Instructions for the Geiger Kit Shield – V3 board

Building the Kit . . .

General tips:

- "***Sometimes just a few hours of trial and error debugging can save minutes of reading manuals.***" RTFM – even if you're experienced, you run the risk of wishing you had considered something beforehand.
- Use the **Build Sequence and Parts List** on the next page as you go through the build process. The parts in the Parts List are **listed in order of how you should install them**. This preferred sequence will make soldering easier. There are also important notes regarding orientation, and special handling for some parts.
- You may not want to install all of the headers when you first build the kit – see **Build Sequence and Parts List**.
- The pictures and schematic (below) should help you orientate the parts.
- Missing parts / extra parts – You may get an extra part, but if something is missing, let me know.
- Take your time! It takes *at least* 1-2 hours to build this kit. Solder the right part, the right way, the first time. Parts are often hard to desolder.
- After you finish the board, you must install the new software. **Nothing** (including the display and even the backlight) **will work until you install the new software**.
- I suggest you power the kit with REG jumper installed. This means either 3 alkaline or 4 NiMH batteries or a 5V power cube. The max current for the regulator is only 100ma, and with a GPS and an microSD card this can be exceeded.
- Because of the microSD card socket, I do not suggest that you clean the board with solvents to remove flux.

Soldering Surface Mount Parts:

There are three SMD (surface mount) parts - IC1 & IC2 and the MicroSD card socket. These are not super fine pitch components, but soldering SMD uses a little different technique. There are lots of tutorials on this subject on the web (http://www.sparkfun.com/tutorials/36 is a good one). Personally, I've found that a flux pen (water soluble) makes the solder flow nicely and avoids bridging. The assembly instructions also provide a few tips.

Soldering Through Hole Parts: (tips)

- The bottom of PCB uses a "ground plane". (lighter red is copper connected to the ground). A neat soldering job is important. Joints that slop over the pad and on to the ground plane will cause a problem.
- Use a good iron, with a clean tip that's freshly tinned. Solder the joint so that you have a nice round dot that stays inside the darker red. The holes are plated through - so don't worry about getting solder up to the top of the board.
- Sometimes it's best to shorten long leads before you solder them, or re-solder them after they are cut. You will notice some pads will connect to the back plane. These have 4 little traces from the back plane to the pad - like a "+" . These will take more heat. I usually solder that side of the part last.

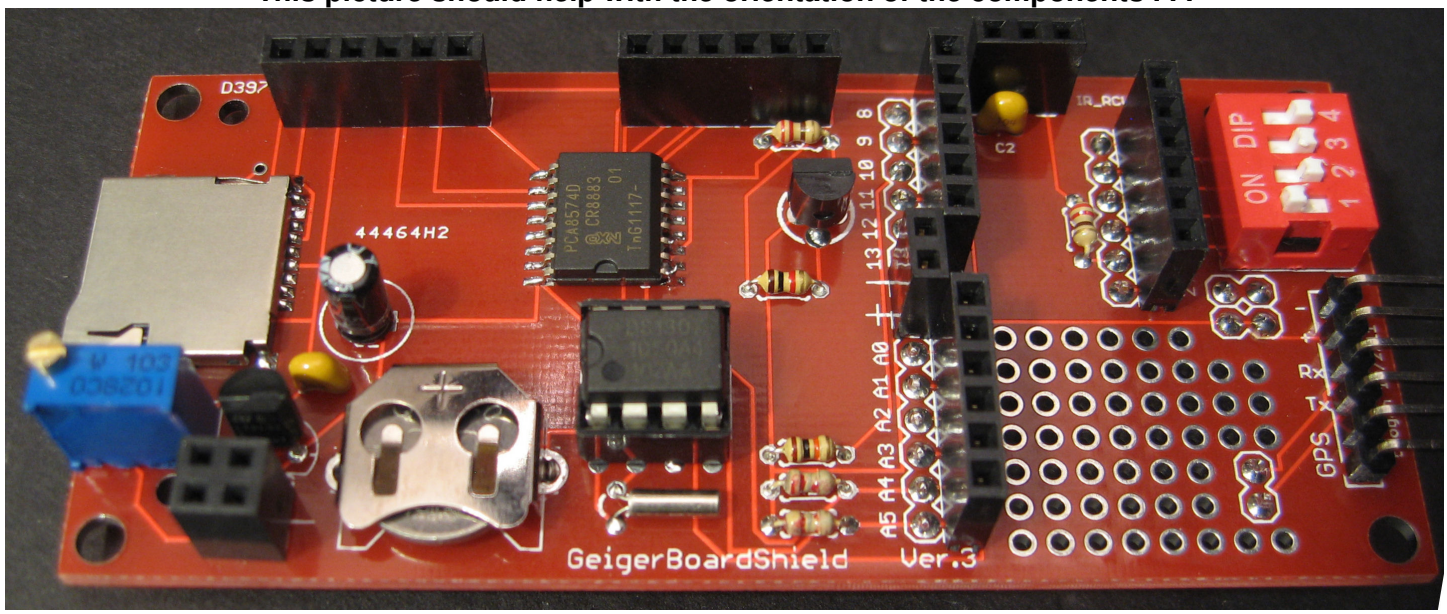
Build Sequence:

