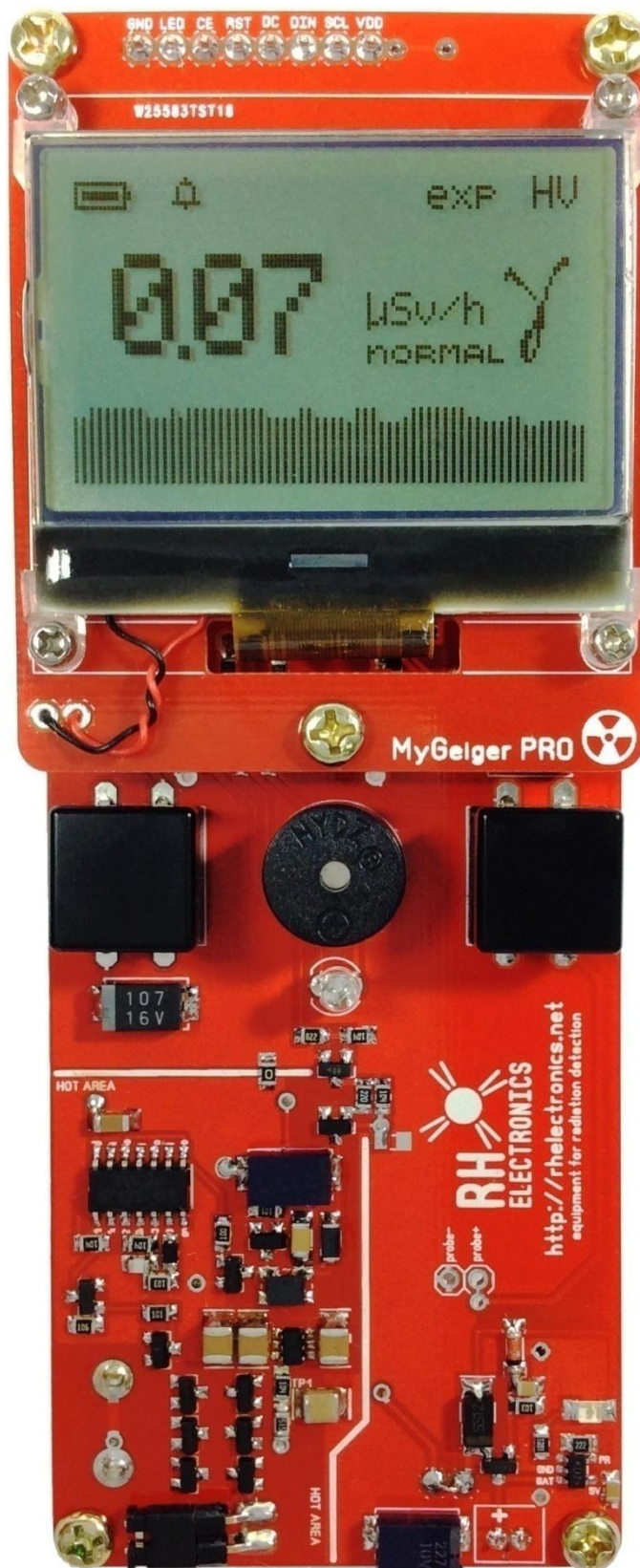# MyGeiger ver. 3.00 Pro - DIY Geiger Counter Kit

MyGeiger ver.3.00 PRO is intended for measuring gamma radiation dose rate and precision CPS counting. The device is designed for enthusiasts, physics students, teachers and researchers engaged in radiation study. It has applications for hobby projects as well as environment monitoring and laboratory testing. The device is compatible with wide range of Geiger tubes, with extensive calibration options for Geiger tube configuration.

The ver.3.00 PRO has redesigned circuitry to deliver efficient high voltages with increased output power, a faster microprocessor loaded with updated and enhanced software, USB interface with CPM logging, a faster lithium charger, reduced power consumption and ergonomically positioned controls. The ver.3.00 PRO now has the ability to operate in radiation environments higher than 1500uSv/h.

