

User Guide for the GK-B5 with v12 Software rev. 1.1

Using the GK-B5

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

Controls:

When it comes time to put the kit in a case, you will need to decide what controls you want to add. You may also want to get familiar with the controls when the kit is on your bench. The wiring diagram below and in the [Build Instructions](#) will show you how to wire the controls. Controls that are attached to I/O pins simply ground that pin.

The possible controls and indicators are as follows:

Select Button (pin 10) – This button has several uses. Pressing and holding it at power on will reset the EEPROM to the default settings. Pressing it at the startup screen will allow you to set the alarm threshold. 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. Finally, pressing the select button during an alarm will silence the alarm for 30 seconds.

Null Button (pin 11) - 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.

Tube Switch (pin 9) - 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. Some users have also installed DPDT switch to select both the GM tube and the ratio.

Click / Tone Jumper (on board) - 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. (See [Tone Mode](#) below)

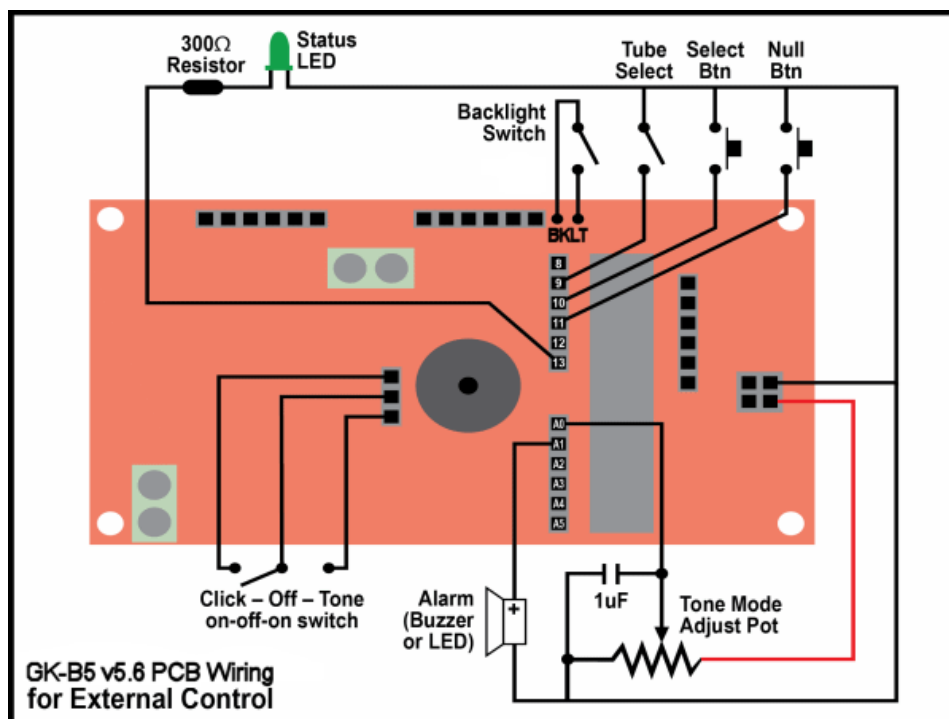
Count LED (on board) - Flashes for each event. This can be extended to your case. Most any LED can be used. Some LED colors may require lowering the resistance of R12 (currently 1.5k Ω).

Status LED (pin 13) - Flashes 4 times at start up, 2 times when sending serial output and once with each key press on the remote. If you add a Status LED make sure you also add the appropriate resistor in series with it.

Alarm (pin A1) – This pin goes high when you exceed the alarm threshold. An active piezo buzzer is included with the kit for this purpose. If you want to use something else. do not exceed 40mA. The alarm can be silenced for 30 seconds by pressing the Select button.

IR (on board) - This is the sensor for the IR receiver. This can be extended to your case.

Backlight Switch - Wiring a switch to control the backlight depends on the version of the PCB you have. Beginning with PCB v5.6 you simply remove the jumper and wire in a switch as shown.



For PCB v5.5 and below:

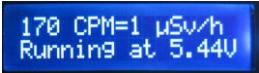
You can simply cut the lead on the top of the D/R resistor and bring both ends to your switch. This leaves the D/R resistor in the circuit.

You can also remove the D/R resistor and replace it right at the switch.

Tone Adjust Pot:

If **TONE SENSITIVITY** is set to "POT", a 100k Ω pot is used to adjust the TONE SENSITIVITY instead of the values in the menu option.
(See [Tone Mode](#) below)

Displays:



When you first power on the kit it will briefly run through a few screens. The first will be the software version that is running. The next screen (*top left*) will show the current settings for your dose rate, and the battery voltage. The third screen (*bottom left*) will show the current setting for the alarm threshold and ask if you would like to change it. 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.

Then the main screen will appear . . .



The top line shows the CPM (updated every 5 sec. by default) and a quick response bar graph (updated 20 times / sec.). The bargraph will be replaced with "ALARM" if the displayed CPM exceeds the alarm threshold. It is also replaced by Vcc when it drops below 4.2V. The second line shows the **dose unit** and the calculated dose. The dose unit and the **dose ratio** (CPM to dose unit) are settable in the menu. See [Menu Options](#)

Pressing the Select button while in this screen will switch to the Scaler screen . . .



Two scalers are provided, each with its own period. The scaler on the *top line* is fixed at one minute and the scaler on the *bottom line* is set to a programmable period from 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, along with the amount of time left for the scaler period.



The screen on the left 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 by setting it below 2. 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.











Using the IR Remote:

An IR remote is used to access the menu system. A mini IR remote using the NEC protocol is provided. When the kit is busy processing very high counts, the IR remote may be less responsive.

