

Images SI, Inc.
109 Woods of Arden Road
Staten Island NY 10312
718.966.3694
718.966.3695 fax
<http://www.imagesco.com>

Manual & User Guide Digital Geiger Counter GCA-07W with on-board Data Logger



NRC
Certification
Available

9V external power supply and USB-TTL cable INCLUDED

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Radiation Detected

Alpha, Beta, X-Ray and Gamma.

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
- X-Ray & 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)

GCA-07W-DL



Product Information

The GCA-07W-DL 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 Lite version of 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

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 converted 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.

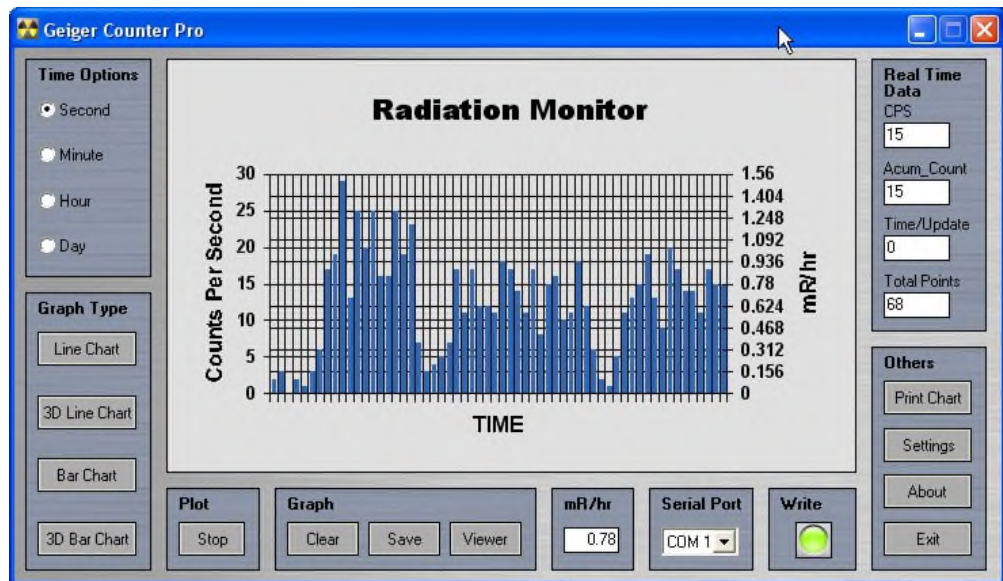
Headphone jack is a standard 3.5mm for private listening. Using a headphone automatically turns off the internal speaker of the Geiger counter.

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.

We offer a Windows PC program that reads this serial information for charting and recording the measured radiation over time (see screenshot below). Free Lite Version of Software, as well as Full Version available for purchase at <http://www.imagesco.com/geiger/geiger-graph.html>

The Serial Data Output is a two byte (8-bit) number every second that represent the previous count per second. High byte is followed by the low byte. Communication parameters are: 9600 Baud, Inverted, 8 data bits, no parity and one stop bit. These parameters are for anyone wishing to read the data from the Digital Geiger counter.



The on-board **Data Logger** records and plays back Counts Per Second (CPS) data from the Geiger counter. The data logger will count the number of pulses received every second and output that number as a two byte serial number via its serial output. Pulse data is recorded and played back as a two byte serial number.

The total CPS data is sent out as a two byte number (most significant byte first) with the following specifications:

- 9600 Baud, Inverted, 8 data bits, no parity and one stop bit.
- Count Per Second (CPS) = (High Byte * 256) + Low Byte
- EEPROM 65536 Bytes can record approx 32,000 samples Over 8-hours of data

USB /TTL Cable Adapter



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.

The required drivers for the Cable are available for downloaded at <http://www.imagesco.com/semiconductors/usb-3.5mm.html>

3.5mm audio jack output configuration:

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

*See page 9 for changing data output to jack's Tip or Ring. Useful for using 3rd party TTL Serial/ USB cables.



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.

Geiger Counter Use

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.

Count Per Second

Current Count



Radiation Reading (Imperial)

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.

3-Second Average : The 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.

3-Second Average of Count Per Second

3-Second Average Current Count



3-Second Average Radiation Reading (Imperial)

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

Timer

Seconds Count Up

Current Count



Previous Minute Radiation Reading

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.