Video demonstration link: https://www.youtube.com/watch?v=QVKTKNaMbnI

Technical summary:

- High Voltage: switchable between 420V and 500V, with stabilization
- High Voltage output current: 50uA at 500V
- High Voltage is independent from microprocessor, can be switched ON/OFF by software
- Geiger Tube PCB physical compatibility: SBM-20 or STS-5
- Geiger Tube Wire connection compatibility: LND-712, LND-7317, SBT-9, SI-29BG and more
- 128x64 High Quality dot-matrix backlit LCD with Shield PCB
- Gamma Radiation Dose Rate Display range: 0.01 uSv/h – 9.99 mSv/h
- Gamma Radiation Dose Rate with SBM-20: 0.05 uSv/h – 1500 uSv/h
- Dose Rate update period on LCD: 1 second
- Dose Rate full measurement period: 60 seconds
- CPS Ratemeter Counter Mode for external scintillation probe
- Average CPS mode for precision sample testing
- Sample time for precision measuring Average CPS: 5-60 minutes
- Built in USB port for logging in Counts Per Minute (CPM) or Counts Per Second (CPS)
- Battery Indicator and USB detection
- LED and switchable piezo sounder detection indicators
- Mute / Backlight / Menu control with ergonomically positioned big buttons
- Sleep function with option to use external mechanical ON/OFF switch if required
- Calibration Menu
    - Gamma Conversion Factor calibration 0.7 – 9.0 CPS for 1uSv/h
    - Dead time correction option: 10uS - 250uS, set zero for disable
    - Audible Alert function with adjustable threshold: from 1uSv/h to 200uSv/h
    - Adjustable USB port UART speed for logging software 2400-9600 baud
- Auto power OFF option after 10 minutes - 4 hours, set zero to disable
- Built in USB charger with overcharge protection for 3.7V lithium battery
- Recommended battery type: 3.7V liPo with capacity >300mAh
- Battery quiescent current consumption at background: 2.5mA
- Battery current consumption in sleep mode: less than 0.2mA
- Operating Voltage: 3.0V – 5V
- Quality soldered PCB with modern SMD components, the kit is assembled
- Dimensions: 51mm x 130mm x 32mm
- UPC Number: 634154871188
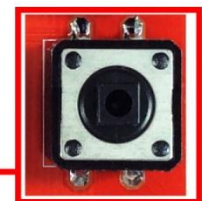- SKU Number: RH-K-GK-PRO

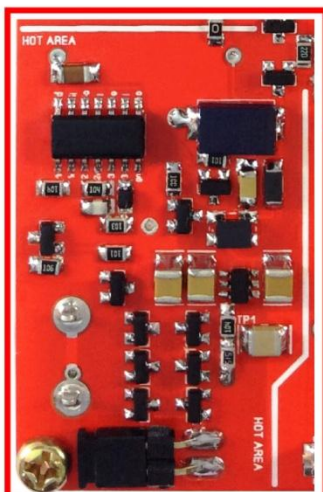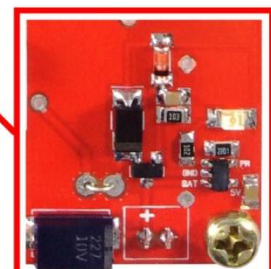**High Performance Microcontroller**
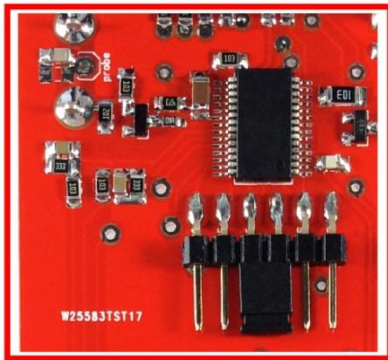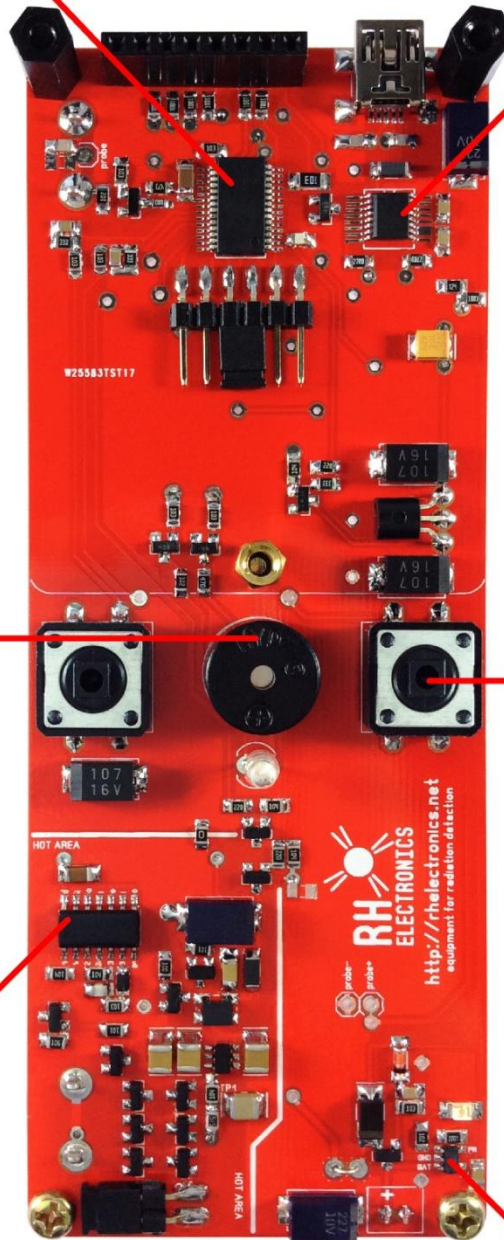
USB for logging
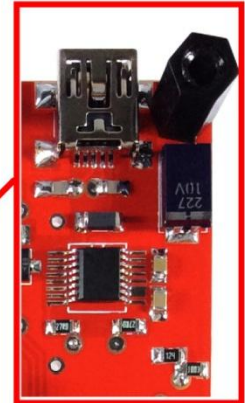
Beeper and LED

