S. Nuclear Regulatory Commission (NRC) determines what radiation exposure level is considered safe. Occupational exposure for worker is limited to 5000 mrem per year. For the general population, the exposure is 500 mrem above background radiation in any one year. However for long term, multi-year exposure, 100 mrem above background radiation is the limit set per year.

Let's extrapolate the 100 mrem number to an hourly radiation exposure rate. There are 365 days/yr x 24 hr/day equals 8760 hours. Divide 100 mrem by 8760 hours equals .0114 mrem/hr or 11.4/hr microrem. This is an extremely low radiation level. The background radiation in my lab hovers around 32 uR/hr. Am I in trouble? No. Typically background radiation in the United States averages 300 mrem/yr, or 34 microrem/hr. The NRC specifications is for radiation above this 34 urem/hr background radiation.

Notice that my lab readings are in microrad (uR/hr) and the exposure limit is given in microrem (urem/hr). I do not know what type of radiation (a , b or y) the Geiger counter is reading in my lab at any particular instant, so I do not know the Q factor of the radiation and therefore can not calculate the mrem. However for general purposes I

2. Operation

Survey Meter Modes

CPS Mode: Set the Conversion switch to mR/hr (milliroentgen/hour). The time function switch to "CPS", Backlight switch on and the audio switch on. Turn on the Geiger counter. If you have a radioactive source bring the source close to the GM tube. For Geiger counters with an external wand, bring the wand close to the radioactive source.

Every radioactive particle detected will cause the Geiger counter to click and the LED to blink.

The LCD digital display in this mode updates the count and radiation level every second, see photo above. The display always shows the previous seconds count and radiation level. The count "Count/Sec" is the number of radioactive particles detected in the previous second. On the second line the equivalent radiation level of that count in mR/hr. You can change the Conversion switch to mSv/hr to read the radiation level in milli-sieverts/hour.

CPM Mode

The CPM mode displays the counts per minute and convert the radiation level into micro-Roentgens (uR/hr) or micro-Sieverts (uSv/hr). The CPM modes is useful for checking background radiation. First set the switch to Metric or Imperial measurement.

Next set the time function switch to CPM. The LCD display changes. The left side of the first line begins a count up to 60 seconds, increasing by 1 each second. The right hand side of the first line displays the number of radioactive particles detected.

At the end of the CPM count the Digital Geiger counter will display the total CPM and equivalent radiation level for one second before beginning another CPM counting cycle.

If you changed to the 1 minute time from 1 second the second line will display the radiation level last calculated from the previous mode. If the Geiger counter is turned on in the 1 minute mode the second line will display the word "Initializing" for the first 60 seconds.

USB /TTL Cable Adapter (sold separately)

Serial data consisting of the CPS counts may be read by a Windows PC computer using a USB/TTL Serial Cable, included. USB TTL Serial Cable allow easy interfacing of the GCA-07 via USB. The cable has a USB connector on one end that plugs into PC, and a 3.5mm stereo jack that plugs into the GCA-07.

3.5mm audio jack output configuration:

- tip - TxD
- ring - RxD
- sleeve - GND

*See page 20 for changing data output to jack's Tip or Ring. Useful for using 3rd party TTL Serial/ USB cables.

Measurement of Radiation

There are a few scales that one can use to measure radiation. Depending upon your application, one scale may be better than the others.

Radiation Measurements

1 Sv = 100 rem	1 rem = .01 Sv
1 mSv = 100 mR (mrem)	1 mR = .01 mSv
1 Gy = 100 rad	1 rad = .01 Gy
1mGy = 100 mrad	1 mrad = .01 mGy

Roentgen: Is the measurement of energy produced by Gamma or X-Ray radiation in a cubic centimeter of air. It is abbreviated with the capital "R". One milliroentgen, abbreviated "mR" is one-thousandth of a roentgen. One microroentgen, abbreviated "uR" is one-millionth of a roentgen.

RAD: Radiation Absorbed Dose. Original measuring unit for expressing the absorption of all types of ionizing radiation (alpha, beta, gamma, neutrons, etc) into any medium. One rad is equivalent to the absorption of 100 ergs of energy per gram of absorbing tissue.

