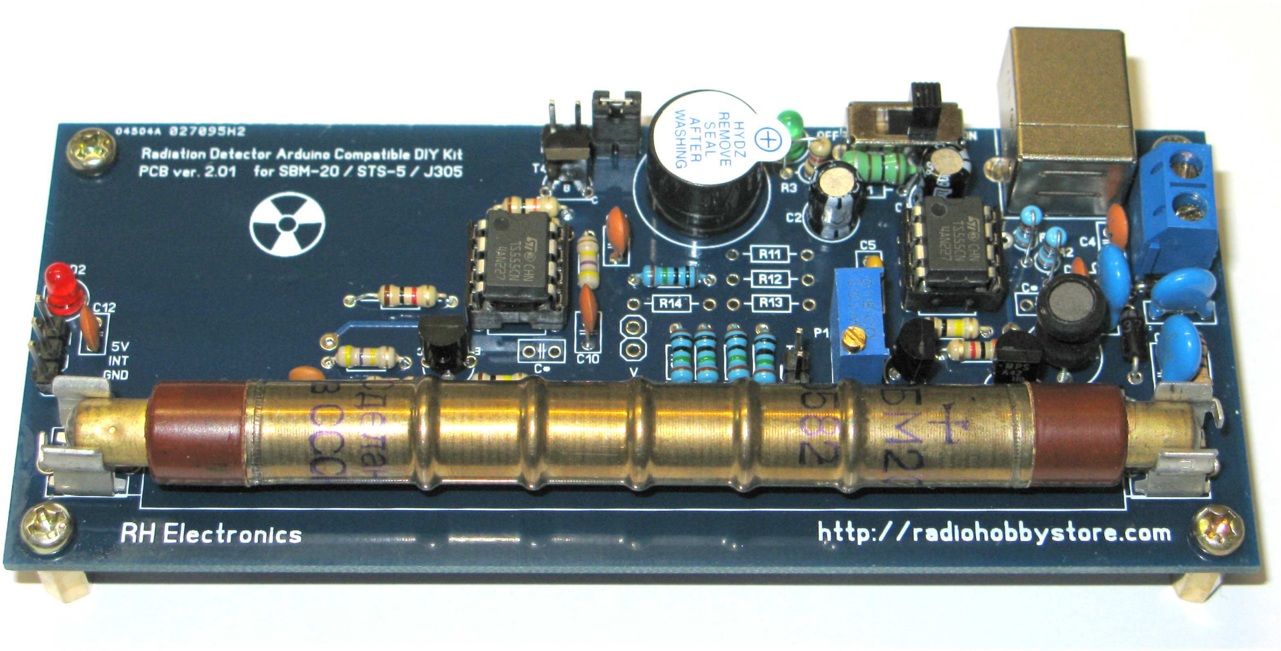
Radiation Detector DIY Kit

Arduino Compatible

ver. 2.01


Radiation Detector Arduino Compatible DIY Kit
PCB ver. 2.01 for SBM-20 / STS-5 / J305
RH Electronics
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Components List:

Resistors:
R1, R2 – Resistor 33K
R3, R21 – Resistor 1K
R4 – Resistor 3K
R5 – Resistor 100K
R6, R7, R8, R9, R10, R15 – Resistor 10M
R16, R22 – Resistor 10K
R18 – Resistor 47K
R17, R19, R20 – Resistor 470K

P1 – Variable Resistor Potentiometer 3296W 100 ohm

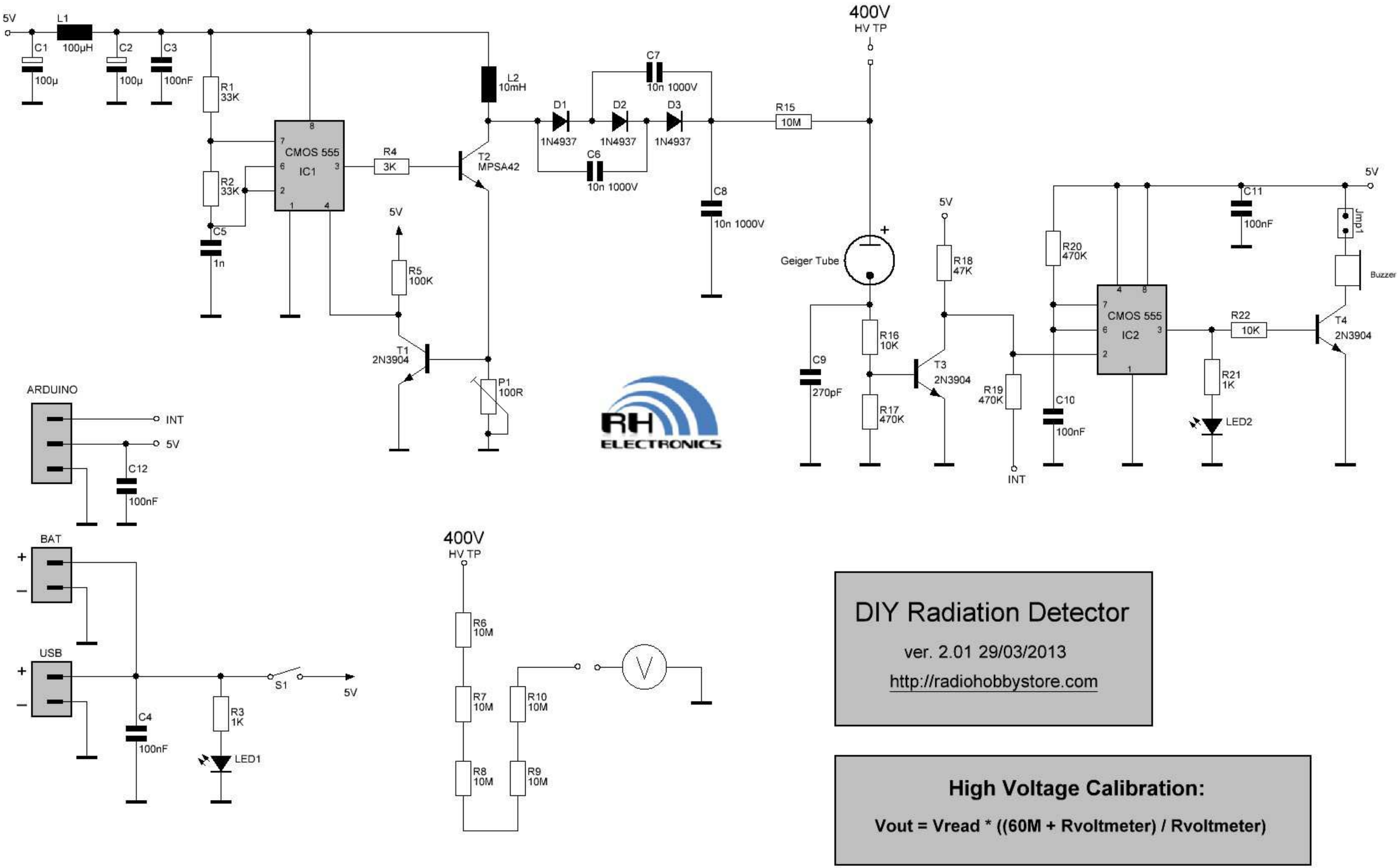
Capacitors:
C3, C4, C12, C10, C11 – Ceramic Disc Capacitor 100nF 50V (104)
C1, C2 – Electrolytic Capacitor 100uF
C5 – Multilayer Ceramic Capacitor 1nF 50V (102)
C6, C7, C8 – Multilayer Ceramic Capacitor 10nF 1KV (103)
C9 – Ceramic Disc Capacitor 270pF 50V (271)