Comfortable tact buttons

Efficient High Voltage 420V / 500V

Fast Lithium Charger with protection

MyGeiger ver. 3.00 Pro (shown with optional Geiger tube and optional LiPo battery)

Kit Contents:

- Assembled and fully tested MyGeiger ver. 3.00 Pro, complete with LCD display
- 2-wire power lead with JST connector

Required Components:

- 3V – 5V DC power source
  or
- 3V – 5V DC battery (3.7V liPo with capacity >300mAh is recommended)
- Suitable Geiger tube (MyGeiger ver. 3.00 Pro is compatible with a range of commercially available tubes)
- Protective case / housing (optional but recommended)

Both Geiger tube and rechargeable LiPo battery are available to order from RH Electronics

Geiger tube installation:

The tube must be installed after the battery is disconnected and the High Voltage output has been discharged through a 10MΩ resistor. Under no circumstances should the tube clips be directly shorted to discharge. Shorting without 10MΩ resistor can result in damage to the unit. Check the tube is installed properly into the clips; the positive (+) anode of the Geiger tube is installed towards the High Voltage block.

Heat shrink insulation over the tube is sometimes necessary to prevent the cathode from accidentally contacting and shorting to the PCB tracks and which can otherwise result in damage to the unit. Insulation is necessary with an SBM-20 tube because the corrugated stiffening ribs of the tube can deflect under an accidental load and contact the PCB. Similarly sized tubes may also require insulation. If an energy compensation shield of lead is added over the tube this too increases tube diameter and insulation is necessary.

When using a LND-712, LND-7317 or similar short tube it should be connected by short wires to the PCB clips.

The board can deliver 420V or 500V to the tube, allowing compatibility with a wide range of Geiger tubes. Voltage is adjusted via a load resistor which is set by the high voltage jumper, located in the Hot Area of the PCB. Set the jumper to the correct voltage to match the Geiger tube: jumper in place for 420V, jumper removed for 500V. To remove the black high voltage jumper firstly to remove the screw to gain access and then gently pull out the jumper to remove.
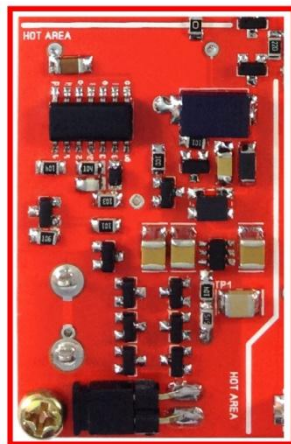
Battery installation:

<u>Please check battery polarity before connecting</u>! The charging IC chip does not include reverse polarity protection. Be careful! Use the supplied JST connector with the supplied wire. It is recommended to use 3.7V LiPO battery with a capacity greater than 300mAh. An example is below:

https://www.sparkfun.com/products/13851

<u>**The board will power ON immediately after connecting the battery**</u>

LiPo batteries from Sparkfun and from Adafruit should come with correct polarity of the connector however it is strongly recommended to re-check polarity before first usage.

