New and Improved Geiger Counter - Now With WiFi!

By prabhat_ in CircuitsArduino

Introduction: New and Improved Geiger Counter - Now With WiFi!

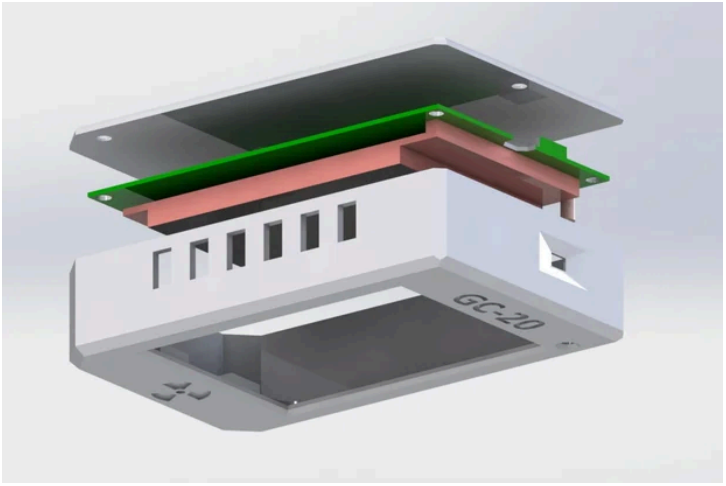
This is an updated version of my Geiger counter from this Instructable. It was quite popular and I received a good amount of feedback from people interested in building it, so here is the sequel:

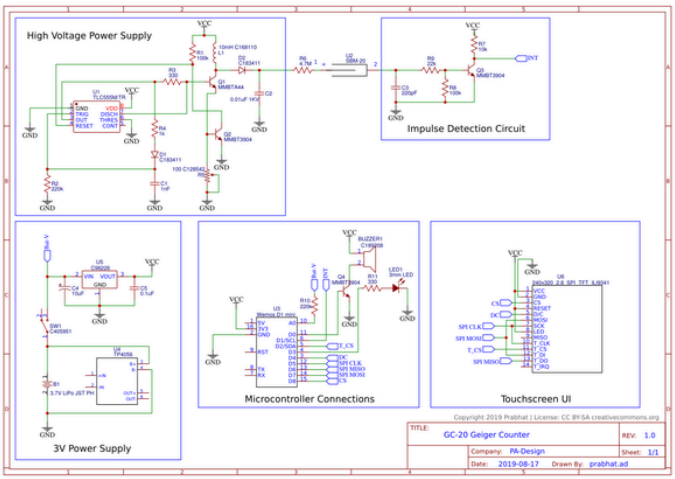
The GC-20. A Geiger counter, dosimeter and radiation monitoring station all-in-one! Now 50% less thicc, and with loads of new software features! I even wrote this User Manual to make it look more like a real product. Here's a list of the main features this new device has:

- Touchscreen controlled, intuitive GUI
- Displays counts per minute, current dose, and accumulated dose on homescreen
- Sensitive and reliable SBM-20 Geiger-Muller tube
- Variable integration time for averaging dose rate
- Timed count mode for measuring low doses
- Choose between Sieverts and Rems as the units for the displayed dose rate
- User adjustable alert threshold
- Adjustable calibration to relate CPM to dose rate for various isotopes
- Audible clicker and LED indicator toggled on and off from homescreen
- Offline data logging
- Post bulk logged data to cloud service (ThingSpeak) to graph, analyze and/or save to computer
- Monitoring Station mode: device stays connected to WiFi and regularly posts ambient radiation level to ThingSpeak channel
- 2000 mAh rechargeable LiPo battery with a 16 hour run time, micro USB charging port
- No programming required from the end user, WiFi setup handled through GUI.

Please refer to the user manual using the link above to explore the software features and UI navigation.