Semiconductors:
D1, D2, D3 – 1N4937, Ultra Fast Diode
T2 – MPSA42, High Voltage NPN Transistor
T1, T3, T4 – 2N3904, Generic NPN Transistor
TS555CN – CMOS 555 Timer IC, x2
LED1, LED2 – 3mm Led

Inductors:
L1 – 100uH, Axial Inductor
L2 – 10mH, Ferrite Core Inductor

Other:
High Quality PCB
Piezo Buzzer, x1
Tube Holder Clips, x2
8 Pin DIP IC Socket, x2
Slide Switch, On/Off, x1
Male Pin Header Pins, 4pin x1, 3pin x2, 2pin x1
Terminal Block, x1
USB Type B Socket, x1
Jumper Cup, x1
M3 Standoff, x4
M3 Screw, x4

Geiger Tube NOT included!



DIY Radiation Detector

ver. 2.01 29/03/2013

http://radiohobbystore.com

High Voltage Calibration:

Vout = Vread * ((60M + Rvoltmeter) / Rvoltmeter)

Technical Specifications:

- Geiger Tube PCB Compatibility: STS-5, SBM-20 or J305
- Geiger Tube Voltage Compatibility: tubes with anode voltages 350-500V
- Supply Voltage: 5V USB; 4x 1.2V Battery; 3x 1.5V Battery
- Supply Current: 12mA-30mA
- PCB Dimensions: 120 x 50 mm
- Led and Sound Radiation Indication
- Arduino Compatible
- Includes High Impedance Voltage Divider

Kit Introduction:

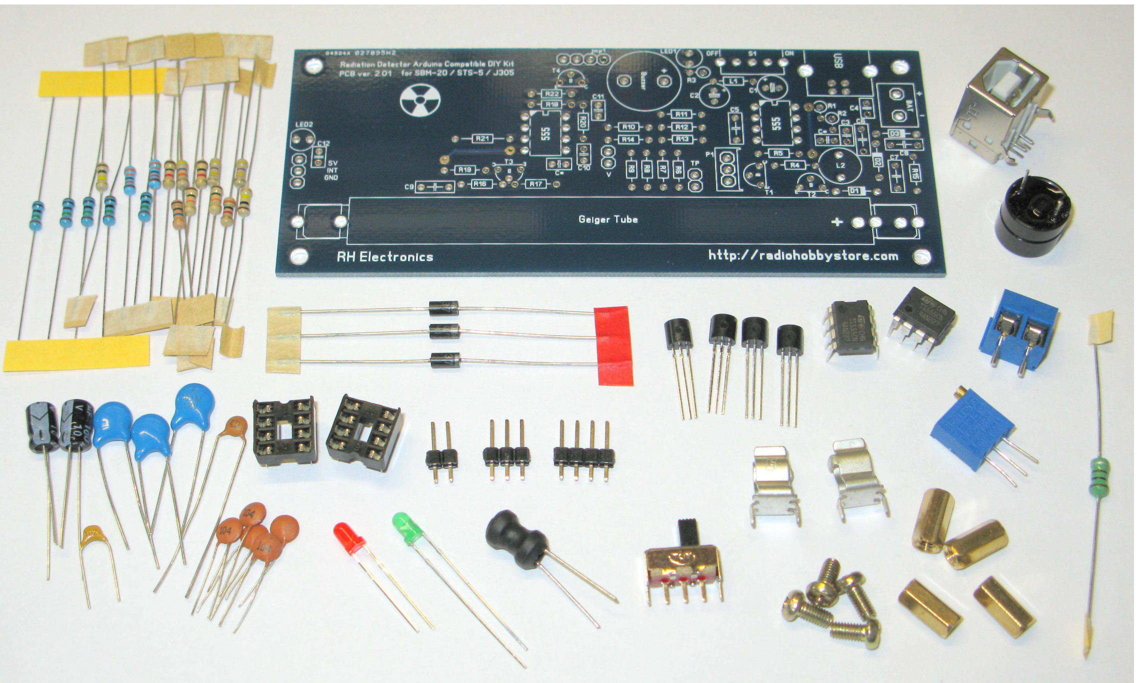
This is simple DIY Geiger Counter Kit that includes a manufactured PCB and components for soldering. Geiger tube must be purchased separately.

The kit can drive any Geiger Tube that needs between 350-480V DC anode voltage. High voltage is calibrated with P1.

For normal operation the high voltage do not need to be stabilized, so several volts drifts will not affect the results, since the voltage is in tube plateau. TS555CN generate square waves drives MPSA42 transistor to produce high voltage spikes over 10mH inductor. Ultra fast diodes rectify and multiply the AC spikes. Since Geiger tube consume only several uA, it do not need large capacitors. 10nF capacitor will supply the required current for the tube.

Pulse registration circuit stage is build with T3 key transistor and second TS555CN IC. 555 is one-shot multivibrator (50ms pulse stretcher).

The concept of the kit is only visual and sound indication of ionizing radiation. This is not a dosimeter device that will measure the dose or level, but it can be connected to Arduino and used in different ways.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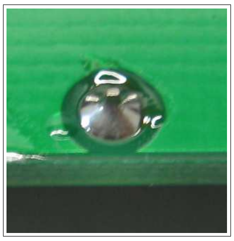
Assembling and Soldering:

Please follow our assembling and soldering instruction steps. Print out the circuit and keep it in front of you during the soldering for easy reference.

Remember, do clean solder work and install right components in the right place, It is always hard to unsolder components from the PCB. We cannot be responsible if you'll overheat your PCB or will damage the kit components by incorrect soldering. Double check yourself before you solder. Use a solder with Rosin Core Flux. Some industrial flux has several Mega-ohms resistance and requires special cleaning that cannot be performed at home.

Take your time when performing solder work. It should take about a hour to complete the kit.

Do not apply too much solder. A good joint should look like:

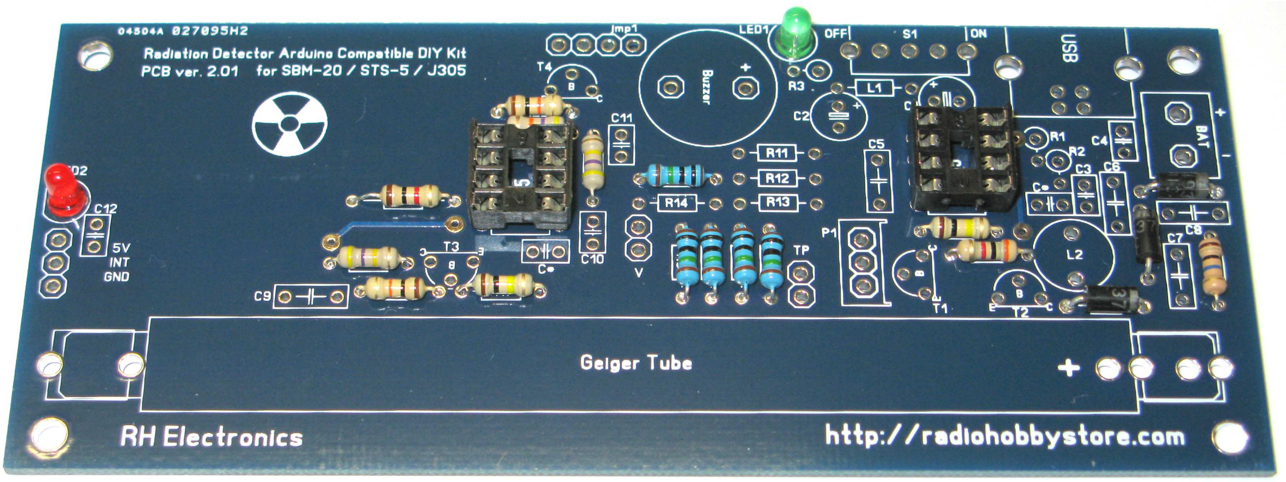


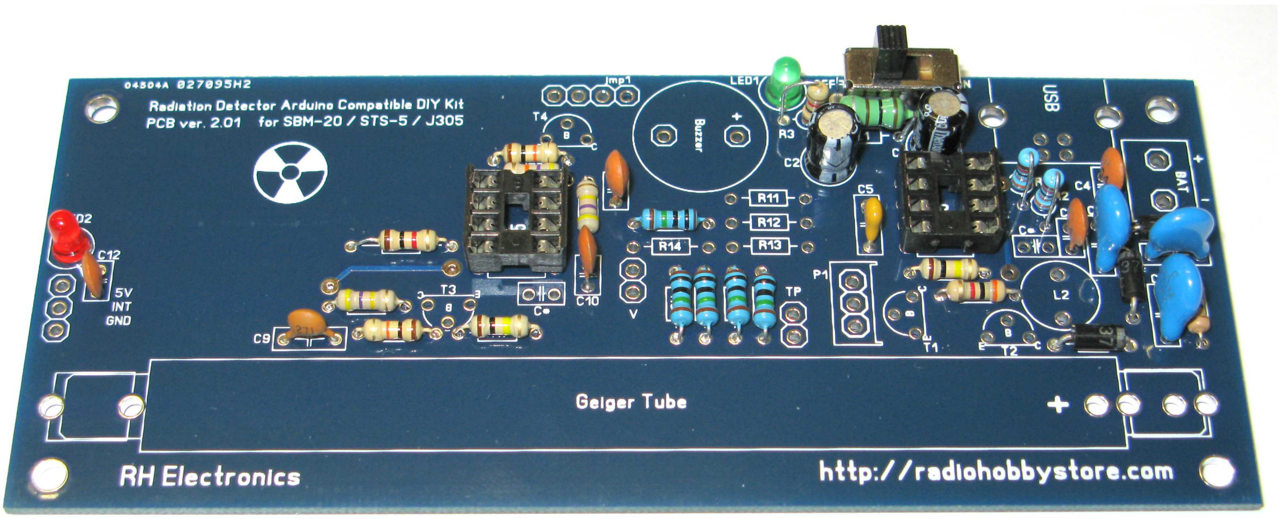
We advice you to use 0.8mm or 1.00mm thickness lead solder wire with low melt point, such as:

60/40 – 186 Celsius (386 Fahrenheit)
63/37 – 183 Celsius (361 Fahrenheit)

If you'll need to remove excess solder from the pad, use desoldering tools (braid wick or small pump). Flux can be cleaned with soft brush and isopropyl alcohol (IPA99%, isopropanol).

Start soldering the resistors. All horizontal components should be soldered first.

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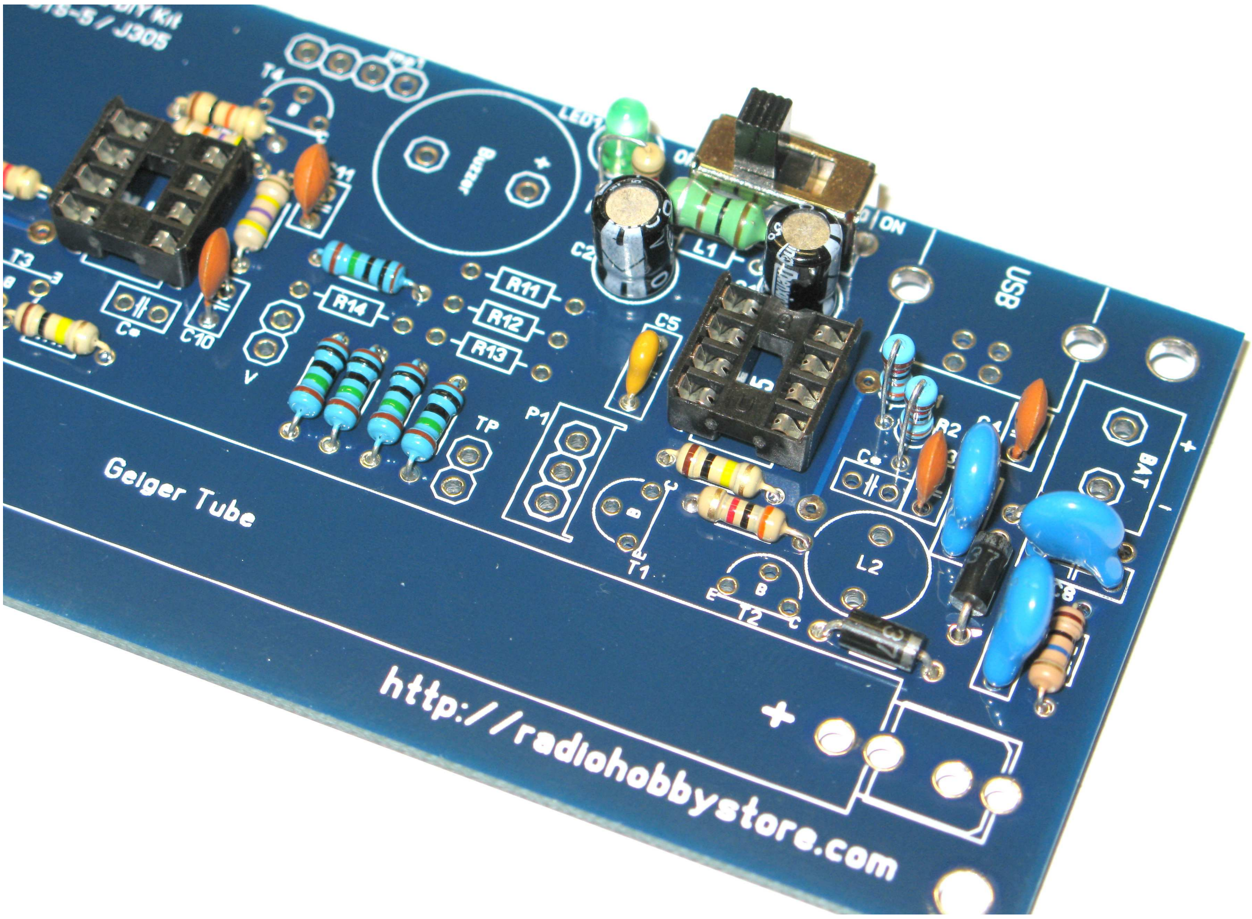
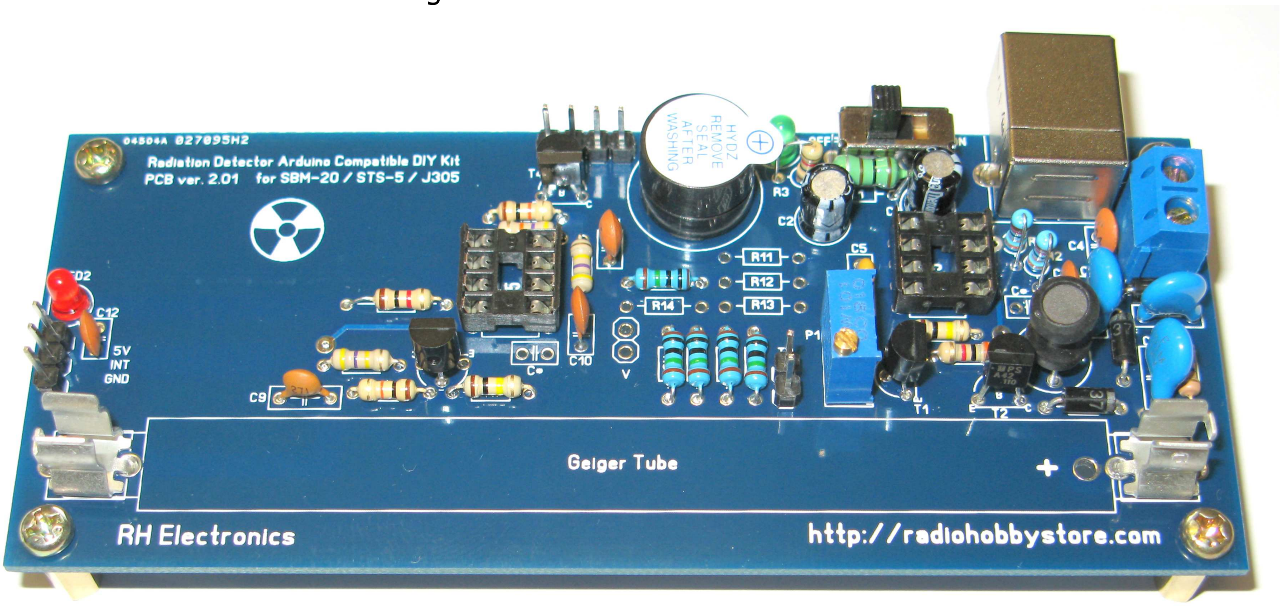
USB
BAT
Buzzer
5V
INT
GND