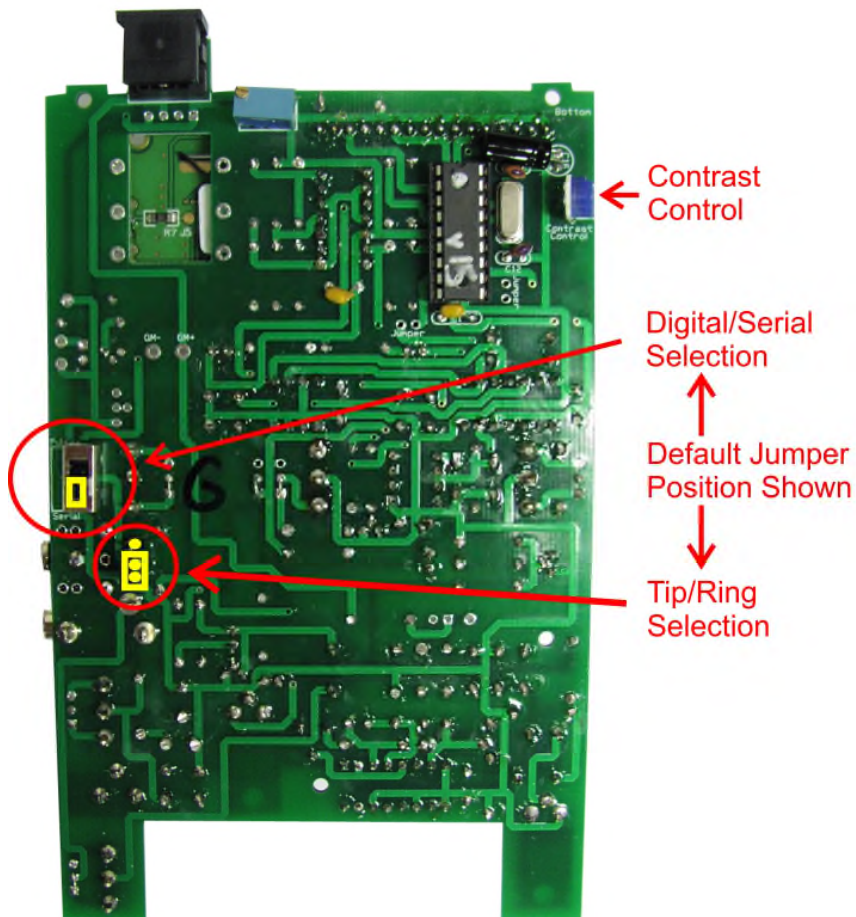
Setting the Back Jumpers / Contrast Control

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 microcontroller 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. The picture shows the default settings for these jumpers.

Tip/Ring Adjustment : If one is using a different USB to TTL Serial cabled adapter , 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.



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.

Data logger Use

The on-board datalogger of the GCA-07W-DL consists of 2 push buttons (one black and one red) and 2 LEDs (red and green), as shown in the image below.

The Data Logger may be used at any time to record data. It does not need to be connected to a PC. Connect the Geiger counter to PC when ready to playback data. The Geiger counter must be connected to the PC with software open in order for playback to occur. The LCD display of the Geiger counter will continue to show real-time data during playback. Recorded data is displayed in the Graphing software on PC.



The data output of the Geiger counter is connected to a Windows PC running Images' Geiger counter software by way of the 3.5mm TTL serial/ USB cable. The cable is plugged into a free USB port of the PC Computer. The image to the right illustrates the connect of the Geiger counter to PC.

The Geiger counter sends all its serial data to the PC program once you have clicked start in the program itself. In this configuration you can monitor the real time output of the Geiger counter using the software, record the data, or playback the recorded data.

Record Data: Press the **Start Recording/Stop** button. Pressing button starts logging the data (either from 0th memory location if memory is erased or from the end of last logging). The Log LED will light signaling the Data Logger is recording. Pressing the **Start Recording/Stop** button again stops logging. The Log LED will turn off.