Again, the parts list on the next page is arranged in order of the (suggested) build sequence. Just start at the top, and solder your way down.

Build Sequence and Parts List for Geiger Shield

Ref #	Qty	Value	Description	Notes polarized? ->	Y N
PCB	1		1.60 x 3.60 inches (~4.06 x 9.14 cm)	The notes below assume the orientation of the PCB is with the microSD card on the left side. The screw holes on the shield will line up with those on the Geiger board. There are also 3 holes that may line up with your LCD display.	–
socket	1	card	MicroSD socket	**SMD part.** It fits in two little holes near the edge of the board. Solder one of the mounting tabs first. The pins tend to line up on the left side of the pads, but if you reheat the tab and "twist" the part a bit, you can get them more centered. However, it does not cause a problem if they are not centered. It's the trickiest of the SMD parts to solder due to a little overhang. Propping up the board so it's on an angle makes it easier to see the pins. Flux is important when soldering this part.	Y
IC1	1	PCA8574D	I2C GPIO – SOC16	**SMD part.** Pin 1 on board is marked with a small circle (lower right). Pin 1 on chip is below the notch with the notch pointing to the left. (see pic below)	Y
IC2	1	74AC125MTR	Quad Buffer - SOP-14	**SMD part.** This part solders to the bottom of the board. There is no notch on this chip! Instead you will notice that one of the long sides has more of a bevel on it. Mount the chip with the bevel on the left – closest to the microSD socket. (see pic below)	Y
socket	1		battery	**Before soldering** – cover the center contact with solder to a *slight* bulge. This will make better contact with the negative side of the battery. With the open side towards the bottom of the board, solder the two tabs that fit in the holes in the board.	Y
R1, R2	2	2.2KΩ	RD,RD,RD (all fixed resistors are 1/8W)	**If hard to read color, check with a meter before you solder. If a blue resistor is included it is 150Ω – an alternate for R5**	N
R3	1	10KΩ	BN,BK,OR		N
R4	1	1KΩ	BN,BK, RD		N
R5, R6	2	220Ω (150Ω also included in some kits)	RD,RD,BN	**Note:** R5 may need to be a smaller value (or shorted) depending on how the backlight is configured on your particular display. (some use a a diode instead of a resistor. Solder it a bit above the board to make it easier to change or bypass.	N
C2, C3,	2	.1uF	#104 ceramic capacitor	**Note:** C3 is not marked on board. It goes under IR socket near top right.	N
Q1	1	2N3906	PNP BJT transistor		Y
REG	1	78L33	3.3V / 100mA regulator		Y
OSC	1	3.2678KHz	crystal	Can be laid down flat	N
socket	1	8 pin	IC socket	For IC3	Y
switch	1	DIP	4 position	You may not want to add this until you decide on what switches you want on your case.	Y
R7	1	10K Pot	25 turn	You will have to adjust the CW before you can read the display.	Y
C1	1	4.7uF	electrolytic capacitor – 4x7mm		Y
header	3	6 pin male	I/O in from Geiger	connects to female headers on Geiger Board. Place each male header into the I/O headers on the Geiger Board. Do the same for the 2 pin male (into RxTx header) and 2x2 male (into power pins header). When all 5 male headers are in place, put the shield board over the Geiger Board so that ends of all male headers stick through. Then solder all 5 headers from the top of the shield board.	-
header	1	2 pin male	RxTx in from Geiger	connects to female headers on Geiger Board – see above.	-
header	1	2x2 male	power in	connects to female headers on Geiger Board – see above.	-
header	3	6 pin female	2 disp + 1 GPS	Pads are offset for easier placement. You may want to "hard wire" this side of the display and / or GPS.	-
header	3	6 pin female	3 breakout	**Note:** It's up to you if you want to install these 3 female headers. There is very little clearance between these headers and the bottom of the display. If you will want to use the pins broken out by these headers, consider not installing them and soldering directly to the pads. Another option would be to use 90 degree male headers. It's usually best to wait on these until you decide on a case.	-
header	1	3 pin female	for IR sensor	You may want to wait on this until you decide on a case.	-
header	1	2x2 female	power out	**Note:** clip leads close on bottom of the board – else they may touch the plastic part of the battery screw terminals on the Geiger Board.	-
IC3	1	DS1307Z	RTC – DIP	install – notch to left	Y
battery	1	CR1225	CR1225	install + side up	Y
IR Sensor	1	TSOP4838	38 kHz IR detector	install – bulge faces away from top of board	Y
ATmega	(1 if B)	ATmega368P	uC for Geiger Kit w/ Shield SW	install in place of the uC on the Geiger Kit board. (Shield KIT-B only)	Y