Next, solder all capacitors and L1 coil. NOTE: the PCB has C* marked capacitors that should be installed only with NE555 timers, NOT with the included CMOS TS555 timers!



The PCB has space for high impedance voltage divider. The kit include six (6) 10M resistors, but the PCB allows installation up to ten 10M resistors. To calibrate high voltage we do not need all 10 resistors; 60M divider is enough. Please solder six (6) 10M resistors as shown on the photo: R6, R7, R8, R9, R10, R15

The finished board before washing.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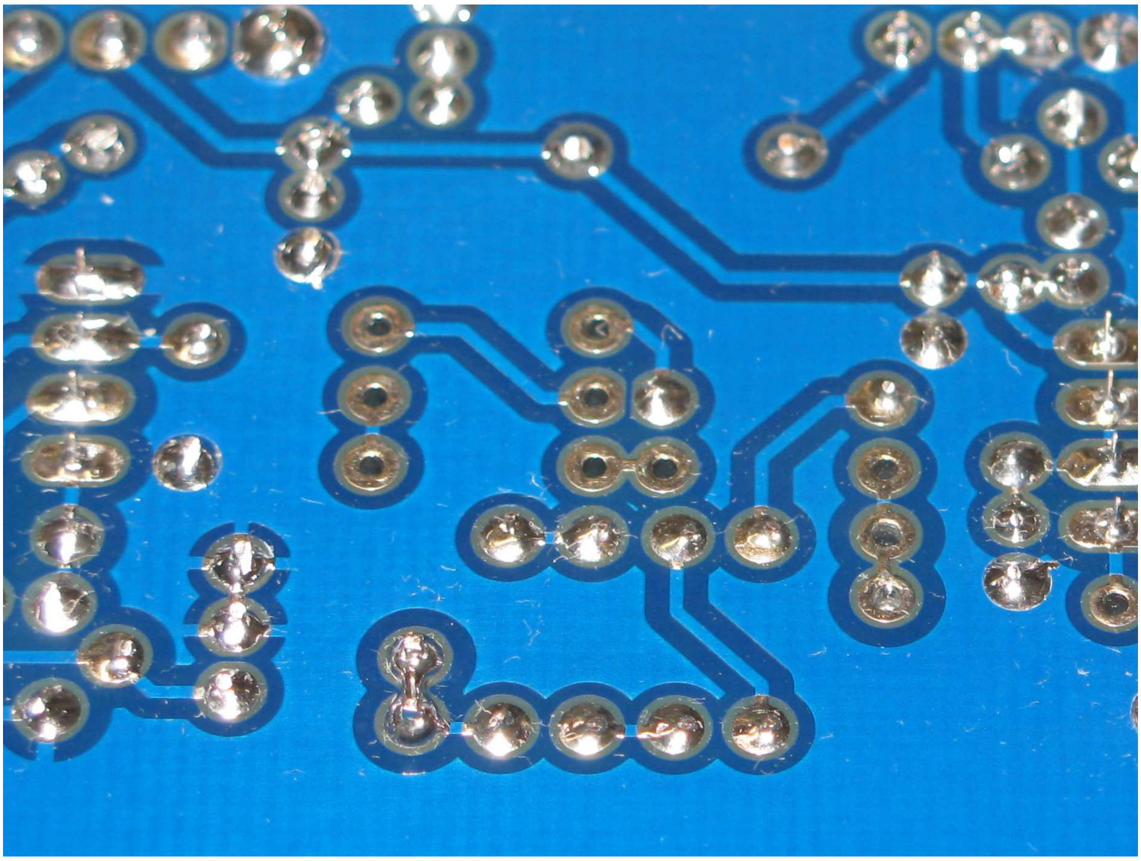
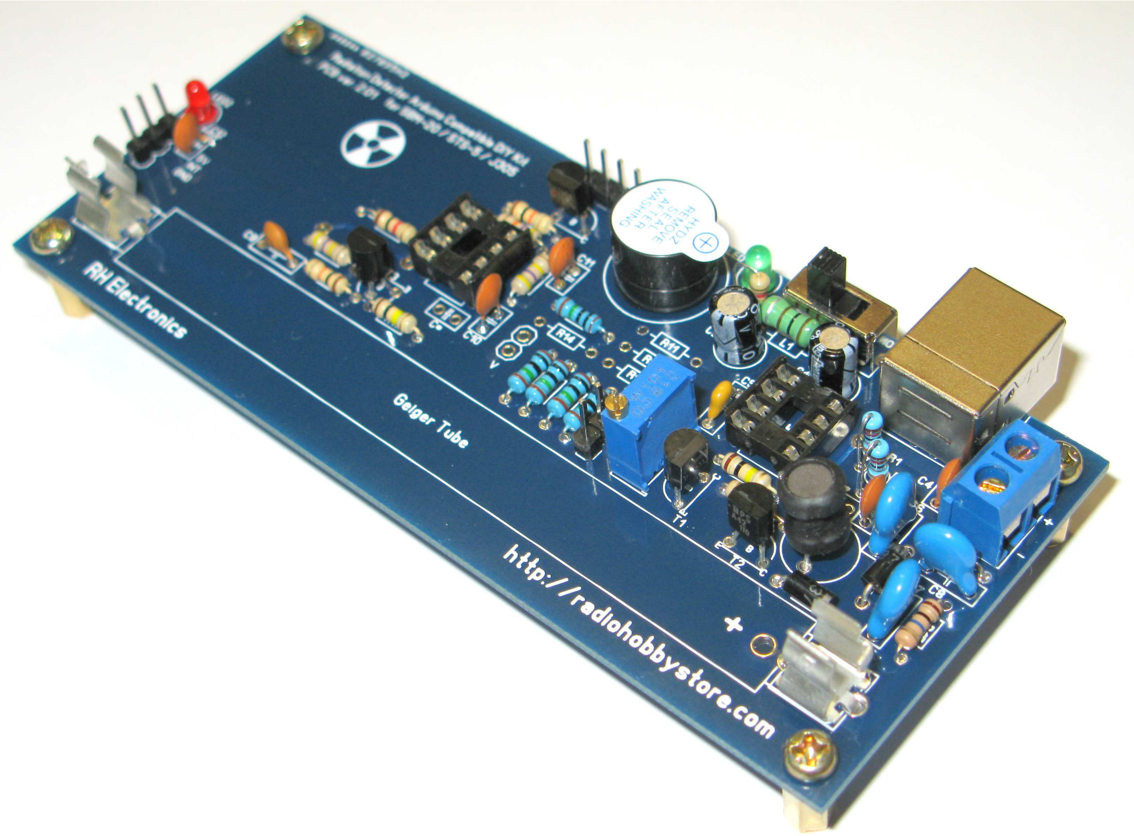
Re-check the orientation of all components. Before you insert TS555 IC's clean the PCB with isopropyl alcohol and soft brush. Circuit produce high voltage; even rosin flux can affect the high voltage converter stage. Several customers who did not washed the board reported the problem with high voltage, so please WASH THE PCB before usage! IPA99% (isopropyl alcohol) are recommended.