Function of Keys on the Mini-remote

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



-  - Enters the menu system. "**DISP PERIOD (MS)**" is the first prompt you will see. 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 toggles the option.
<< - Decrements the value already set for the current option or toggles the option.
-  - ("Enter") Finalizes the entry in the current menu option.
Sets the null point if in tone mode *when out of the menu.*
- Digits 0-9** - For direct entry of values (instead of arrows). Use the "Enter" (>) key after entering digits.
-  - Enters a decimal point when setting **CPM->[DOSE] RATIO**
-  - ("Mute") Silence the speaker - *used when out of the menu.* An asterisk shows on line 2 when muted.
-  - ("Select") Switches between the main screen and scaler screen - *used when out of the menu.*
-  currently not used

Any other key - if in the menu system - the key code for unknown keys will display. This may happen if the remote is too far from the sensor.

Menu Options:

Initially, the menu options are set to defaults. Settings made will be stored in EEPROM on the ATmega328, so they will be in effect when you power back on. Pressing and holding the physical Select button at power on until the software version appears will reset all menu settings back to their default settings.

Here's a brief description of each menu option along with its default setting:

DISP PERIOD (MS) - The number of milliseconds before the display refreshes. **Default = 5000 mS (5 sec)**

(Display counts are based on a "running average" I do not recommend settings of less than 5 seconds.)

LOG PERIOD - Interval to write the CPM, 'dose', and MCU voltage to the serial output. **Default = 1 minute**

Zero means logging is turned off.

CPM->[DOSE] RATIO - Sets that ratio for the type of GM tube used. **Default = 175.43 CPM and 100 CPM to dose unit (uSv)**

Note this ratio will depend on the dose unit being displayed - see **DOSE UNIT**. Also note that 2 ratios can be stored. The second ratio can be selected by the Tube Switch. Depending on the position of the switch this menu option will set the value for either the 1st or 2nd ratio. 175.43 is the common default for the SBM-20 and 100 for the LDN 712. The "C" key on the remote can be used to enter a decimal point

ALARM THRESHOLD - When the CPM or DOSE units is greater than this value 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 at startup, 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 - Use the arrow keys to select the *name* of the unit for the dose value - "uSv/h", "uR/h" or "mR/h". **Default = uSv/h**

ALARM UNIT - Sets whether the alarm is based off of CPM or the DOSE unit. Use the arrow keys to select. **Default = CPM**

Note that the ALARM THRESHOLD only accepts whole numbers, so CPM is best for low thresholds.

SCALER PER (MIN) - Sets the period for the second scaler. **Default = 10 minutes**

If scaler period set to "Infinite" (setting below 2) , the accumulated dose rate is displayed on the scaler screen.

BARGRAPH MAX CPM - Sets the CPM that will give a full scale reading on the bar graph. **Default = 1000 CPM**

Also see the [Tone Mode](#) section for how this option affects tone mode.

tone SENSITIVITY - Determines how sensitive the tone is to changing activity. **Default = 4**

Low numbers are more sensitive. There is also a "Pot" setting (below 0 and above 1000) to enable an external pot for this setting. See [Tone Mode](#) below for more information.

USE RADLOGGER? - When "Yes" serial output is compatible with *Radiation Logger* and *Radmon.org* applications. **Default = OFF** (see [Graphing to a PC](#) page). If you are using the GKnet or GK-WiFi to connect *directly* to Radmon.org, this setting should be OFF.

REG. VOLTAGE - Displays the voltage powering the MCU (Vcc). To a large degree, this represents the state of the battery.

Note that each menu setting has a minimum and a maximum setting. Entries that are out of bounds will wrap 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 1uSv = 0.1mR. 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 x 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 x 10 x .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 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 here and 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 was set at when the menu option was entered. Press the ENTER key to see change made each time you adjust the pot. (Use the right or left arrows and press ENTER to leave the Pot setting mode.)

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 the 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 most normal background radiation is ignored and the tone is seldom heard.
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. This replaces the **TONE SENSITIVITY** menu setting. The two outside pins of a 100k potentiometer are connected to ground and Vcc, and the wiper is connected to A0. 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](#) here and in the [Build Instructions](#).

Logging

Logging is provided in the form of serial output through the FTDI connector at 9600 baud, N,8,1. The frequency to send the serial output is determined by the **LOG PERIOD** menu setting.

The default format has a header on the first line with each line of data in comma separated values for CPM, Dose, and Vcc. For example, **36,0.2052,4.79<CR/LF>** (36 CPM, 0.2052 dose, 4.79V)

When **USE RADLOGGER?** is set, no header is created, and only CPM is output. This setting is used when connecting the serial output to the [Radiation Logger](#) application.

Software Switches

If you are willing to load the software, modify it, and upload it, you can set #defines to change certain behavior or add special features to the program. In general all the common features are enabled and you don't have to mess with it. But if, for example, you want to use a 2x8 LCD, you simply change a #define, and upload the new release.

All user based #defines are located at the beginning of the sketch and may change based on the version. Below is a list of the defines in the current version.

- **EIGHT_CHAR** - formats for 2x8 LCD when true
- **ANDROID** - include Android support if true
- **ANALOG_METER** - support for analog meter output - REQUIRES HARDWARE - see [this project](#)
- **DOGM_LCD** - if true, DogM LCD used for display (SPI interface)

There are step by step instructions on installing the Arduino IDE and uploading new software. You can get it [here](#).

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 6 separate counters in the GK-B5 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 Counter:

This counter is refreshed by the period set in the "LOG PERIOD" set in the menu. It is a simple accumulator with the result extrapolated to a 1 minute period. If the period is set to the recommended 1 minute, then its value is a true one minute count. Since this counter is output in the rears, it is actual rather than predictive.

3 Scaler Counters:

Two of these counters operate in much the same way as the Serial Counter. One is refreshed by the SCALER PER 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!