This picture should help with the orientation of the components . . .



bottom view of board – IC2 is soldered on this side

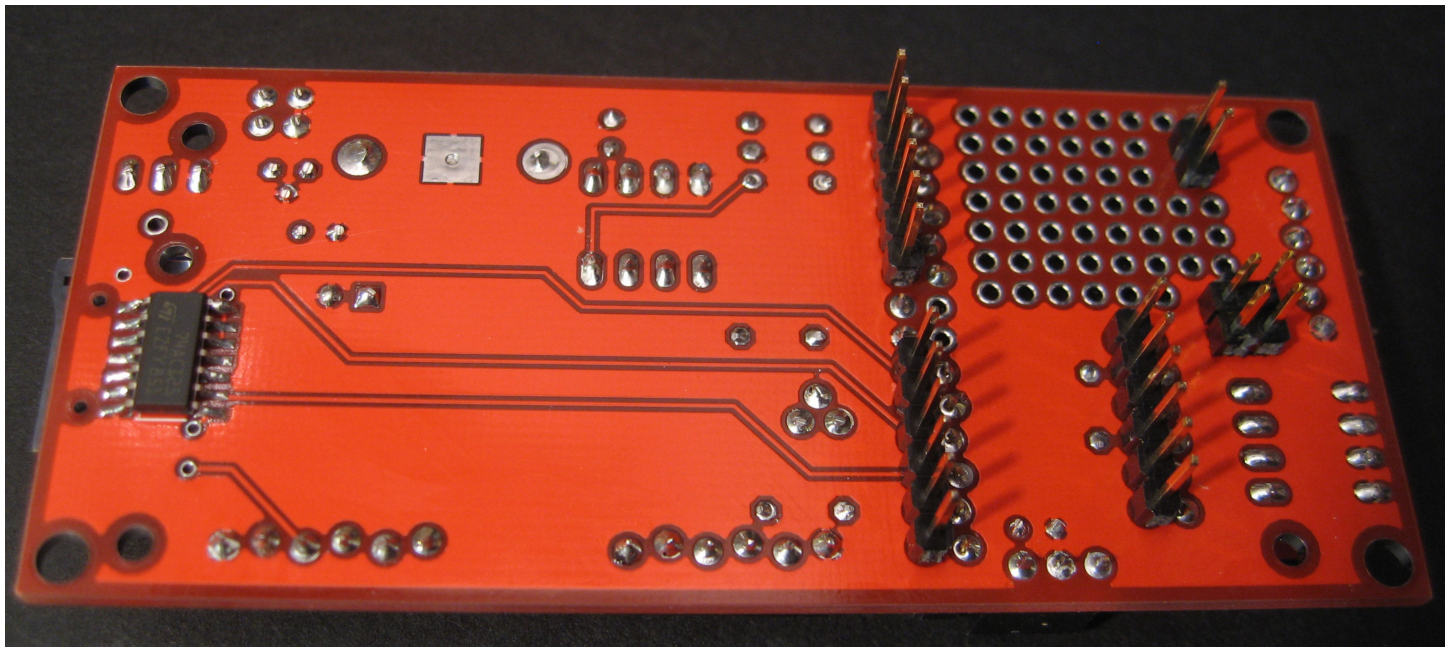
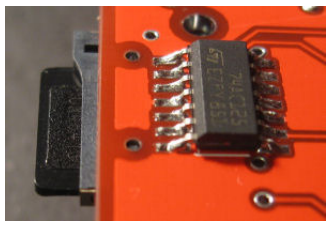
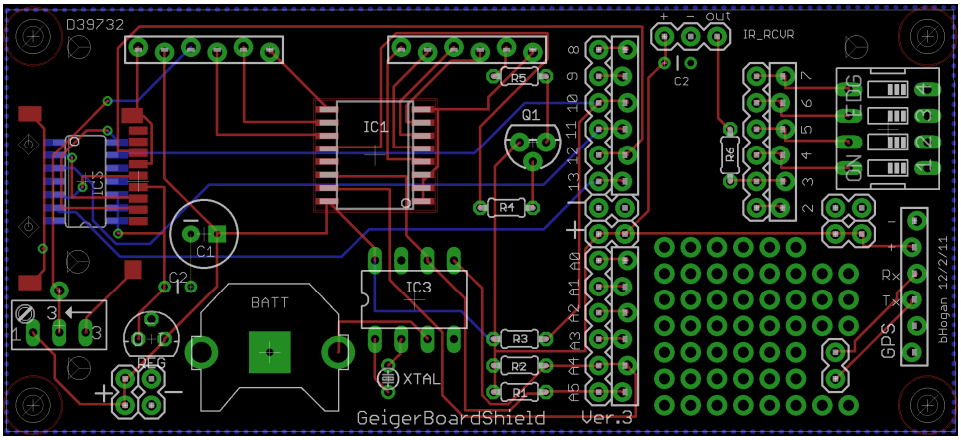