The PCB should be free of flux and very clean.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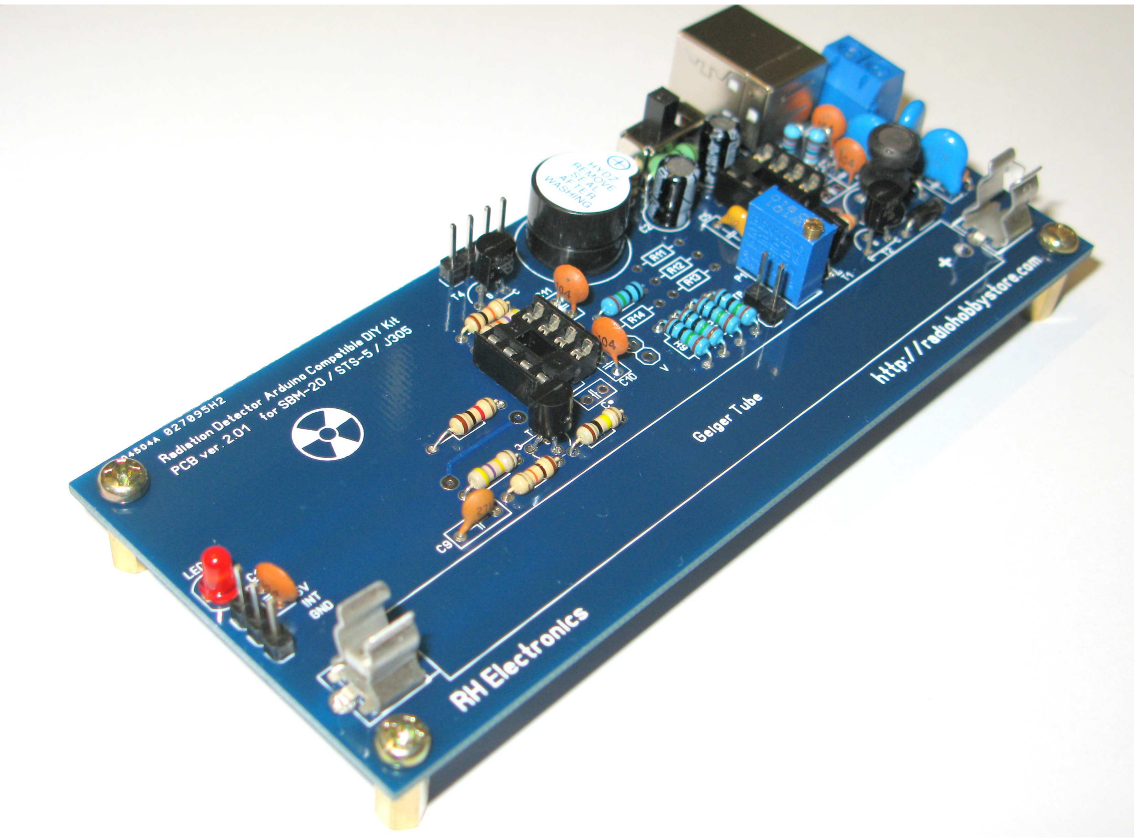
HYDZ
REMOVE
SEAL
AFTER
WASHING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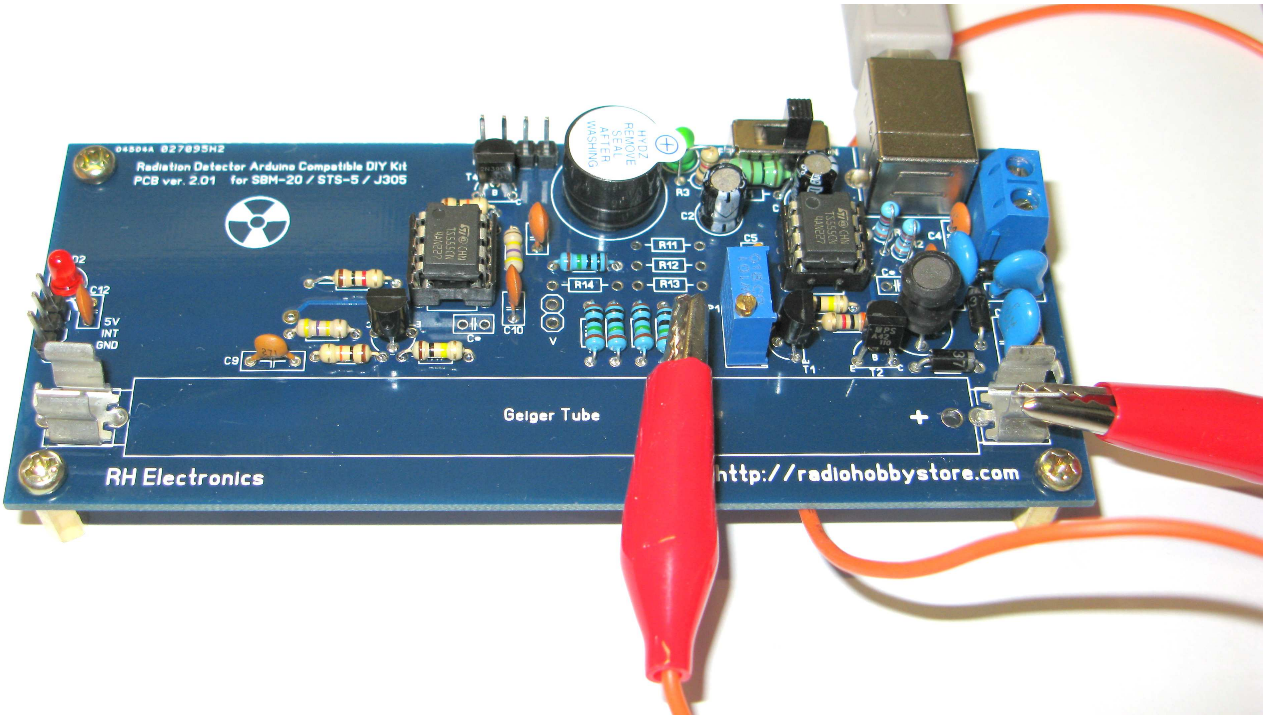
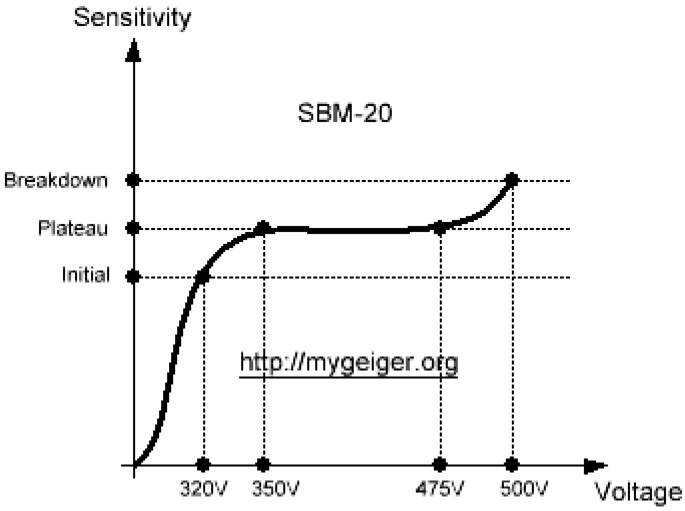
LED
INT
GND
HYDZ
REMOVE
SEAL
AFTER
WASHING

