

# User Guide for the GK-Plus with v2.0 Software

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Now that you have assembled your kit, here is some basic information on the features and functions of the GK-Plus kit.

## Controls:

If you built the Display Adapter, it provides the push buttons, switches, LEDs, and jumpers that demonstrate the features of the kit. If the Display Adapter is not used, see the wiring diagram in the [Build Instructions](#) which will show you how to wire the controls. Controls that are attached to I/O pins simply ground that pin.

**The controls and indicators are as follows:**

**Select Button** (pin 18) - This has a variety of uses. Pressing and holding the Select button at power on until the screen fades to black and starts up will reset all menu settings back to their default settings. Pressing it at the startup screen will allow you to set the alarm threshold. Pressing it at the main screen it will switch to the scaler screen and at the scaler screen it will take you back to the main screen. If the alarm is sounding, the Select button will silence the alarm for 30 seconds. What a button!

**Log Button** (pin 21) - This button is used to manually log an entry to the SD card and serial output. When pressed the current CPM, dose, time / date, battery voltage, and GPS data (if used) are logged to the SD card and a serial log is output. SD and Serial Logging are also provided *automatically* in a period set by the menu. Entries made with the Log button end with "\*\*\*\*" to distinguish them from automatic entries.

**Null Button** (pin 20) - This button is used in "Tone Mode" where clicks are replaced by a tone which varies in pitch based on the CPM. When pressed, a new baseline is created for the pitch so if you are moving to an area with a higher background the pitch will still indicate changes at the new level.

**Speaker Switch** - This button just silences the speaker. Only available on the Display Adapter. (It's labeled "mute" on earlier versions.). See **Click / Tone Jumper** below for how to achieve the same effect.

**Tube Switch** (pin 22) - Two different CPM to dose ratios can be set by the menu. So if you change to a different GM tube you can change the ratio to match. The Tube switch switches between the two ratios. Note that when setting the ratio in the menu, you are setting it for the current position of this switch. Changing its position allows you to set both ratios.

**Click / Tone Jumper** - Selects either click sound or Tone Mode. (Or no sound if removed) A "SPDT center off" switch can be wired to this 3 pin jumper to control the sound. This jumper is found on both the main board and the Display Adapter. (see [Tone Mode](#) below)

**Count LED** - Flashes for each event. On the Display Adapter this is just an extension of the LED on the main board.

**Status LED** (pin 23) - Flashes 4 times at start up, 2 times when sending serial output, and 1 time when logging to the SD card or pressing a key on the remote.

**Alarm** (pin 19) - A piezo "buzzer" with a built in 2.5kHz oscillator is included with the kit. It draws 25mA. If you want to use something else, do not exceed 40mA. This buzzer sounds when you exceed the alarm threshold and can be silenced for 30 seconds by pressing the Select button.

**IR** - This is the sensor for the IR receiver. On the Display Adapter this is just an extension of the one on the main board that would be covered if the Display Adapter is used.

## Screens:

When you first power on the kit you will briefly see a splash screen with the software version on it.

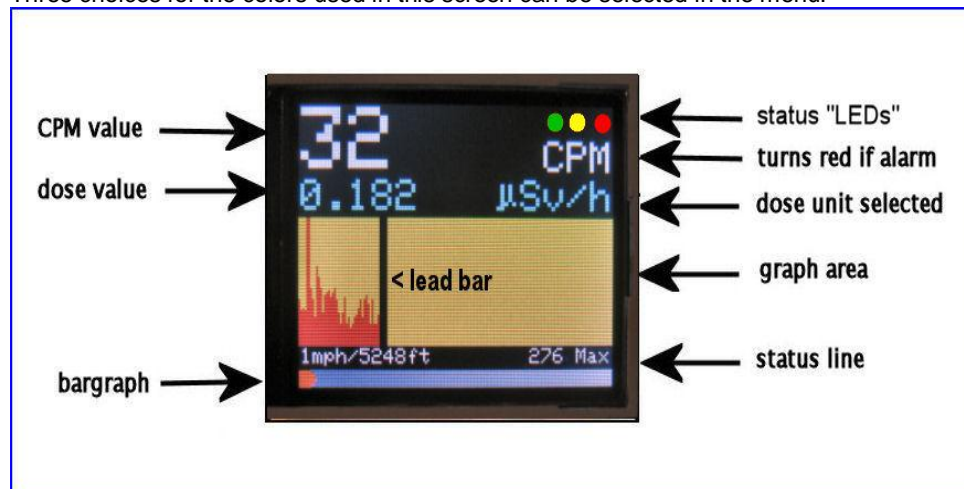
The next screen will show the current settings for your dose rate, battery voltage, and alarm setting. The date and time is shown at the bottom of the screen. If you have an SD card inserted, you will see the filename that will be used for the log. Filenames will begin with [GKLOG000.CSV](#) and go to [GKLOG999.CSV](#). A new file is created with each boot. *Note that the more files on the card, the longer it takes to create one, so moving files off the card is a good idea.*