Battery Charging and protection:

The board has an intelligent chip which controls lithium battery charging and protects the battery from overcharging. The battery can be charged from a computer USB jack or from a USB 5V power bank connected to the USB port on the device. The charge STATUS LED will turn OFF when charging is complete. The maximum charge current is 500mA. Charge time depends on the USB current output and the battery capacity.

The software continuously monitors the battery level. If the battery output voltage falls below the critical 3.00V threshold then the device will automatically shut down to protect the battery from deep discharge.

Turn OFF / ON and SLEEP Function:

Turn OFF the device by making a long press on the left button. To turn ON the device make a short press on the right button.

If a sleep timer is set in the Calibration Menu then the device will automatically turn OFF after the elapsed time has passed. Auto sleep function is active only in Gamma Ratemeter working mode and is not active in Average CPS working mode.

Please Note! High voltage is still present on the charged capacitor output after turning OFF the device. Component leakage is low and complete self-discharge can take a very long time! Do not touch the tube clips! Always discharge the High Voltage output through a 10MΩ resistor before touching or working on the board! Under no circumstances should the tube clips be shorted to discharge. Shorting without 10MΩ resistor can result in damage to circuitry.

Adding mechanical power switch to the project:

When turned OFF via the buttons the device continues to draw a very small current while in standby. To add a mechanical power switch to the device, cut the small metal link above 200uF capacitor on the PCB and to connect a mechanical power switch. As before, note that high voltage is still present on the charged capacitor output after turning OFF the device, even by mechanical switch. Do not touch the tube clips until high voltage is discharged through a 10MΩ resistor.
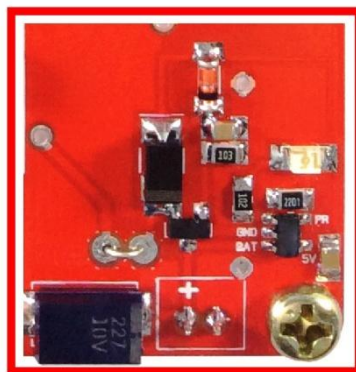
LCD Shield:

MyGeiger 3.00 PRO has 128x64 high quality dot-matrix LCD with blue backlight installed on an LCD shield board. Install the shield with 3 screws into the 8-pin socket.
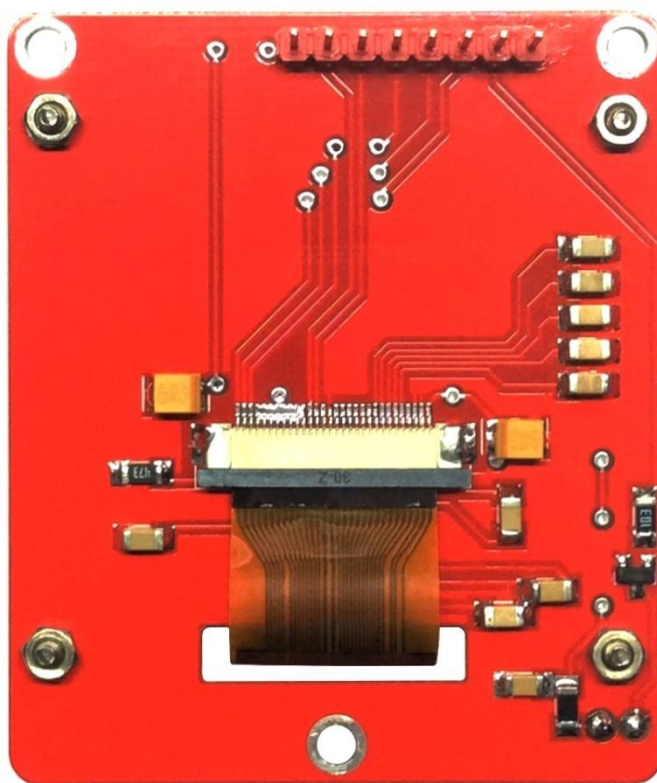
Mute and Backlight control:

To mute the beeper, make one short press on the left button. Toggle the beeper back ON by a short press on left button again. Beeper status is indicated by the sound icon on the upper line of the LCD. Beeper toggling function is active only in the Gamma Rate Dosimeter mode. Set the beeper ON or OFF before entering Average CPS mode.