Use a multimeter continuity test to ensure you do not have any short circuits. Insert TS555 IC's in proper orientation (notch toward the top). You can now to calibrate the high voltage.



You cannot measure high voltage directly with a typical voltmeter. It will overload the circuit because of low internal resistance of the multimeter. That's why you need to use high impedance voltage divider.



The optimum for SBM-20 (STS-5) tube is 400V. You also can run the tube without any problem on 380V or 420V. We urge you not go above 420V for STS-5/SBM-20/J305.

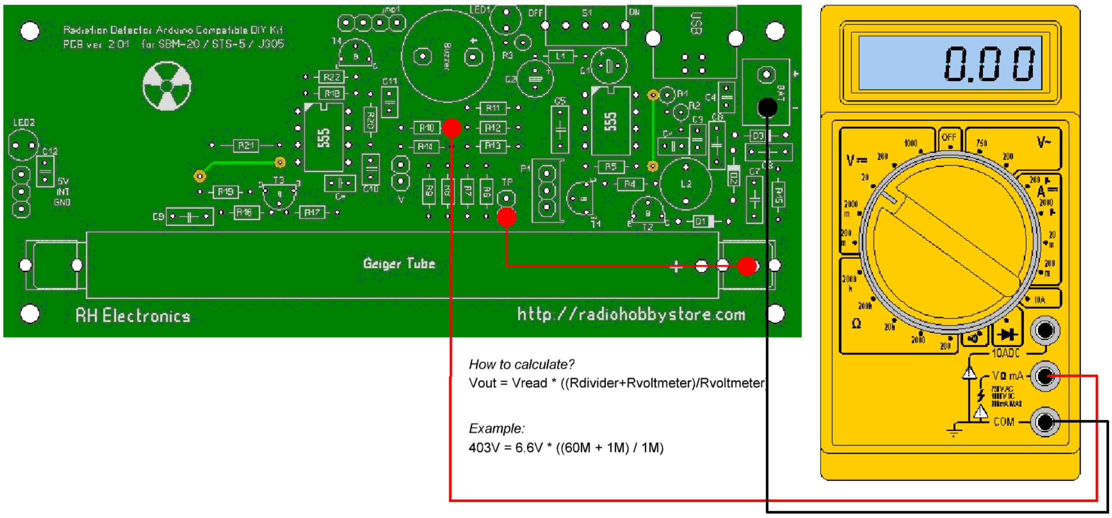
You can calibrate the kit with 1M or 10M multimeter. When measured after the 60M voltage divider, 400V will read as 6.5V with a 1M multimeter and as 57V with a 10M multimeter. Calculate true values with the formula :

Vout = Vread* ((Rdivider + Rvoltmeter)/Rvoltmeter)

Calibration:

You need to calibrate the high voltage **BEFORE** installing Geiger tubes. The HV calibration steps are:

1. Trim P1 potentiometer to approximately 50 ohm when kit power is off.
2. Connect positive Tube Clip to TP pins (R6) with a jumper wire.
3. Connect multimeter black probe to any GRN point
4. Connect multimeter red probe after R10 point
5. Set your multimeter on 20V/200V DC range.
6. Power up the device (PCB <u>washed</u> and IC555 <u>installed</u>).
7. Adjust voltage with P1 to 6.5V if you use 1M multimeter or adjust the voltage to 57V if you use 10M multimeter. Use formula: Vout = Vread* ((60M + Rvoltmeter)/Rvoltmeter)



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How to calculate?
Vout = Vread * ((Rdivider+Rvoltmeter)/Rvoltmeter)

Example:
403V = 6.6V * ((60M + 1M) / 1M)

Tubes Installation:

Geiger tubes are very fragile items. Handle with care!
Do a visual test: tube must be free of cracks and dents. Shake the tube; if there any sounds from inside, the tube is damaged and should not be used.
Clean rust from tube terminals for good electrical contact.

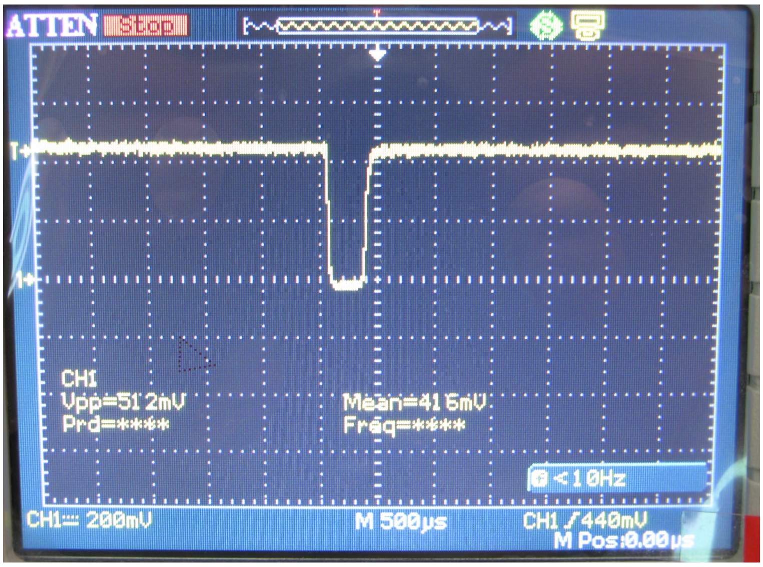
The tube has anode (+) and cathode (-) sides. Anode side is marked on tube body and it connected to R15 resistor.