Step 1: Design Files and Other Links





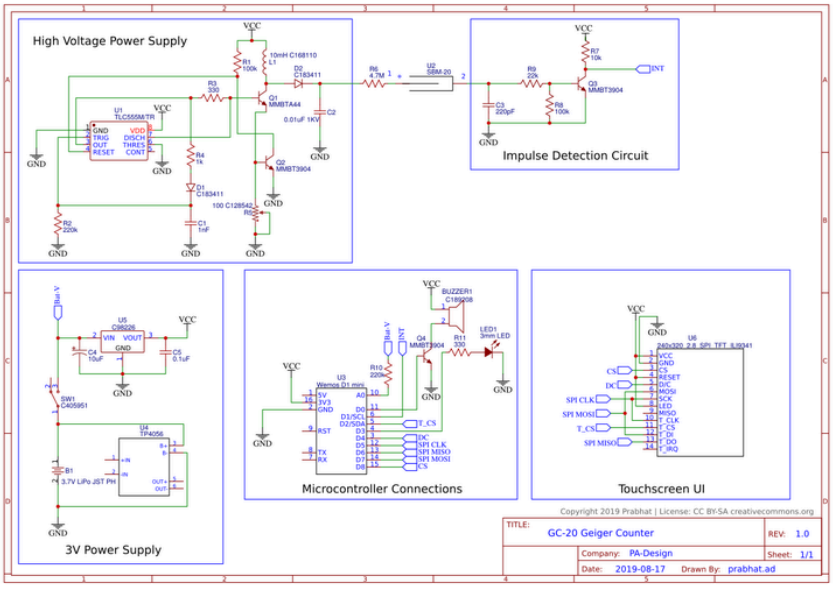
All design files, including the code, Gerbers, STLs, SolidWorks Assembly, Circuit Schematic, Bill of Materials, User Manual and Build Guide can be found at my GitHub page for the project.

Please note that this is a fairly involved and time-consuming project and requires some knowledge of programming in Arduino, and skills in SMD soldering.

There is an information page for it in my portfolio website here, and you can also find a direct link to the build guide I put together here.

Step 2: Parts and Equipment Needed

LCSC order information for electronic components for the GC-20			
Reference Designator	Value/Description	LCSC Part Number	Footprint
U1	CMOS 555 timer	C383061	SOP-8
U5	3V LDO linear regulator	C98226	SOT-89
C1	1 nF MLCC 50V	C1885	1206
C2	10 nF 1000V	C107192	1206
C3	220 pF MLCC 500V	C106036	1206
C4	10 uF Tantalum	C119050	CASE-B_3528
C5	100 nF MLCC	C82601	1206
R1	100K	C17900	1206
R2	220K	C17956	1206
R3	330	C104763	1206
R4	1K	C4410	1206
R5	100 Ohm Variable Resistor	C128542	Custom
R6	4.7M	C37800	1206
R7	10K	C140407	1206
R8	100K	C17900	1206
R9	22K	C25830	1206
R10	220K	C17956	1206
R11	330	C104763	1206
D1	Fast recovery 600V diode	C183411	SMAF
D2	Fast recovery 600V diode	C183412	SMAF
Q1	NPN Transistor 200mA 400V	C181174	SOT-23
Q2	NPN Transistor 200mA 40V	C111113	SOT-23
Q3	NPN Transistor 200mA 40V	C111113	SOT-23
Q4	NPN Transistor 200mA 40V	C111113	SOT-23
L1	10 mH Power Inductor	C168108	Custom
BUZZER1	Magnetic Buzzer	C189208	7.5*7.5*2.5mm
SW1	Power switch SMD	C405951	Custom
B1	JST PH battery connector	C265016	TH, 2mm pitch
LED1	Red LED 3mm	C330752	TH



The Circuit Schematic contains part labels for all discrete electronic components used in this project. I purchased these components from LCSC, so entering those part numbers in the LCSC search bar will show the exact components needed. The build guide document goes into more detail, but I'll summarize the information here.