The backlight can be toggled via the right button. Make one short press to toggle the backlight. Backlight toggling function is active in both Gamma Dosimeter mode and in Average CPS mode.

Radiation Alert Function:

Gamma radiation level for the audible alert is set in Calibration Menu. By default it calibrated to 1 uSv/h. The audible alert threshold can set up to 200uSv/h in the Calibration Menu. Alert function for high dose rate is active only in Gamma Ratemeter mode.

Gamma Ratemeter:

The default software working mode is Gamma Ratemeter. The software will calculate current Dose Equivalent Rate (DER) in uSv/h or mSv/h units. Initial settings are for SBM-20, but this can be recalibrated from within the Calibration Menu to suit a wide range of Geiger tube types.

Software begins a new measuring cycle immediately after the unit is turned on or if the radiation level changes critically (as defined by Set Dose Ratio within the Calibration Menu). The DER is updated on the LCD every second and the unit will initially estimate the dose rate until the estimation cycle is complete. During this initial estimation the estimation symbol ≈ will be visible on the upper line of the LCD. It is recommended to wait until the estimation cycle is complete to get the most accurate DER value.

In addition to the user specified radiation alert threshold as specified from within the Calibration Menu, the LCD will display "normal" when the radiation level is below 0.3uSv/h and "ALARM" when the radiation level is above 0.3uSv/h, notifying the user that radiation levels have increased to a suitably significant level. This LCD alert operates independently of the user specified radiation alert threshold.

Dead time dose rate correction:

If dead time correction is used "**exp**" symbol will appear in the upper line of the LCD. The correction has noticeable effect on high count rate, but almost no effect on low source activity measurement.

After a count has been recorded it takes the Geiger tube a very small but measurable amount of time to reset itself to be ready to record the next count. This "dead time" is the time it takes for the detector to reset itself. The detector is not operating while it is being reset so the measured activity on the device could be slightly under the true activity of the sample. If the counting rate is high then the effect of dead time may become significant. The software uses following formula to apply a correction, so allowing for this dead time:

$$n = \frac{m}{1 - m\tau}$$

Most Geiger tube specifications list the dead time and this can be adjusted from within the Calibration Menu. Users can set zero dead time if the function is not required for test conditions.

Average CPS measuring:

To enter Average CPS mode, make one long press on the right button. The software will switch to Average CPS measuring. To return back to Gamma Rate mode make one long press on the right button again.

Average CPS mode is intended for precision CPS (count per second) testing of radioactive samples.

Default sampling period for the sample test is 5 minutes but the sampling period can be changed from within the Calibration Menu. Usually low activity samples require longer time, high activity samples can be estimated in less than a minute. A more precise measurement of average CPS is obtained with a longer sample period.

The Average CPS results are presented in the bottom left side of the display and the timer is displayed in the bottom right side. The averaging period can be restarted at any time by pressing left button.

Beeper toggling function is not active from within Average CPS mode, set the beeper on or off from within Gamma Ratemeter mode before entering Average CPS mode.

Average CPS counter without fixed timer:

This mode is intended for use with external scintillation probes or if a CPS measurement is required without a fixed time reference. To enable this feature set zero SAMPLE TIMER in Calibration Menu prior entering CPS measuring mode. The counter will average up to one hour; the counter averaging can be restarted at any time by pressing left button.

USB logging:

The dosimeter has an FTDI USB virtual COM port. USB drivers install automatically when the device is connected to a computer. In Gamma Ratemeter mode the dosimeter will log CPM (counts per minute) once every second to USB. In Average CPS mode it will log CPS (counts per second) readings.
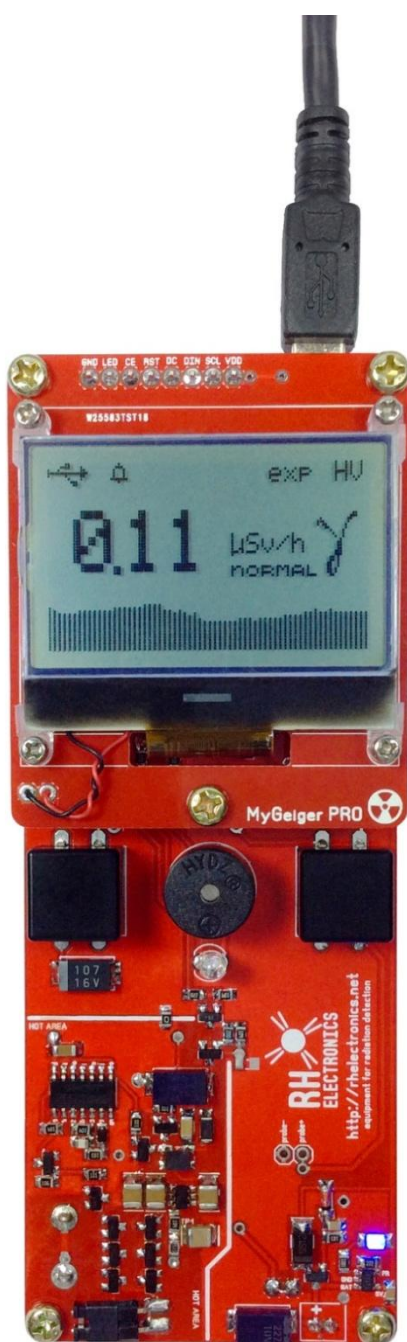
Default and recommended baud rate is 9600 (setting can be changed in Calibration Menu).

Download RH Electronics freeware Windows software for logging and online monitoring here:

http://www.rhelectronics.net/store/radiation-logger.html

Third-party freeware UART software for CPS logging:

 https://sites.google.com/site/terminalbpp/

Calibration Menu:

To Access Calibration Menu: Turn OFF the unit by a long press on left button. After unit is switched OFF, press and hold the left button to turn back ON and make short press on right button (while still holding down left). The device will enter the Calibration Menu.

Calibration Menu is navigated by scrolling with the left button and selecting with the right button. The menu has in-built hints for easy setup.

SET CONVERSION: Can be set from 0.7 – 9.0 CPS to 1 uSv/h. Use Geiger tube datasheet to determine the correct value for the specific tube being installed. The conversion factor is usable only for <u>Gamma</u> radiation.

SET ALERT LEVEL: Can be set from 1 uSv/h up to 200 uSv/h.

SET DEAD TIME: Can be set from 10uS up to 250uS. Use Geiger tube datasheet or oscilloscope to determine the correct value for specific tube being installed. If this function is not required set dead time to zero.

SET SLEEP TIMER: Timer for automatic power OFF. Can be set from 10 minutes up to 4 hours. Set to zero to disable this function.

SET SAMPLE TIMER: Timer for Average CPS mode. Can be set from 5 minutes up to 60 minutes. Set to zero for Average CPS mode without a fixed timer.

SET UART SPEED: Default and recommended is 9600 baud. Options available are 2400/4800/9600

USE EXTERNAL PROBE: Set to NO if using Geiger tube is connected and powered by the board. Set to YES if using external scintillation probe driver or external Geiger tube driver. If YES is selected then internal High Voltage block will be turned OFF and only external tube can be active. Regardless of setting, HV capacitors are charged during device initialization, therefore a high voltage can still be present on the board. Be careful!

"YES" > Internal HV is OFF > **XLR** symbol on LCD

"NO" > Internal HV is ON > **HV** symbol on LCD

SET DOSE RATIO: The ratio of dose rate to estimated dose rate. It defines how the software reacts to rapid changes in dose rate. This feature is most useful when a sudden change occurs in CPS. For example, if the unit is suddenly exposed to a hot source the software will quickly estimate the new dose rate and display this on the LCD screen while at the same time will start the timer for precise dose rate measurement from this new point. The ratio can be set from 3 to 20. Recommended value for the SBM-20 tube is 6.

SET TO DEFAULT: Restore all settings to default. The counter will reset.

