

User Guide for the GK-B5 with v10.3 - v10.3C Software

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. *Note: In v10.3 the scaler cannot be entered with the Select button when the alarm is on. This has been corrected in v10.3B.*

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.

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. This jumper is found on both the main board and the Display Adapter. (See [Tone Mode](#) below)

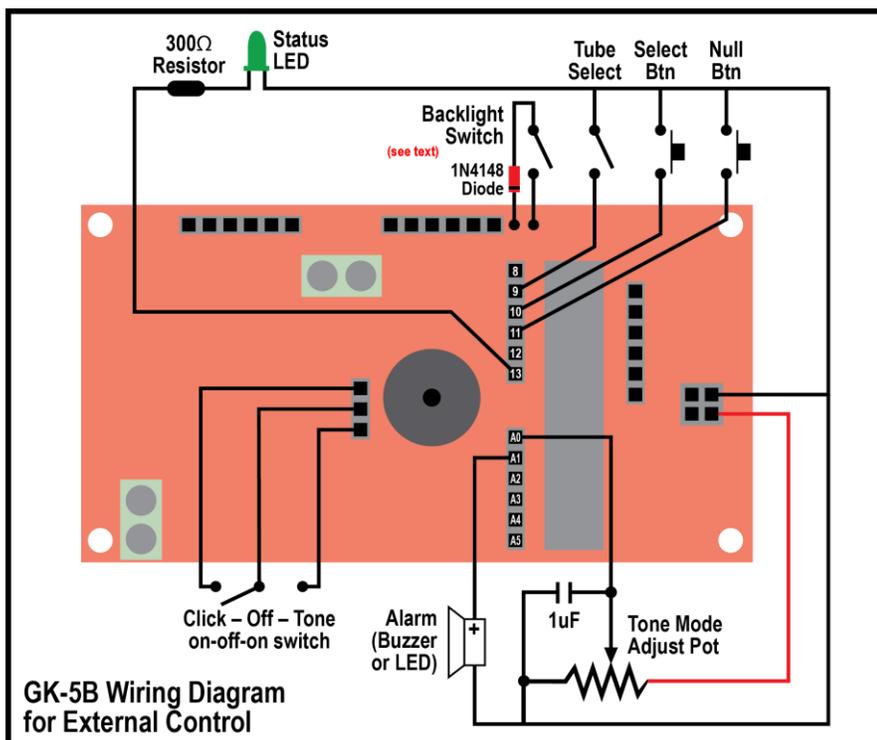
Count LED (on board) - Flashes for each event. This can be extended to your case. Most any LED can be used. Some LED colors may require lowering the resistance of R12 (currently 1.5kΩ).

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 orange LED with a built-in resistor is included with the kit for demonstrating the alarm. If you want to use something else like a piezo buzzer, 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 - This would make the most sense if you are using the green display that can be read without the backlight. To wire it, see the following.



For the backlight switch there are several options:

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. Instead of a resistor, you can also use a diode as shown in the wiring diagram.

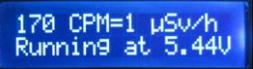
Note that in v10.2 you must enable the Tone Mode Adjust Pot in the software by setting its #define to true.

Tone Adjust Pot:

This feature must be enabled in the sketch by setting the #define TONE_POT_ADJ to true.

If set, a 100kΩ pot is used to adjust the TONE SENSITIVITY instead of the menu option.

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:

The setup menu is used to configure several operating parameters for the kit. For the most part, these are "set once" features and therefore a TV remote works fine for this.

Universal Remotes

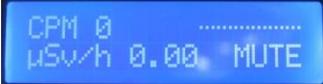
It's usually best to get a "universal" remote - the kind where you enter a numeric code for the brand of TV. The kit is looking for standard Sony TV codes. Generally a cheap one from a big box store will work. In the US [this remote](#) is widely available and works well (it uses code 8201). After you enter a Sony TV code in the remote, press the **On/Off** button to test if you have the right code. If the kit goes into the menu try the other buttons to see if they all work. If not try another code. Once you have the remote set up, the keys should perform the functions listed below.

Support for a Phillips remote (RC-5 IR protocol) is also provided in the software, but it requires the ability to upload a modified sketch. (see the [Build Instructions](#) for your kit.)