Playback/ Erase - Press **Playback** button once and it will playback the stored contents of memory. When the **Playback** button is pressed, both the Playback LED and LOG LED will light for 3 seconds before playback actually begins. This is to allow time to set up Counting program. During this time period real time data from Geiger Counter will not occur. Once Playback begins, only the Playback LED will remain lit. If you want to terminated the playback midway, press the Playback button again. This will halt Playback. When Playback has finishing playing back its recorded data, both the Log and Playback LED's will light for two seconds signaling the end of the playback data. The Data Logger will not pass through data from the Geiger counter during this two second signal period. Once this has completed, real time data from the Geiger counter will begin again.

Erase Data: Press and hold the **Playback** button until PlayBack LED starts to blink (hold approximately for 2 seconds). This signals that the memory is erased. Once LED blinks, the data is erased and you can remove your finger from pressing Playback button.

Record Only Mode :

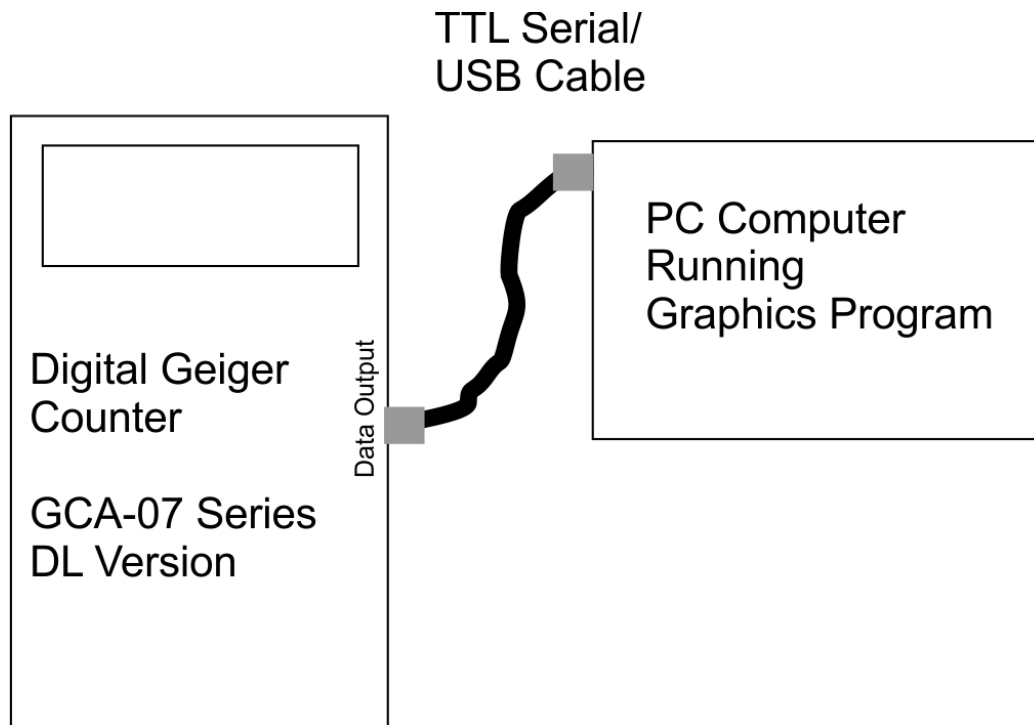
One can record data from the digital Geiger counter without it being connected to a PC for later playback. This may be used for mobile recording and nuclear experiments.

Use the Playback/Erase button and Start Recording / Stop Buttons as described previously.

Playback Mode

Connect the Geiger counter to the PC as previously described. Open the Geiger Counter Software. Press the playback button on the Geiger counter. Both the Playback LED and LOG LED will light for 3 seconds before playback actually begins. During this period click start in the PC program. Once Playback begins, only the Playback LED will remain lit. When Playback has finishing playing back its recorded data, both the Log and Playback LED's will light for two seconds signaling the end of the playback data. The Data Logger will not pass through data from the Geiger counter during this two second signal period. Once this has completed, real time data from the Geiger counter will begin again.

Use the Playback/Erase button as described previously.



The Geiger Counter

Geiger Counters are instruments that can detect and measure radioactivity. H. Geiger and E.W. Muller invented the Geiger counter in 1928.

The Digital Geiger Counter can check materials and environment for radioactivity. Geiger counters are useful in performing experiments with radioactivity and nuclear energy. You could even go prospecting for uranium, if you desire.

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.