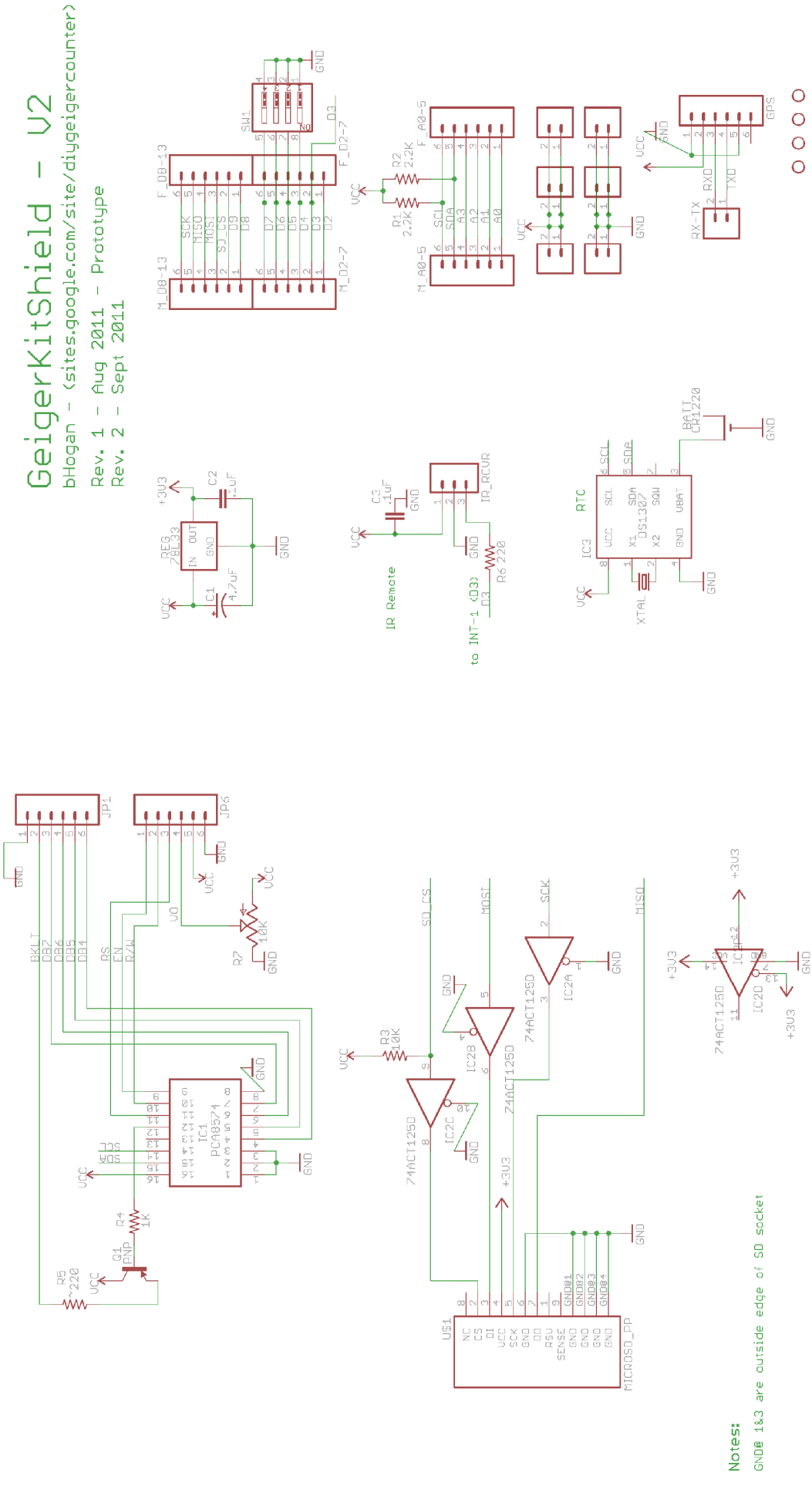
Image of PCB layout . . .