UPDATE: I've added an Excel sheet of the LCSC order list to the GitHub page.

Most of the electronic parts used are SMD, and this was chosen to save space. All passive components (resistors, capacitors) have a 1206 footprint, and there are some SOT-23 transistors, SMAF size diodes, and SOT-89 LDO, and an SOIC-8 555 timer. There are custom footprints made for the inductor, switch and the buzzer. As mentioned above, the product numbers for all of these components are labeled on the schematic diagram, and a higher quality PDF version of the schematic is available at the GitHub page.

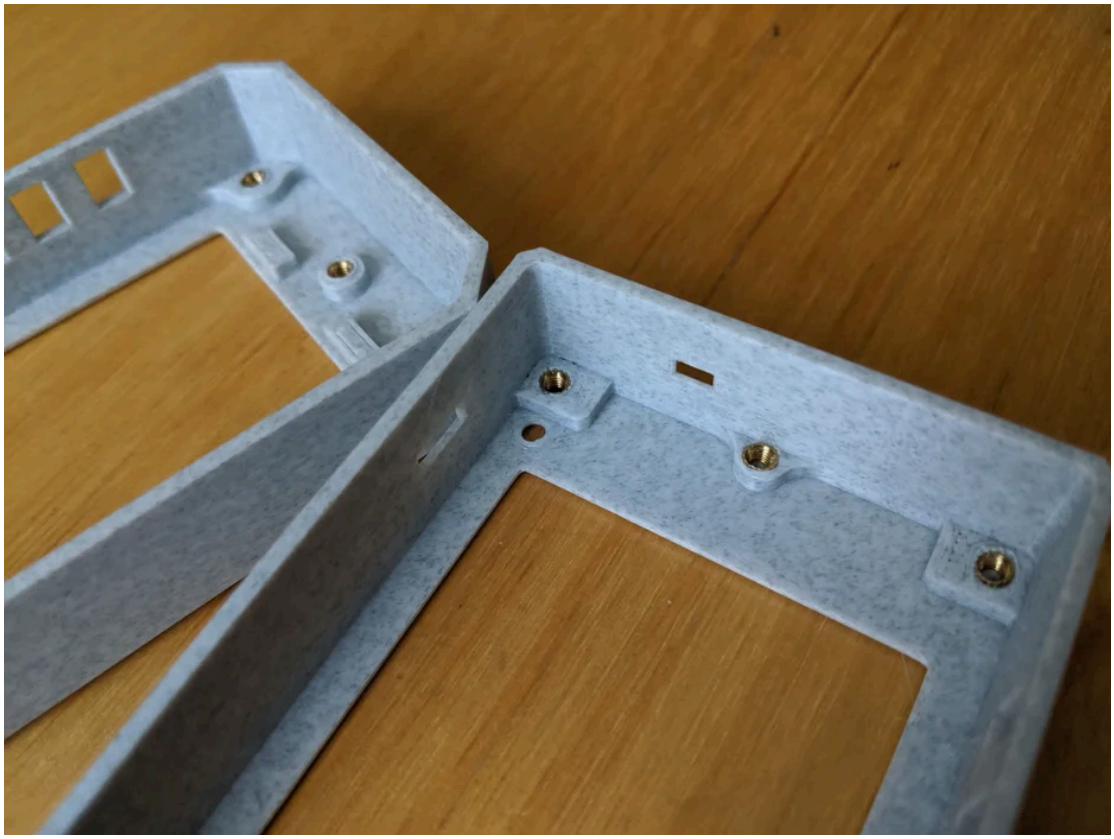
The following is a list of all the components used to make the full assembly, NOT including the discrete electronic components to be ordered from LCSC or a similar supplier.