You may also see "No card" or "Logging off" if you have the SD CARD LOG PERIOD set to Off.

"Set Alarm" will prompt at the bottom of the screen. Pressing the Select button during this prompt will take you to another screen where repeated presses of the Select button will change the alarm threshold.

**Finally, the main screen will appear . . .**

Three choices for the colors used in this screen can be selected in the menu.



Other menu options also affect this screen such as update period, dose unit, graph type, bargraph max, etc. See [Menu Options](#) below.

With the default 5 sec. refresh, the graph area shows about 13 minutes of activity. It then starts again from the left with the lead bar separating the two sections of the graph.

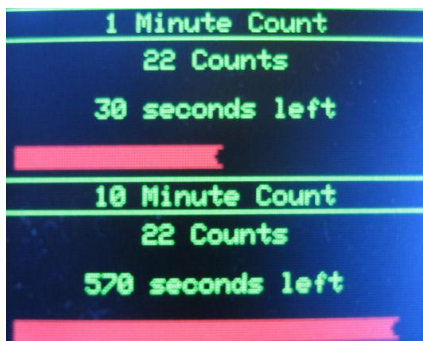
The status line shows the max CPM since power on, and will also show the speed and altitude if a GPS is used. It will also show a "LOGGED" lit if the Log button was pressed for a manual log entry. If the battery voltage is low it will also display on the status line.

The responsive bargraph at the bottom of the screen is another way of showing activity.

A set of status "LEDs" on the display has been added to show the following:

- leftmost - blinks twice with every serial log and once with every SD log
- center - on when the Scaler Mode is active
- right - red when in the alarm state – flashes white when MUTE received from the remote

Pressing the Select button (or the key on the remote) while in this screen will switch to the Scaler screen . . .



Two scalers are provided, each with its own period. The top scaler is fixed at one minute and bottom scaler is set to a programmable time in the menu.

Each scaler has two modes - counting and ongoing. The screen on left shows both scalers counting. A running total of the counts is displayed, and the amount of time left for the scaler period along with a bargraph representing the time left.

The screen on the right shows that the one minute scaler finished the counting mode and is now showing the average CPM and dose rate for the period. These values now become a moving average.

The bottom scaler can also be set to "Infinity" in the menu. This is a special mode that shows the total accumulated dose since the scaler screen was first started.

Pressing the Select button while in the scaler screen will bring you back to the main screen. However both scalers will still be accumulating counts, so you can go back and forth between the main screen and the scaler screen and still see meaningful data.

Counts on the scaler screen can be reset by pressing the key on the remote while in the scaler screen. Counts are also reset when the unit is powered off.

Note the alarm will not sound while the scaler screen is being displayed.



Pressing the key on the remote will switch to an "information screen" which will display the current date and time, battery voltage, alarm setting, and speed and altitude if a GPS is used. Pressing this key again will return to the main screen.

## Using the IR Remote:

An IR remote is needed to access the menu system. Beginning with v2.0 of the software, the kit includes a mini IR remote that uses the NEC protocol. The remote supplied is "ready to go" without the need to pair the remote with the Geiger kit.

### Function of Keys on the Remote

The functions for the various keys on the remote are as follows:



**MENU** - Enters menu system. The current selection is highlighted and the selections before and after are shown. Pressing the Menu key while in the menus exits them.

**-** **+** - Moves down to the next menu option, or up to the previous menu option.

**>>** **<<** - Increments the value already set for the current option or toggle the option.  
**<<** **>>** - Decrements the value already set for the current option or toggle the option.