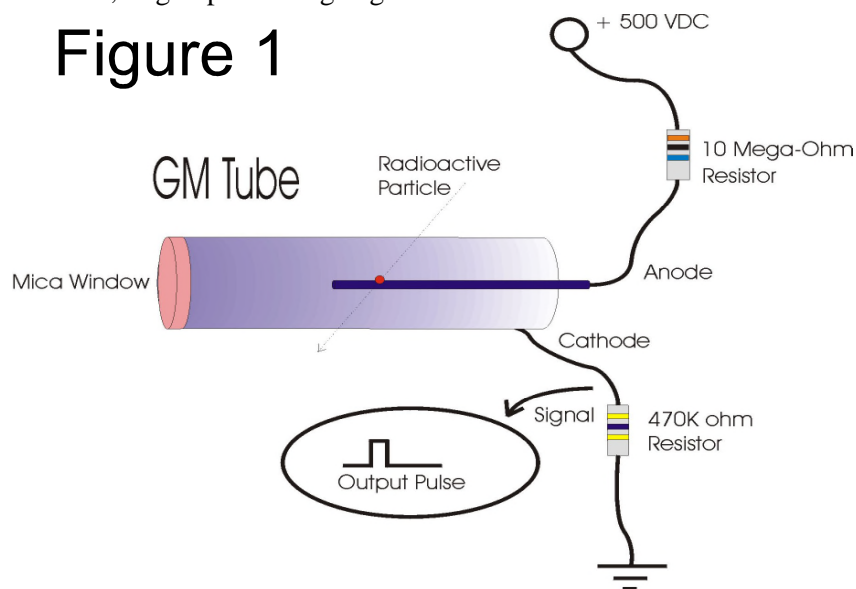
Gamma rays are high-energy photons. This has the greatest penetrating power being able to pass through several centimeters of lead and still be detected on the other side.

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

Geiger Tube

The Geiger Mueller (GM) tube hasn't changed much since it was invented in 1928. The operating principle is the same. A cutaway drawing of the tube is shown in figure 1. 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.

Figure 1



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. To the right is the GM tube's response to a cesium-137 source, shown in figure 2.

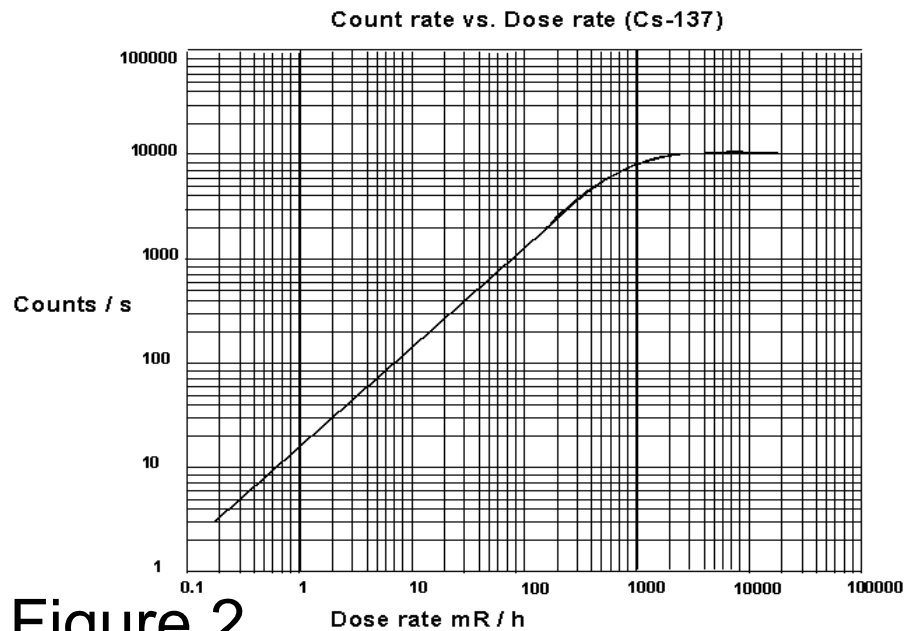


Figure 2

Background Radiation

Background radiation, from natural sources on earth and cosmic rays will cause the Geiger counter to click. In my corner of the world I have a background radiation that triggers the counter 22-34 times a minute.