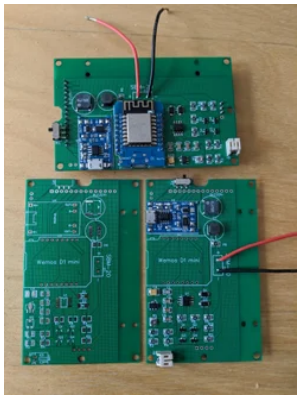
- PCB: Order from any manufacturer using Gerber files found in my GitHub
- WEMOS D1 Mini or clone (Amazon)
- 2.8" SPI Touchscreen (Amazon)
- SBM-20 Geiger tube with ends taken off (many vendors online)
- 3.7 V LiPo charger board (Amazon)
- Turnigy 3.7 V 1S 1C LiPo battery (49 x 34 x 10mm) with JST-PH connector (HobbyKing)
- M3 x 22 mm Countersunk screws (McMaster Carr)
- M3 x 8 mm hex machine screws (Amazon)
- M3 brass threaded insert (Amazon)
- Conductive copper tape (Amazon)

In addition to the parts above, other miscellaneous parts, equipment and supplies are:

- Soldering iron
- Hot Air soldering station (optional)
- Toaster oven for SMD reflow (optional, either do this or the hot air station)
- Solder wire
- Solder paste
- Stencil (optional)
- 3D printer
- PLA filament
- Silicone-insulated stranded wire 22 gauge
- Hex keys

Step 3: Assembly Steps





1. Solder all SMD components to the PCB first, using your preferred method

2. Solder the battery charger board to the pads SMD-style

3. Solder male leads to the D1 Mini board and to the bottom pads of the LCD board

4. Solder the D1 Mini board to the PCB

5. Cut off all protruding leads from the D1 Mini on the other side

6. Remove the SD card reader from the LCD display. This will interfere with other components on the PCB. A flush cutter works for this

7. Solder through-hole components (JST connector, LED)

8. Solder the LCD board to the PCB AT THE END. You won’t be able to de-solder the D1 Mini after this

9. Cut off the bottom-side protruding male leads from the LCD board on the other side of the PCB

10. Cut two pieces of stranded wire around 8 cm (3 in) long each and strip the ends

11. Solder one of the wires to the anode (rod) of the SBM-20 tube

12. Use the Copper tape to attach the other wire to the body of the SBM-20 tube

13. Tin and solder the other ends of the wires to the through-hole pads on the PCB. Make sure the polarity is correct.

14. Upload the code to the D1 mini with your preferred IDE; I use VS Code with PlatformIO. If you download my GitHub page, it should work without needing any changes

15. Attach the battery to the JST connector and power on to see if it works!

16. 3D print the case and the cover

17. Attach the brass threaded inserts into the six hole locations in the case with a soldering iron

18. Install the assembled PCB into the case and secure with 3 8mm screws. Two on top and one on the bottom

19. Place the Geiger tube on the empty side of the PCB (towards the grill) and secure with masking tape.

20. Insert the battery over the top, sitting over the SMD components. Guide the wires to the gap at the bottom of the case. Secure with masking tape.

21. Install the cover using three 22 mm countersunk screws. Done!

The voltage to the Geiger tube can be adjusted using the variable resistor (R5), but I've found that leaving the potentiometer in the default middle position produces just over 400 V, which is perfect for our Geiger tube. You can test the high voltage output using either a high-impedance probe, or by building a voltage divider with at least 100 MOhms of total impedance.

Step 4: Conclusion

In my testing, all features are working perfectly in the three units I've made, so I think this is going to be pretty repeatable. Please post your build if you end up making it!

Also, this is an open-source project so I would love to see changes and improvements made to it by others! I'm sure there are many ways to improve it. I'm a mechanical engineering student and I'm far from an expert in electronics and coding; this just started as a hobby project, so I'm hoping for more feedback and ways to make it better!

UPDATE: I'm selling a few of these on Tindie. If you'd like to buy one instead of building it yourself, you can find it at my Tindie store for sale here!