During device testing and using ALWAYS remember about high voltage 400V presented! Do not touch the tubes clips. Depend on your skin resistance and humidity you may feel the "bite" of HV, so avoid touching the PCB with your hands or any metal items.

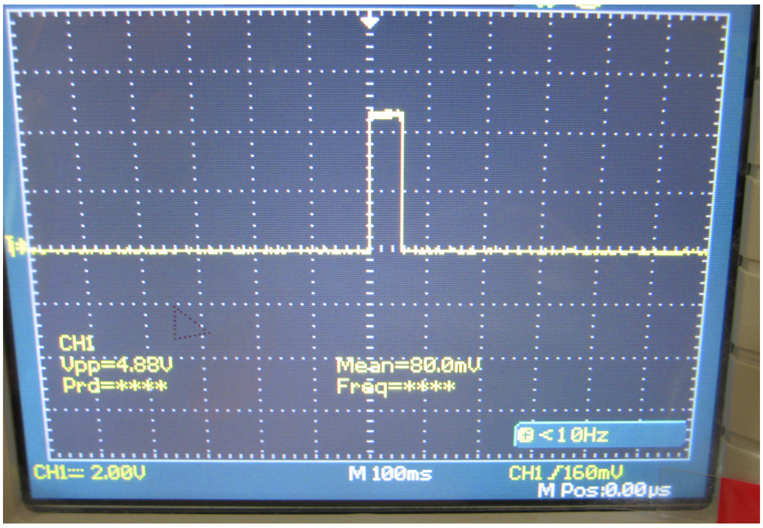
Because the signal from the tube captured on cathode, the circuit may be sensitive to static electricity. Avoid touching Geiger Tube because it may cause false led flashing.

When you power up the radiation detector it will begin to register the normal background radiation. For SBM-20/ STS-5 is about 10-50 events per minute.

1. 500uS signal from tube on INT pin. Use 10M probe.



2. 50mS pulse on pin#3 of IC2.



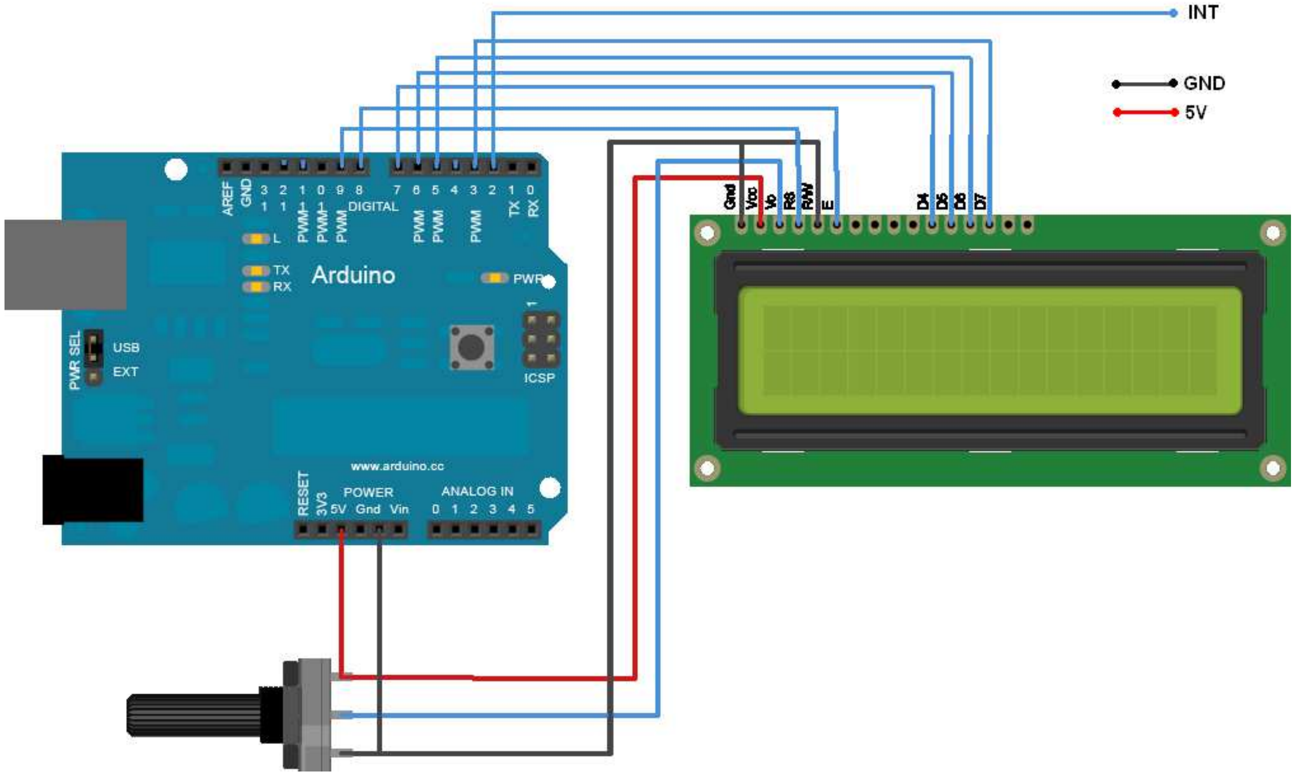
Arduino MCU Communication

The PCB has 3 pins for communication with MCU: INT, GND, 5V. You can power up the kit from 5V Arduino board directly. Or, if you use batteries for Geiger Kit, you have to connect only 2 pins to Arduino: INT and GND.

There is many different application you can use this kit, especially if you are software developer. The board send 500uS high-low-high interrupts to Arduino. We offer 2 simple sketches as an example, please modify it for your needs. We do not provide technical support for Arduino code. You can learn more at: http://www.arduino.cc/

Actually its possible to use this kit with any other microcontroller, not only Arduino boards because it has the same principles, but if you are beginner it will be easy to start with Arduino.