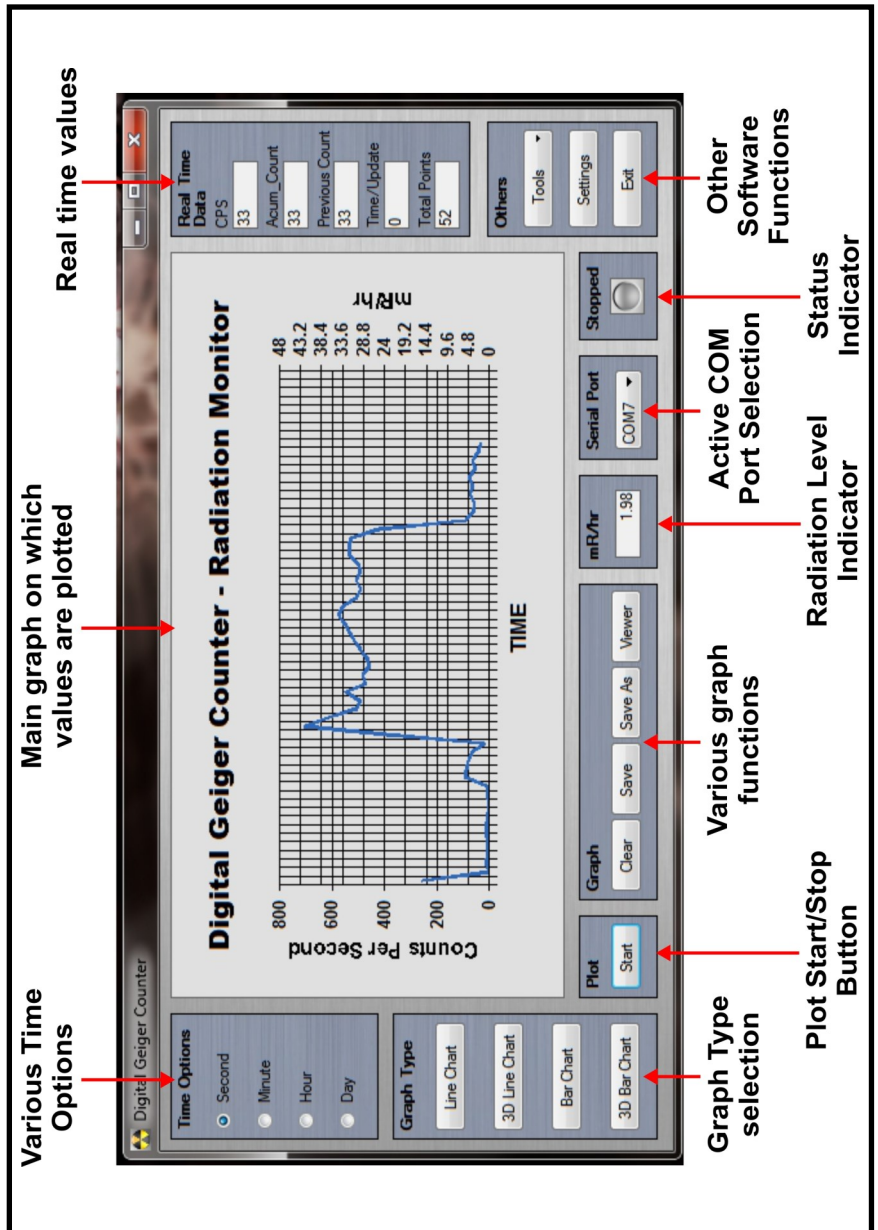
REM: Roentgen Equivalent Man is a measurement that correlates the dose of any radiation to the biological effect of that radiation. Since not all radiation has the same biological effect, the dosage is multiplied by a "quality factor" (Q). For example, a person receiving a dosage of gamma radiation will suffer much less damage than a person receiving the same dosage from alpha particles, by a factor of three. So alpha particles will cause three times more damage than gamma rays. Therefore, alpha radiation has a quality factor of three. Following is the Q factor for a few radiation types.

The difference between the rad and rem is that the rad is a measurement of the radiation absorbed by the material or tissue. The rem is a measurement of the biological effect of that absorbed radiation.