IC2 – bevel to the left





The schematic is the same for the V2 and V3 boards.



Using the Shield . . .

What you need:

- a Geiger Kit with microcontroller (KIT-B).
- Since the Geiger Shield requires a different sketch than the default, you will need an FTDI cable or board to load this sketch. (Unless you purchased a pre-loaded Atmega328 with the kit.)
- a 2x16 LCD display (the contrast pot is already on the board)
- a universal remote set to a Sony TV. (see below)
- a MicroSD card – All my testing was with a 2GB card or less. 6GB has been reported to work.

Getting started:

- Most people will already be using the Geiger Kit, but with the shield, it will be necessary to get the new software and download it into the uC on the Geiger board. It will not run with the default Geiger sketch. You can get the logging sketch from a link at the bottom of the Shield web page. (Instructions for doing this from scratch this can also be downloaded from that page.) If you have a GPS connected, you must disconnect it before downloading. It's best to start simply, so don't change the sketch to use the GPS at this point.
- **When you do plug in your GPS – make sure it's plugged in the right way! Read the datasheet for your particular model. The ground, Vcc, Rx and Tx are marked on the silkscreen**.
- You will also need a set of libraries in order to compile the new sketch. I have created a zip file of the ones you will need. Again, it can be downloaded from the Shield web page.
- With the power off, plug the daughter board over the top of the Geiger board. Then plug your LCD into the daughter board. (The display plugs into the two 6pin connectors at the top of the board.)
- Power up the Geiger board. You will need to adjust the contrast on the LCD using the pot on the left side of the board. You should see the sketch start. Get a cup of coffee and a good cigar.

Using the IR Remote:

I've had good success with the kind of universal remote where you enter a code for the brand of TV. The sketch is looking for standard Sony TV codes, and now there is a compile option to look for Phillips RC-5 codes.

I've tried two different cheap key-chain types - one with a keypad – *eventually* I got them to work, but it was a pain. They use an automatic code scan while you hold the Mute button in. This system seems to change codes too quickly, and if I make the sketch respond faster, I get multiple entries when the buttons are pressed. I can't suggest them.

No matter what type of remote is used, pressing the Mute button will display "**IR OK!**" if the remote has communicated. When you get that message, press the "**On/Off**" button to verify that it brings up the menu. *(The keychain remotes will often give IR OK!, but then not respond to the Power button, or the Mute button again – until you finally hit it right.)* Once you have the remote set up, the keys should perform these functions:

- **Mute** – test communications. IR OK! displayed if IR received.
- **On/Off** – enter menu system. "SEC LONG COUNT" 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
- **Volume Down** or **Left Arrow** – decrements the value already set for the current option
- **Enter** or **AV/TV** – finalizes the entry in the current menu option
- **Info** – on v4d, toggles the back light on and off
- **Digits 0-9** – for direct entry of values (instead of Volume or Arrows) – must use **Enter** or **AV/TV** before and after using digits. (Needing to do it *before* is a bug.)
- **Any other key** – *If you are in the menu system* the key code for unknown keys will display.

You can also set the date and time and parameters without using the remote. There is a sketch you can download on the Shield web page. Upload that sketch to the Geiger board, and use the serial monitor in the Arduino IDE (set to 9600 baud). The display on the shield is not operative with this sketch.