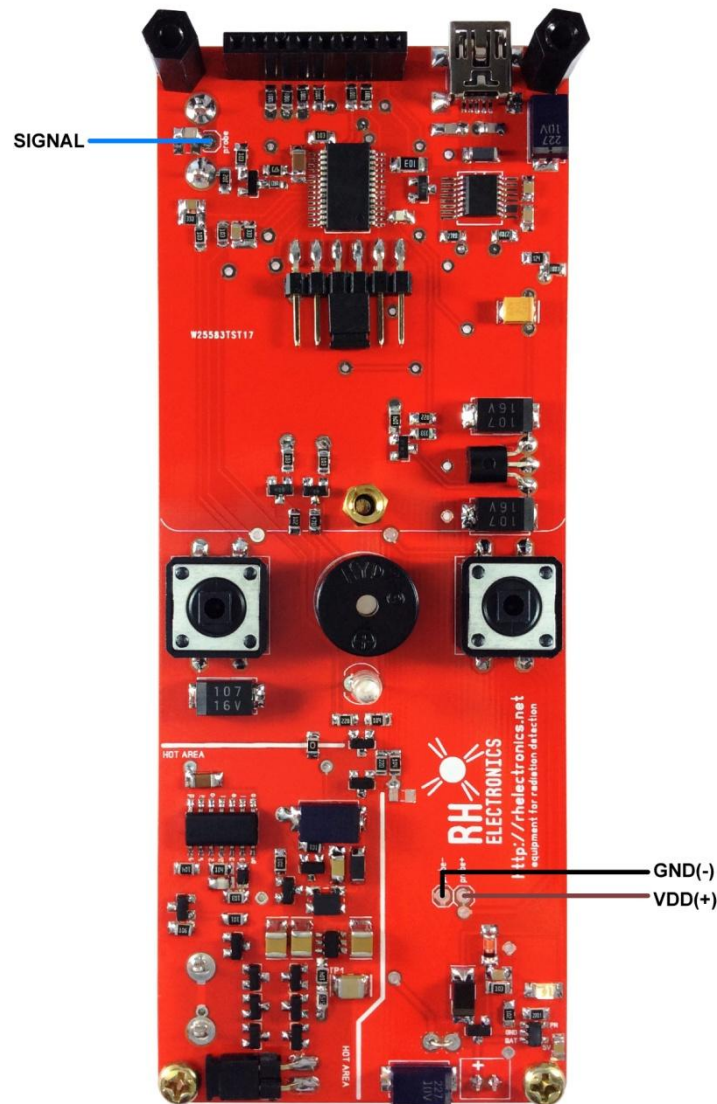**SAVE SETTINGS:** Confirm if changed settings are to be saved prior to exit. The counter will reset.

Menu video demonstration link: https://www.youtube.com/watch?v=MP4P-uzwaTg

GM Tube Parameters:

GM Tube	HV settings	Dead time uS	CPS for 1uSv/h
SBM-20 / STS-5	420V	190	2.9
LND-712	500V	90	1.8
LND-7317	500V	40	5.8
Vacutec 70019A	500V	60	1.6

Connecting external probes:

An external Geiger or Scintillation probe driver can be wired by 3-wire configuration. Please see the diagram below. Supported Geiger probe drivers for long cables are offered on the RH Electronics website. We also accept custom orders for Scintillation Counter drivers; please contact support@rhelectronics.net to make an inquiry.

Supported External Probe Drivers:

http://www.rhelectronics.net/store/high-voltage-geiger-probe-driver-module-380v-550v-with-ttl-output.html

UPC Number: 635292807381

http://www.rhelectronics.net/store/high-voltage-geiger-probe-driver-power-supply-module-420v-550v-with-ttl-digitized-pulse-output.html