Keychain Remotes

Keychain remotes are small, low priced remotes that are setup differently than "universal remotes". Instead of entering a code number to pair with the device, keychain remotes scan through all the device codes when pressing and holding MUTE button. When a match is made, the device will mute. Then you must *immediately* release the MUTE button.

This makes them a bit tricky to setup with the kit. However, a new feature has been added beginning with v10.3C that lets you know immediately when the kit has detected a MUTE command from the remote so you can release the button. This makes it a bit easier to setup this type of remote.



There are a few things to keep in mind. The first is that codes do not change immediately when the MUTE button is pressed. It usually takes about 3-4 seconds before they begin to advance. You can see this if you have the Status LED connected. It will flash with any IR signal, and as you hold down the MUTE button it will flash for a few seconds, stop, and begin flashing again. The second period of flashing is when the remote is changing its codes.

It's been reported that batteries in these remotes will discharge over time even when the remote is not used, so be sure you have a good battery before you begin. You can check its voltage, see if the Status LED flashes, or look at the IR LED through a digital camera to see it flash.



There are two kinds of keychain remote, a "JY-520" with a 10 key pad (i.e. [this](#)) and a tiny one without the 10 key pad (i.e. [this](#) or [this](#)). The 10 key pad certainly makes it easier to set the higher value numbers like the conversion ratio, but if your patient it can also be done with right and left arrow keys on the tiny remote. Note however that the tiny remote does not have a key for the decimal and some of the "out of menu" functions. Also note some of the "new" JY-520 remotes have other functions instead of the arrow keys and you must use the channel and volume keys instead. I would avoid that type.

To setup a keychain TV remote for the Geiger Kit:

1. It's best to disconnect the GM tube when programming.
2. Press and hold the MUTE button. Codes will begin to change after about 4 seconds.
3. As soon as you see the "MUTE" indication on the kit, release the button. You must be quite fast at this.
4. Press the MUTE button again. Did the kit indicate mute? If not, you didn't release the button in time and it went on to the next code. Start again at step 2. If you did see mute indication, congratulations, you're fast! Go to step 5.
5. Now press the POWER button. You should go into the setup menu. Then try other buttons like the arrows and key pad. Sometimes you can get in the menu but other buttons will not work. In that case, it's back to step 2.

Function of Keys on the Remote

The names may vary somewhat between remotes. **Names in green refer to the keychain remote with the number pad.**

- **On/Off** – enter or exit the menu system. "**DISP PERIOD (MS)**" is the first prompt you will see.
- **Channel Down** or **Down Arrow** – moves to the next menu option
- **Channel Up** or **Up Arrow** – moves to the previous menu option
- **Volume Up** or **Right Arrow** – increments the value already set for the current option or toggles an option
- **Volume Down** or **Left Arrow** – decrements the value already set for the current option or toggles an option
- **Enter / Menu** – finalizes the entry in the current menu option if changes were made
- **Digits 0-9** – for direct entry of values (instead of Volume or Arrows) – must use **Enter / Menu** after using digits.
- **DEC PNT / "--/-"** or **AV/TV** - enters a decimal point - used when setting the ratio.
- **Mute** – **used when out of the menu** – mutes the speaker if in "tone mode" or the clicks if that mod has been made to the Geiger board.
- **Info/Select / ** - **used when out of the menu** - switches between the main screen and the scaler screen
- **Any other key** – **if you are in the menu system** the key code for unknown keys will display.

You can just arrow down to the menu option that you want to change, then enter the new value, press **Enter** and **On/Off** to exit the menu.

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 Select button at power on 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 **DEC PNT** or **AV/TV** 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, 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**

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. (see below)

USE RADLOGGER? - When "Yes" serial output is compatible with Radiation Logger application. **Default = OFF**
see [Android / PC BT Graphing](#) page.

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 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 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 175.43×10 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 by the **TONE SENSITIVITY** menu option. 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](#) 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 most interesting defines in the current version.

- **EIGHT_CHAR** - formats for 2x8 LCD when true
- **DOGM_LCD** -DogM LCD used for display (SPI interface)
- **IR_RC5** - use Phillips RC5 IR protocol instead of Sony
- **ANALOG_METER** - support for analog meter output - REQUIRES HARDWARE - see [this project](#)
- **TONE_POT_ADJ** – if set, a 100kΩ pot can be used to set TONE SENSITIVITY instead of the menu option.
- **SELF_TEST** - adds one to each counter every 167ms - simulates a ~360CPM count

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

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!