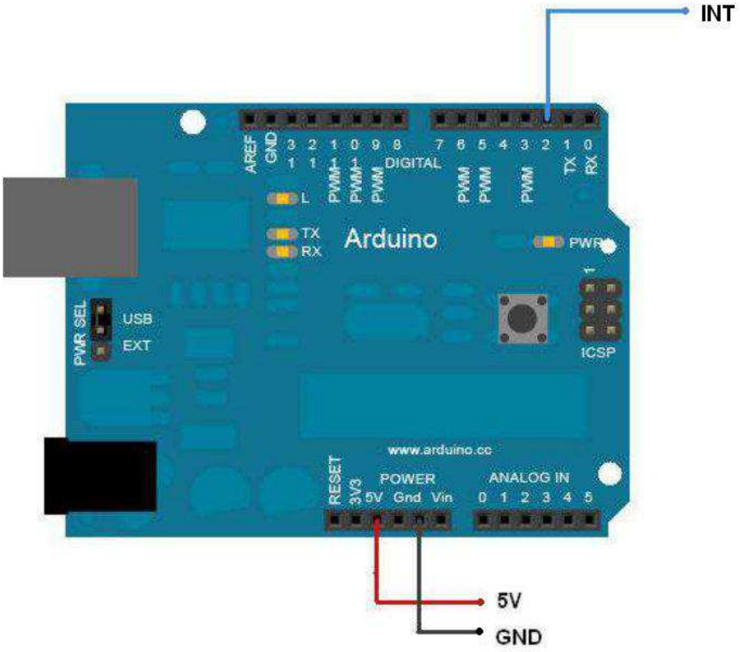
The first example allows you to build your own simple dosimeter. The MCU will count pulses from tube during 60 seconds and display CPM value. Hardware requirements: Geiger Kit with tube, Arduino UNO board, 16x2 LCD display, 10K potentiometer, jumper wires.



```
/*
**************ARDUINO SKETCH FOR GEIGER COUNTER******************
Author: RH Electronics www.radiohobbystore.com / www.mygeiger.org
*****************************************************************
This sketch can be used with DIY Geiger Counter board. It allow
to receive CPM data during minute. You can modify the sketch
for your needs.
*****************************************************************
 *  LCD Connection:
 * LCD RS pin to digital pin 9
 * LCD Enable pin to digital pin 8
 * LCD D4 pin to digital pin 7
 * LCD D5 pin to digital pin 6
 * LCD D6 pin to digital pin 5
 * LCD D7 pin to digital pin 3
 * LCD R/W pin to ground
 * 10K resistor:
 * ends to +5V and ground
 * wiper to LCD VO pin (pin 3)


*****************************************************************/

// include the library code:
#include <LiquidCrystal.h>

#define PERIOD      60000.0         // (60 sec) one minute measure period

volatile unsigned long CNT;         // variable for counting interrupts from dosimeter
```

```
unsigned long dispPeriod;           // variable for measuring time
unsigned long CPM;                  // variable for measuring CPM

// initialize the library with the numbers of the interface pins
LiquidCrystal lcd(9, 8, 7, 6, 5, 3);

void setup() {                      // setup

  lcd.begin(16, 2);
  CNT = 0;
  CPM = 0;
  dispPeriod = 0;
  lcd.setCursor(0,0);
  lcd.print(" RH Electronics ");
  lcd.setCursor(0,1);
  lcd.print(" Geiger Counter ");
  delay(2000);
  cleanDisplay();

  attachInterrupt(0,GetEvent,FALLING);  // Event on pin 2
}

void loop() {
    lcd.setCursor(0,0);              // print text and CNT on the LCD
    lcd.print("CPM:");
    lcd.setCursor(0,1);
    lcd.print("CNT:");
    lcd.setCursor(5,1);
    lcd.print(CNT);

  if (millis() >=dispPeriod + PERIOD) {   // If one minute is over
    cleanDisplay();                  // Clear LCD
    // Do something about accumulated CNT events....
    lcd.setCursor(5, 0);
    CPM = CNT;
    lcd.print(CPM);                  //Display CPM
    CNT = 0;
    dispPeriod = millis();
  }

}


void GetEvent(){                     // Get Event from Device
  CNT++;

}

void cleanDisplay (){                // Clear LCD routine
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.setCursor(0,0);
}
```

The second example allows you to connect the kit to your https://xively.com (COSM) monitoring feed. For more technical information please visit xively website. RH Electronics monitoring feed can be visited here:
https://xively.com/feeds/122314/
Hardware requirements: Geiger Kit with tube, Arduino UNO board, W5100 Arduino Ethernet Shield, jumper wires.



```
/**
 * Cosm Arduino sensor client example.
 * Author: RH Electronics www.radiohobbystore.com / www.mygeiger.org
 * This sketch can be used with DIY Geiger Counter board.
 * This sketch demonstrates connecting an Arduino to Cosm (https://cosm.com),
 * Full tutorial available here: https://cosm.com/docs/quickstart/arduino.html
 *
 */

#include <SPI.h>
#include <Ethernet.h>
#include <HttpClient.h>
#include <Cosm.h>

#define API_KEY "API KEY" // your Cosm API key
#define FEED_ID 123456 // your Cosm feed ID

volatile unsigned long CNT;         // variable for counting interrupts from dosimeter

// MAC address for your Ethernet shield
byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
unsigned long lastConnectionTime = 0;              // last time we connected to Cosm
const unsigned long connectionInterval = 60000;      // delay between connecting to Cosm in milliseconds


// Define the string for our datastream ID
char sensorId[] = "CPM";

CosmDatastream datastreams[] = {
  CosmDatastream(sensorId, strlen(sensorId), DATASTREAM_FLOAT),
};

// Wrap the datastream into a feed
CosmFeed feed(FEED_ID, datastreams, 1 /* number of datastreams */);


EthernetClient client;
CosmClient cosmclient(client);

void setup() {
  // put your setup code here, to run once:

  CNT = 0;

  attachInterrupt(0,GetEvent,FALLING);  // Event on pin 2

  Serial.begin(9600);

  while (Ethernet.begin(mac) != 1) {
    Serial.println("Error getting IP address via DHCP, trying again...");
    delay(15000);
  }

  Serial.println("Network initialized");
  Serial.println();
}

void loop() {
  // main program loop
  if (millis() - lastConnectionTime > connectionInterval) {
    // read a value from the pin
    unsigned long sensorValue;


    sensorValue = CNT;         //CPM

    // send it to Cosm
    sendData(sensorValue);

    sensorValue = 0;

    //CNT = 0;
    CNT = 0;
    lastConnectionTime = millis();
  }
}

void sendData(int sensorValue) {
  datastreams[0].setFloat(sensorValue);
  int ret = cosmclient.put(feed, API_KEY);
}
void GetEvent(){                          // Get Event from Device
  CNT++;
}
```

Need help with the DIY Kit you purchased?

If you soldered the kit according the circuit and manual, but it's not operate, recheck that all components are in the correct place and correct polarity. In you cannot identify the problem please send a support request to us at: support@radiohobbystore.com

Support request requirements:

- Include your order number or eBay ID
- Please describe your problem fully; attach screenshots or pictures and tell what you already tried to do for resolving the problem.
- Attach high resolution focused photos of your soldered kit, from both sides of the PCB.
- Please wait up to 24 hours for the response.
- Please follow our support instruction because we can help you only if you'll work with support team. If you'll not provide a information for support team we'll not be able to resolve the problem.

Several advices for successful kit assembling:

- Print the circuit schematic page from user manual and refer to it OFTEN during soldering.
- Follow the User Manual for assembling and calibration.
- Take your time! Please do accurate soldering.
- Use only Rosin Flux and Solder 60/40 with low melt point.
- Clean the PCB after soldering.
- Locate and download components datasheets for reference.

Your feedback for eBay purchase.

If you purchased our kit on eBay, we'll be very grateful for your positive feedback. Please leave us 5 star score positive feedback if you are satisfied with our product and service. If there was any problem with your purchase please contact us and we'll do our best to resolve it.

Share your worklog!
You are invited to share the photos of your project. Please send it to us and we'll post the photos on special page.
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Thanks to David Child for editing this manual and making it more readable for native English speakers!