For general purposes most physicists agree that the Roentgen, Rad and Rem may be considered equivalent.

GCA-07's response to a cesium-137 source.

Radiation:	**Quality Factor (Q)**
Beta, Gamma and X-rays	1
Thermal Neutrons	3
Fast n, a, and protons	10
Heavy and recoil nuclei	20



3. Geiger Counter and Radiation Basics

Radioactivity

Radioactivity is the spontaneous emission of energy from the nucleus of certain elements, most notably uranium. There are three forms of energy associated with radioactivity; alpha, beta and gamma radiation. The classifications were originally made according to the penetrating power of the radiation.

Alpha rays were found to be the nuclei of helium atoms, two protons and two neutrons bound together. Alpha rays have a net positive charge. Alpha particles have weak penetrating ability; a couple of inches of air or a few sheets of paper can effectively block them.

Beta rays were found to be electrons, identical to the electrons found in atoms. Beta rays have a net negative charge. Beta rays have a greater penetrating power than Alpha rays and can penetrate 3mm of aluminum.

Gamma rays are high-energy photons. This has the greatest penetrating power being able to pass through several centimeters of lead and still be detected on the other side.

Images Digital Geiger Counters are sensitive to all three types of radioactivity.

The Geiger Mueller Tube

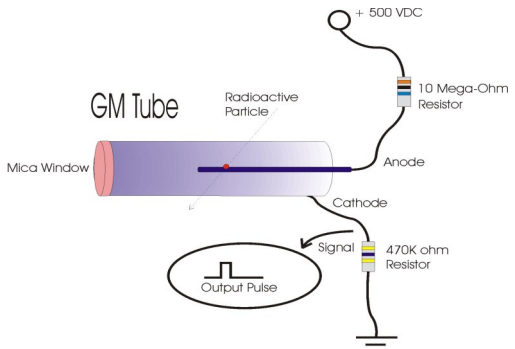
Geiger Mueller tubes are simple devices that detect and measure radioactivity. The original design by H. Geiger and E.W. Mueller in 1928 hasn't change very much. The basic sensor functioning remain the same.

A cutaway drawing of the tube is shown below. The wall of the GM tube is a thin metal cylinder (cathode) surrounding a center electrode (anode). It is constructed with a thin Mica window on the front end. The thin mica window allows the passage and detection of alpha particles. The tube is evacuated and filled with Neon, Argon plus Halogen gas.

It is interesting to see how the GM tube detects radioactivity. A 500-volt potential is applied to the anode (center electrode) through a ten mega-ohm current limiting resistor. To the cathode of the tube a 460-k ohm resistor is connected.

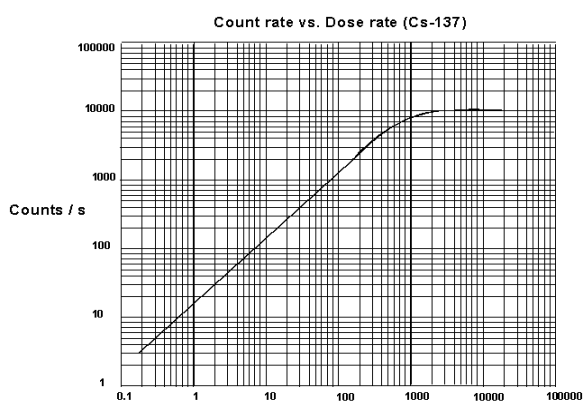
In the initial state the GM tube has a very high resistance. When a particle passes through the GM tube, it ionizes the gas molecules in its path. This is analogous to the vapor trail left in a cloud chamber by a particle. In the GM tube, the electron liberated from the atom by the radioactive particle and the positive ionized atom both move

rapidly towards the high potential electrodes of the GM tube. In doing so they collide with and ionize other gas atoms. This creates a small conduction path allowing a momentary surge of electric current to pass through the tube.



This momentary pulse of current appears as a small voltage pulse across R2. The halogen gas quenches the ionization and returns the GM tube to its high resistance state making it ready to detect radioactivity.

Count Rate vs Dose Rate



Each output pulse from the GM tube is a count. The counts per second give an approximation of the strength of the radiation field. Below is the GM tube used in the