Finding Radioactive Sources

The mantle in some Coleman lanterns are radioactive. Bring your Geiger counter to a local hardware store and check them out.

Uranium ore from a mineral or a rock store should also emit sufficient radiation to trigger the counter.

A more reliable source is to purchase a radioactive source. Small amounts of radioactive materials are available for sale encased in 1 inch diameter by ¼" thick plastic disks. The disks are available to the general public license exempt. This material outputs radiation in the micro-curie range and has been deemed by the Federal government as safe.

The cesium-137 is a good gamma ray source. The cesium 137 has a half-life of 30 years.

Radioactive uranium ore and radioactive isotopes are available for purchase from Images Scientific Instruments. <http://www.imagesco.com/geiger/radioactive-sources.html>

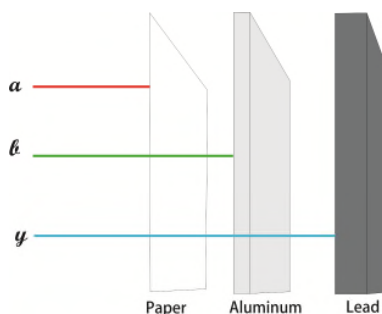
Separating & Detecting Alpha, Beta and Gamma



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:

<http://www.imagesco.com/geiger/shields.html>



Penetration Power of Radiation

Appendix 1 - For TTL Cable and Graphing Software

USB/ TTL Serial Program Function

Install the Windows Geiger counter program on your computer. The digital Geiger counter has TTL serial output. Connect the Geiger counter to the computers serial port using the USB TTL serial cable. Make sure the serial/TTL jumper is set to serial, see “Setting the Back Jumpers/Contrast Control” on page 7.

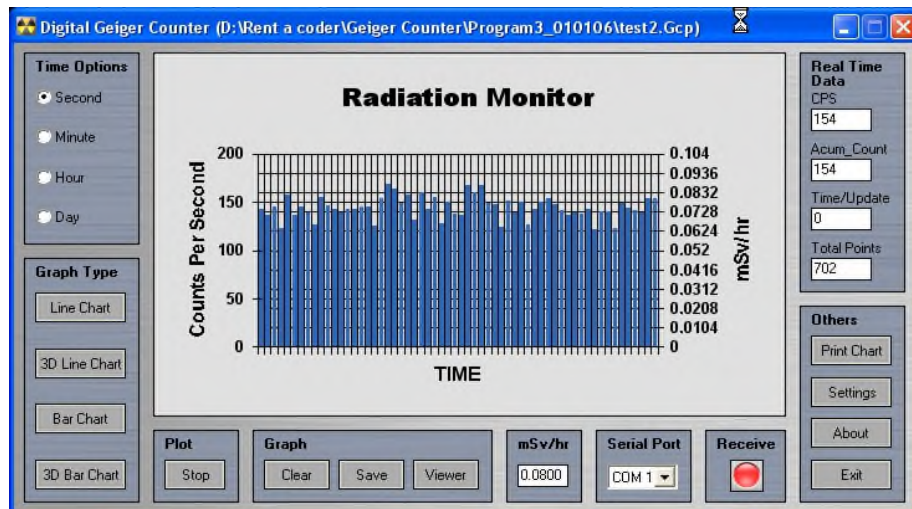
The digital Geiger counter outputs the Counts Per Second (CPS) to the computer.



Load the driver(s) for the cable onto your computer. Make sure the program's COM port is set to the correct COM port where the USB cable and Geiger counter has been connected. The Geiger counter must be on and connected to the computer for the program to begin graphing. The graphs generated by the program may be save to disk and loaded for viewing and analysis later on. See screen image below.