**▶** - ("Enter") Finalizes the entry in the current menu option.

**Digits 0-9** - For direct entry of values (instead of arrows) - must use > after using digits.

**C** - Enters a decimal point when setting **CPM->(unit)**. If "C" is used when *out of the menu* - it will clear the graph data if on the main screen and clear the scaler counts if in the scaler screen.

**Power** - ("Mute") Silence the speaker - *used when out of the menu*. Setting saved for reboot. Cleared if reset to defaults.

**↺** - ("Select") Switches between the main screen and scaler screen - *used when out of the menu*.

**TEST** - Switches between the main screen and the "Info" screen - *used when out of the menu*

**Any other key** - *if in the menu system* - the key code for unknown keys will display.

## Menu Options:

Initially, the menu options are set to defaults. Settings made will be stored in EEPROM on the ATmega1284, so they will be in effect when you power back on. **Pressing and holding the Select button at power on until the screen fades to black and starts up will reset all menu settings back to their default settings.** Here's a brief description of each menu option:

**DISP PERIOD (MS)** - "Interval between screen refreshes on the main screen, in milliseconds" **Default = 5000 mS**

Display counts are based on a "running average" Settings of less than 5 seconds have not been tested. (5 seconds is a good setting.)

**SD CARD LOG PERIOD** - "Interval between writes to the log file on the SD card" **Default = 1 minute**

Zero means SD logging is turned off. A file will not be created at startup.

**SERIAL LOG PERIOD** - "Interval between writes to the serial port" **Default = 1 minute**

Zero means serial logging is turned off.

**CPM->(unit)** - "Conversion ratio from CPM to the selected dose unit" **Default = 175.43 CPM and 100 CPM to dose unit (uSv)**

Set the ratio for the type of GM tube used. Note this ratio will depend on the dose unit being displayed - see **DOSE UNIT**. Note that 2 ratios can be stored. The second ratio can be selected by the DIP switch on the Display Adapter (or ground I/O pin 22). Depending on the position of the switch this menu option will set the value for either the 1st or 2nd ratio. 175 is the common default for the SBM-20 and 100 for the LDN 712. The "decimal point" or "TV/VCR" key on the remote can be used to enter a decimal point.

**BACKGROUND CPM** - "Normal background CPM for this tube and location" **Default = 44 CPM**

The background rate you enter is used if the **DOSE UNIT** is set to "xBg". The background dose unit is how many times the current CPM is above or the background CPM you set here. So for example, if this is set to 30, at 45 CPM, xBg will be 1.5. This value may also be used as a base for the graph if **GRAPH SCALE MODE** is set to "Background". (see below)

**ALARM THRESHOLD** - "Threshold above which the alarm is triggered" **Default = 500 CPM**

This can be either in CPM or the dose unit selected - see **ALARM UNIT**. Zero means the alarm is turned off. Unlike using the Select button, any value may be entered. The alarm will stop when activity drops back under the alarm threshold. You can also silence the alarm for 30 seconds by pressing the Select button when the alarm is sounding.

**DOSE UNIT** - "Unit for dose display" **Default = uSv/h**

Choose between uSv/h, uR/h, mR/h or xBg as the dose unit that will be displayed and logged. This will start a new SD log file. See

**ALARM UNIT** - "Use dose unit for alarm setting" **Default = CPM**

Typically the **ALARM THRESHOLD** is based on CPM, but you can base it on your selected dose rate by using this option.

**SCALER PERIOD (MIN)** - "Length of time, in minutes, for the scaler" **Default = 10 minutes**

If scaler period set to Infinite, the accumulated dose rate is displayed on the scaler screen.

**BARGRAPH MAX CPM** - "Full scale reading on rapid response bargraph. Also used for tone mode" **Default = 1000 CPM**

This option sets the sensitivity of the horizontal bargraph. It is also used by the **GRAPH SCALE MODE** if set to "Bargraph". Also see the [Tone Mode](#) section for how this option affects tone mode.

**SERIAL OUTPUT MODE** - "Serial output in Default, Radlogger, GK-B5 format, or GPS NMEA output" **Default = Default**

Default sends all fields, Radlogger only sends CPM, GK-B5 only sends CPM, Dose, and Vcc. Use Radlogger with that app. Use GK-B5 if GKnet board is attached. See [Logging](#) section. GPS NMEA outputs the NMEA sentences from your GPS. Useful for interfacing to mapping applications. (A **GPS MODULE** must be selected and connected.)