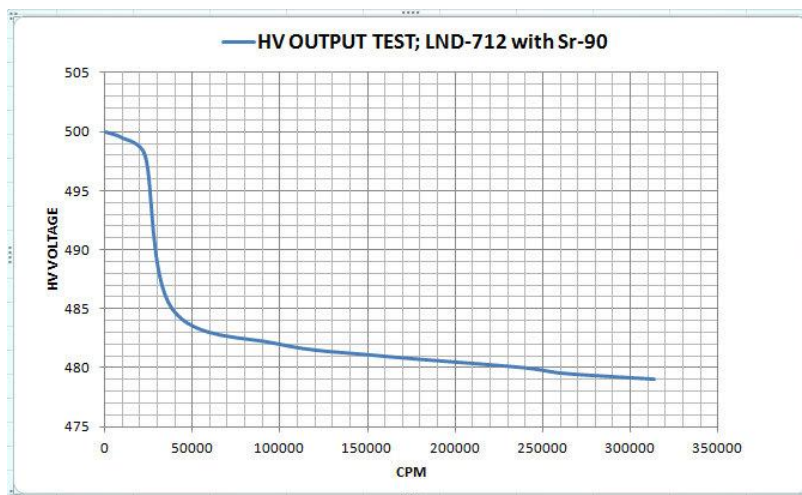UPC Number: 635292807428
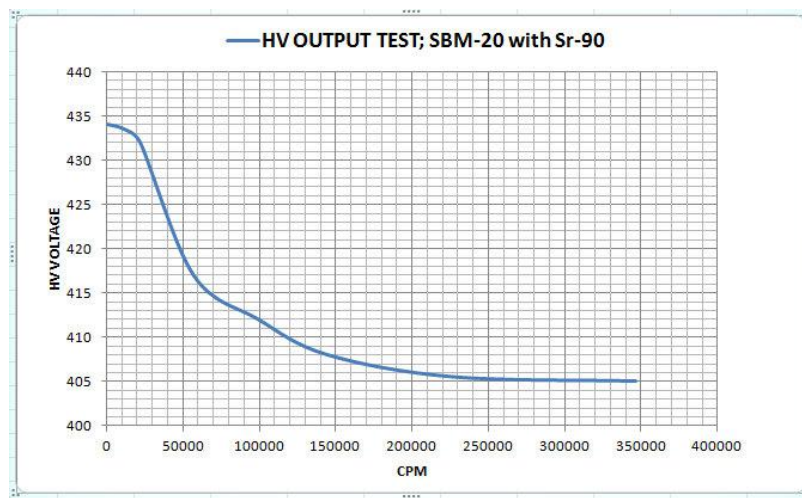
High Voltage Test Results:

The accuracy of a many Geiger counters fall as radiation levels increase because the high voltage circuitry is unable to maintain a sufficiently high voltage at high CPM. MyGeiger ver. 3.00 Pro has been purposefully designed to give a consistent voltage output at very high CPM, allowing the unit to continue to take accurate measurements at very high measured radiation levels.

All measurements are undertaken on PCB test point before tube load resistor.

High voltage output with load of 10 Mega Ohm: 420V / 500V

Quality of HV stabilization under radiation load: ±5%

High voltage output under radiation load test with Sr-90 control source:

Links to GM tube manufacturers:

http://www.lndinc.com/
http://consensus-group.ru/welcome
http://www.vacutec-gmbh.de/
http://niitfa.ru/

RH Electronics can only warrant the stability and accuracy of RH Electronics supplied Geiger tubes. RH Electronics cannot guarantee stability or accuracy of the measurements of any Geiger tube which was from old stock/eBay/USSR surplus. Whilst cheap, in our experience many old stock items which are purchased online have a large percentage of defects. If possible, purchase new and modern Geiger tube from a reputable manufacturer / stockist.

Conditions of sale:

MyGeiger ver.3 PRO is sold without an enclosure. It has an assembled PCB with installed components and a programmed microcontroller. It possible to purchase the kit with Geiger tube and lithium battery included for additional cost. Any design files or source files are closed and are not shared.

The device is intended only for persons competent in electronics and who are familiar with high voltage electrical devices for study or hobby projects.

 The default software settings are for SBM-20 / STS-5 / Gamma 7C tube. Integration with other tubes might require settings changes from within the Calibration Menu. RH Electronics makes no warranty that the MyGeiger ver.3 PRO is compatible with every available Geiger tube.

It's recommended to use beta-filter in gamma dose rate measurement mode to prevent increasing readings of gamma radiation.

Technical warranty:

The PCB of the kit is not protected from climate effects, moisture, any dust, mechanical damage or short circuit by external items. RH Electronics strongly recommends the board is suitably installed into a plastic box or container.

The technical warranty for the kit is offered during 6 months after purchase, which covers only reasonable usage. The warranty does not cover any mechanical damage or any electronics damages caused by deliberate misuse, impact or drops, short circuit, moisture or wrong polarity connection. The warranty does not cover attempting to modify or solder the PCB of the kit, however we offer a free diagnosis service in the event that something goes wrong.

support@rhelectronics.net