Writing Your Own Interface Software

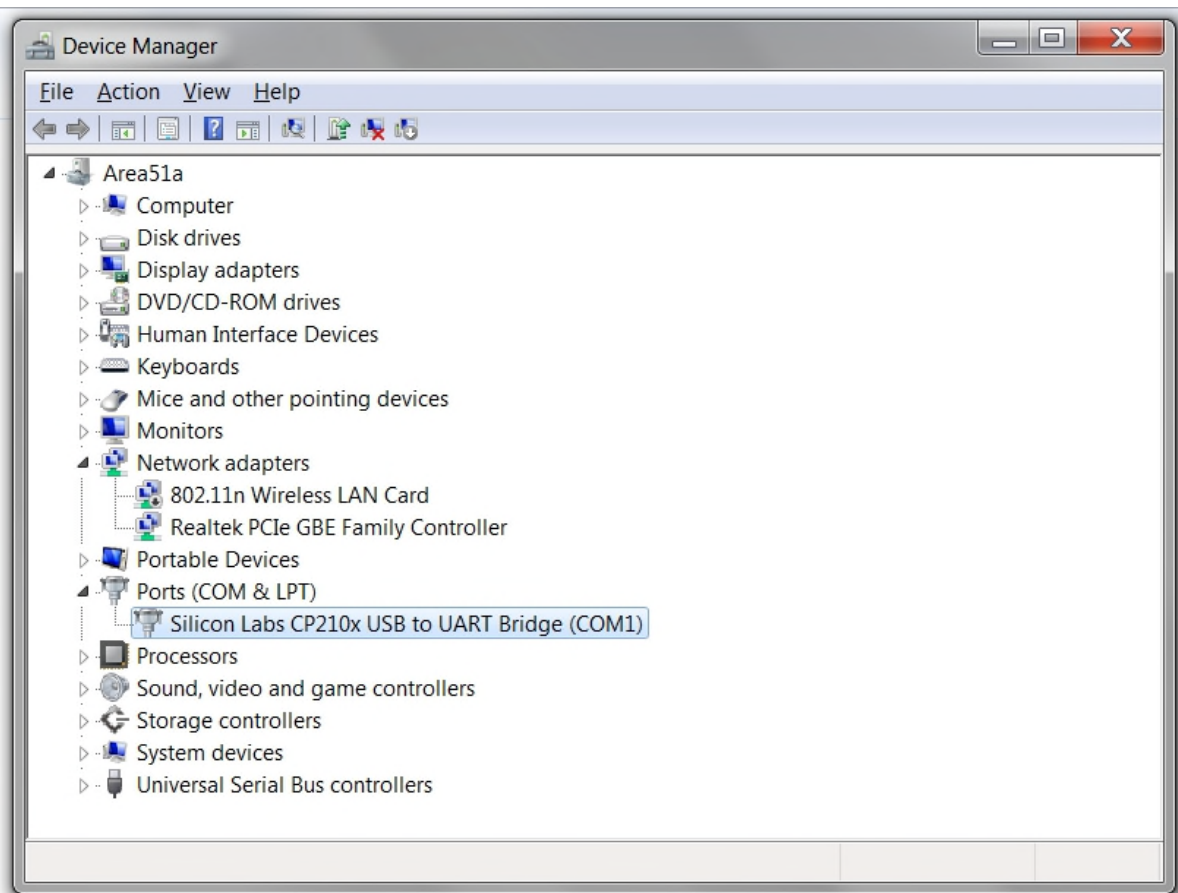
It is possible to write your own software to read the data from the digital Geiger counter. The data is outputted from a 3.5 MM stereo jack, see picture above. The +5V serial data is sent out as a two byte number (most significant byte first) with the following specifications: 9600 Baud, Inverted, 8 data bits, no parity and one stop bit.



Trouble Shooting

Before trouble shooting the TTL USB Cable:

1. Be sure you have downloaded and installed the proper USB drivers to your computer to use the USB Cable.
2. Check that you have selected the correct COM port in the Geiger Counter Program for the USB Cable. To see which COM port the USB cable is seen as do the following. Open the “Control Panel” on your computer. From the “Control Panel” open the “Device Manager”. In the “Device Manager” select Ports as shown in the figure. In the picture you can see the USB is assigned to COM1. You can change the COM port assigned to the USB by double clicking on the USB listing. This will open another window where the assignment and communication speed may be changed. You can change the COM port assignment if you like but leave the communication speed at 9600 baud.



The Geiger counter has been set up to use Images’ 3.5mm TTL serial to USB Cable. The photograph on page 9 shows the jumpers in their default position.

If you use a different 3.5mm TTL Serial USB cable and the Geiger Counter is not sending the serial information to the PC, you may need to change the Serial Out jumper position. Remove the four screws from the back of the Geiger counter and remove the cover. Locate the Serial Out jumper and change the jumper position. Try Again.