**tone sensitivity** - "Controls how quickly tone increases in pitch for an increase in CPM" **Default = 4**

See the [Tone Mode](#) section below for details.

**GRAPH SCALE MODE** - "Auto-scaling can be done based on the peak or average value" **Default = Auto: Peak**

The two "Auto" modes mean that the *entire* graph will adjust based on the peak or average reading that is present *anywhere* on the displayed graph. The graph is continuously updating its range, so it may become more or less sensitive based on all values stored for its display.

**Auto: Peak** - The graph auto scales based on the highest peak currently displayed on the graph.

**Auto: Avg** - The graph auto scales based on the average of all values currently displayed on the graph.

**Bargraph** - The graph is based on the setting made in **BARGRAPH MAX CPM**.

**Background** - The graph is based on **3X** the setting made in **BACKGROUND CPM**.

**TIME SETTINGS** - "Press enter to open the time settings menu"

If you are using a GPS, the time and date will be set when you get a fix. Otherwise, you need to set the date and time. The date-time is backed up by the coin cell battery.

**GMT OFFSET** - "Time offset from GMT. Press enter to toggle +/-" **Default = -5**

When using the GPS, you need to set your time zone because the GPS provides time in UTC format.

**AUTO DST** - "Automatically adjust for daylight savings time (US rules)" **Default = Off**

**TIME FORMAT** - "Select the time display format" **Default = 24:MM:SS**

Choice affects data written to the SD card and output to serial.

**DATE FORMAT** - "Select the date display format" **Default = MM:DD:YY**

Choice affects data written to the SD card and output to serial.

**DAY** - "Day of the month (1-31)"

**MONTH** - "Month (1-12)"

**YEAR (YY)** - "Two-digit year (00-99)"

**HOURS (24)** - "Hour in 24-hour format (0-23)"

**MINUTES + SET** - "Minute (0-59) Press enter to update clock." (The clock is not updated until Enter is pushed here.)

**MAIN MENU** - "Return to the main menu"

**BRIGHTNESS** - "Adjust the backlight brightness" **Default = 7 bars (7/8<sup>th</sup>)**

Note that high brightness uses much more power (see chart in the [Build Instructions](#)

**UNITS** - "Choose metric or Imperial units" **Default = Metric**

Choice affects data written to the SD card and output to serial. (GPS feet / meters, mph / km/h, etc) This will start a new SD log file.

**GPS MODULE** - "Choose a GPS module" **Default = None**

Switching between any GPS and no GPS will start a new SD log file.

**SCREEN ORIENTATION** - "Select the screen orientation. Press enter to save." **Default = landscape (no rotation)**

You can orientate the screen 4 ways - portrait or landscape. This may be useful if you want to locate the SD card in a different direction.

**DISPLAY SCHEME** - "Select a display scheme" **Default = Default**

You can select one of three preset display color schemes for the main display.

**REG. VOLTAGE** - "This is the actual supply voltage for the CPU"

Voltage is now displayed real time.

Note that each menu setting has a minimum and a maximum setting. Entries that are out of bounds will revert to the minimum or maximum.



## About dose units:

The menu allows you select the name of the dose unit that appears on the display. However, to be clear, there is no built in conversion between them. Instead the **CPM->(unit)** is adjusted depending on the name of the **DOSE UNIT** selected. For example, 175.43 is the default set for the SBM-20 with uSv as the dose unit. Suppose you pick "mR" as the dose unit name, and want to measure in milirems. ("mR" more correctly abbreviates as milliroentgens but is used to save display space.) The rem is defined as .01 seivert, and  $1\text{uSv} = 0.1\text{mR}$ . Therefore, to use the same ratio that was designed for the tube, you would multiply that ratio by 10. You would enter a **CPM->(unit)** as  $175.43 \times 10$  or **1754.3**. Likewise if you wanted microrems ("uR") you would divide the ratio by 10 and enter **17.54**.

If you do want to use roentgens ("exposure" - used in older instruments) [this source](#) states that they are .96 rem in soft tissue. So the **CPM->(unit)** for actual mR would be  $175.43 \times 10 \times .96$  or **1684.1**. (for uR it would be **16.84**)

## Tone Mode

Instead of the usual 'clicks', tone mode produces tones that vary in frequency with the current activity - much like a metal detector. There is also an associated "null" button that resets the scale to the current activity. Tone mode is very responsive to changes in activity, and the change in pitch is much more noticeable than a change in the rate of clicks. It was primarily designed for field surveying.

The sensitivity of the tone mode is set either by the **TONE SENSITIVITY** menu option or by adding a tone adjustment pot. See the wiring diagram in the [Build Instructions](#) for how to connect the pot. When using the pot you must set the **TONE SENSITIVITY** menu option to "Pot". The display will show you the sensitivity the pot is set at in real time.

Sensitivity refers to the 'bandwidth' of the tone. When set to low numbers, say 4 (the default) only a small increase in activity is needed to produce higher tones. When dealing with more sensitive GM tubes, decrease the sensitivity by using a value of say 8 or 10. Experiment with values that suit your ear.

The **BARGRAPH MAX CPM** menu setting also affects tone mode by defining the CPM that will produce the highest frequency of tone. Normally this is set to highest CPM for situation and tube being used.

In order to get the best spectrum of tones, tone mode is based on a logarithmic progression rather than a linear one. This fits with the fact that radiation intensity is inversely proportional to the square of the distance from the source.

The "null button" resets the range of tones so that the low notes are set back to the current activity. This is a useful feature when switching from a low to a high background for instance. The null button removes the higher background so increased activity may be more easily discerned.

### Setting up Tone Mode

1. Set the proper conversion ratio for your tube. With the proper ratio set, the null point will automatically be set when the counter is powered on so normal background radiation is ignored.
2. Place a sample of the mineral or other radioactive item you are trying to detect approximately one inch from the detector. Note the CPM reading after it has stabilized.
3. In the menu, set the **BARGRAPH MAX CPM** to the CPM value you noted in step 2.
4. Adjust the tone sensitivity setting to suit your preferences. For most mildly radioactive items (such as red Fiestaware), sensitivity settings from 1-5 work well. The ideal value varies depending on the activity level of the target object, the tube, and the distance. Lower settings cause the tone to increase in frequency faster in response to smaller changes in the count rate. Higher settings cause the frequency to increase much more slowly for changes in count rate. When the sensitivity setting is 0, the frequency will jump very rapidly from the lowest frequency to the highest one. This setting is useful to quickly scan an area to determine if there are hot spots. You will likely want to change the setting to a higher number to help locate the hot spot.

A potentiometer can also be added to easily change the sensitivity while in the field. Pins 1 and 3 of a 100k potentiometer are connected to ground and Vcc, and the wiper is connected to A7. An audio taper pot will give for more sensitivity at lower settings but a linear pot with a 10k resistor across the ground and the wiper will also work well. If you hear fluctuations in tone due to the increased sensitivity on the low settings, also add a 1uF tantalum capacitor between the wiper and ground. See the [Wiring Diagram](#) in the [Build Instructions](#).

## Adding a GPS:

The GK-Plus currently supports these models of GPS – EM406A, EM408A, EM411, MTK3339, U-blox 6, and SkyTraq 22.

A GPS will provide additional functionality:

- latitude, longitude, altitude and speed will be added to SD log file and the serial output.
- the Status bar will display altitude and speed
- the exact time from the GPS will be used to set the clock automatically

See your [Build Instructions](#) for information on how to connect a GPS.

## Logging

Logging is provided in two forms - logging to the SD card and serial output. In the default mode, both forms have the same data output, and both forms use comma separated values with the Date and Time fields as quoted strings. For example,

**"01/03/14", "22:11", 39.32427975, -104.1759374, 561.7, 0.6, 36, 0.2052, 4.79<CR/LF>**

Serial output is through the FTDI connector at 9600 baud, N,8,1 .

Each time the kit is started a new log file is created on the SD card with the filename **GKLOGnnn.CSV** where nnn is a 3 digit sequence number beginning with 000. Therefore, 1000 log files can be created before the card must be cleared. Note however, that the more log files there are on the card, the longer it takes at startup to create a new file, so it's best to move old files off the card.

The first line of the file or serial output is a header line which names all the fields below. The fields output depends on some of the menu settings being used. Note that the header is now compatible with [www.gpsvisualizer.com](http://www.gpsvisualizer.com) an on-line mapping site. (See section 10 on [this page](#) for how it applies.)

If a GPS is not being used, the following fields are logged:

Date	Time	CPM	uSv/h	Vcc	
1/3/2014	21:18	58	0.3306	4.83	
1/3/2014	21:18	42	0.2394	4.79	**

With a GPS, latitude, longitude, altitude, and speed are also logged.

Date	Time	Lat	Lon	Alt(ft)	Vel(mph)	CPM	uSv/h	Vcc	
1/3/2014	06:57 pm	39.32427975	-104.1759374	5320.5	0.7	36	0.2052	4.94	
1/3/2014	06:57 pm	39.32426831	-104.1759374	5320.5	0.3	58	0.3306	4.86	**

Note that second line in each example has been manually logged using the Log button which puts "\*\*\*" in the last field.

Menu options such as Unit (metric / imperial), and date and time formats adjust the header and data accordingly.

There are exceptions to the above depending on the setting of the **SERIAL OUTPUT MODE** menu setting:

- When **Radlogger** is set, for the serial output only, no header is created, and only CPM is output. This setting is used when connecting the serial output to the [Radiation Logger](#) application.
- When **GK-B5** is set, for the serial output only, no header is created and only CPM, Dose, and Vcc is output. This setting emulates the GK-B5 version of the Geiger Kit. It's used when the [GK-WiFi or GKnet board](#) is attached to the Plus to send the serial data over the internet to monitoring sites. This allows for the same software to be used on the GK-WiFi and GKnet board for either the GK-B5 kit or the Plus kit.
- When **GPS NMEA** is set, for the serial output only, the NMEA sentences from your GPS are output to serial. (A GPS module type must be selected and connected.) The interface to the GPS is two way, meaning that you can send commands to the GPS. This setting is useful for interfacing to mapping applications as well as debugging.

## Description of counters:

It may be helpful to describe how the various counts are generated by the kit.

From a hardware perspective, each "event" at the GM tube produces a negative going pulse. (See the schematic in the Build Instructions for details.) Each pulse causes an *interrupt* in the microprocessor. An interrupt forces the microprocessor to immediately handle the event, which in this case is to increment a counter.

There are actually 7 separate counters in the GK+ software. All of them increment with each event from the tube. The main differences between each of them is; when they are reported and cleared, and how they calculate a minutes worth of counts.

### Display Counter:

This is the primary counter that you see on the display. It is refreshed by the period set in the "DISP PERIOD" set in the menu. The count value is basically a moving average. However, in order for it to be responsive to sudden changes the moving average is recalculated every 30 seconds, or if a sudden increase or decrease in the rate exceeds 35% of the previous rate.

You have to consider that there is a tradeoff between responsiveness and reporting a true one minute count. In effect, one either "predicts the future" or waits on the past. As you will see, other counters wait on the past.

### Serial and SD Logging Counters:

These 2 counters are refreshed by the period set in their respective menu options. They are simple accumulators with the result extrapolated to a 1 minute period. If their periods are set to 1 minute, then their values are true one minute counts. Since these counters are output in the rears, they are actual rather than predictive.

### 3 Scaler Counters:

Two of these counters operate in much the same way as the Serial and SD Logging Counters. One is refreshed by the SCALER PERIOD in the menu options and the other is fixed at 1 minute. At background levels, one can see each count being accumulated and the resulting CPM after the period is over. When the period is over, the CPM result is averaged with a 3rd counter fixed at 1 minute intervals.

### Fast Counter:

This is the most responsive counter. It is examined once a second and it's result is extrapolated to CPM. It is used for the bargraph, alarm, and tone mode.

## Notice

**THE GEIGER KIT IS NOT INTENDED TO GUIDE ACTIONS TO TAKE, OR NOT TO TAKE, REGARDING EXPOSURE TO RADIATION. THE GEIGER KIT AND IT'S SOFTWARE ARE FOR EDUCATIONAL PURPOSES ONLY. DO NOT RELY ON THEM IN HAZARDOUS SITUATIONS!**