Setting the Menu Options:

Initially, many of the options are set to defaults. The idea is that if you don't have a 10 key pad on your remote, you won't have to hit the arrow key 175 times to set the CPM -> uSv ratio! Note that the previous settings that were made have been stored in EEPROM on the ATmega328, so you tend to pick up where you left off. (With exception of setting the time.) Here is a brief description of each menu option:

- **SEC DISP PERIOD** is the number of seconds before the display refreshes.
  (5 seconds is a good setting. Display is now based on a "running average" like the Geiger Kit.)
- **1= DOSE MODE ON** - Dose Mode shows the running average of CPM & uSv/h on an alternate display that comes up after 4 display periods have passed. It can also be activated by closing DIP switch #1 on the board. Note that Dose Mode will only begin to display once 1 minute has passed.
- **MIN LOGGING** is when to write the log data to the MicroSD card (in minutes). Zero means logging is turned off.
  (Since the setting is in minutes, logged results will not be subject to rounding errors.)
- **CPM->uSv RATIO** is ratio for the type of GM tube used. 175 is the default for the SBM-20 and 100 is for the LDN 712. Unlike the "default sketch" only one ratio is supported, but now it can be easily changed.
- **ALARM > CPM** when the CPM is greater than this value, pin 15 goes high (+5V) what you do with it is up to you. Caution! If you exceed 40mA. You can burn out the pin. You can trigger a transistor if you need more than that. You can also get a piezo with a built in oscillator such as this one (http://www.radioshack.com/product/index.jsp?productId=2062397). (no transistor needed) Pin 15 will go back to low (Gnd) when the CPM drops back under the alarm threshold.
- **Date and Time** (non-GPS mode only) Without the GPS, you need to set the date and time. There are separate menu options for DAY, MONTH, YEAR (YY), HOURS (24), and MINUTES + SET. Only after minutes are set, will the time clock be set. After setting you should see the correct date and time on the second line of the display when you leave the menu system. The date-time is backed up by the battery on the daughter board so it will stick. Note that there is a compile option to automatically adjust for the US version of daylight savings time. There are also several other compile options to set the format of the date and time. By default, the format is DDMMYY 24Hr, but MMDDYY, YYMMDD, AM/PM can also be set. See the beginning of the sketch for these options.
- **ZONE (>12= +)** (GPS mode only) When using the GPS, you need to set your time zone because the GPS provides time in UTC format. The time zone can be anything between -12 and +12, but avoid the complexities of entering negative numbers, values between 0 and 12 are considered negative, and above 12, positive. So if your zone is +5 you would set 17. Note: you must restart to have the new zone setting take effect.
- Note - more menus options may have added in later versions of the software**.**

Using the 4 DIP Switches:

Switches 1 and 2 are already used by the default sketch. Switches 3 and 4 are available for your own use. The switches are all "active low" which means that they are ON when the uC see a ground. In order to use them, you must modify the sketch. I have provide a "flag" (i.e. **SW3_On**) that indicates if the switch is on or off. Switches are tested at each display refresh.

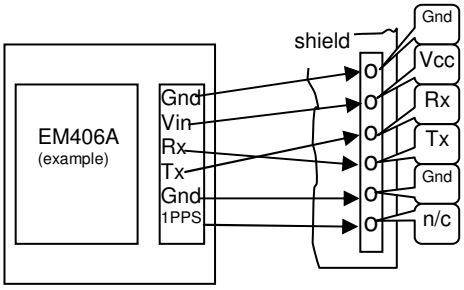
DIP switch 1 is used for Dose Mode display. As described above, it shows the running average of CPM & uSv/h on an alternate display that comes up after 4 display periods have passed. Note that Dose Mode will only begin to display once 1 minute has passed. For that switch, you can use a pushbutton so the dose display will come on only as long as the button is held, (it will display immediately when the button is pushed), or you can use a switch so that the display continuously alternates between the two displays. It can also be activated through the menu.

DIP switch 2 is in version 4d to turn off the backlight on the display. This can also be done using the INFO key with v. 4d software.

Connecting the GPS:

Note: The shield supports GPS modules that run at the same voltage as the uC – by default this is **5V.**

The EM 406A:



The connections to the common EM406A are shown at left. Note that the Rx and Tx lines are crossed.
Also note that the arrangement of the connector on the shield puts the GPS *over* the shield board. Depending on where you mount the GPS in your case, you may need to give the wires a 180º twist.

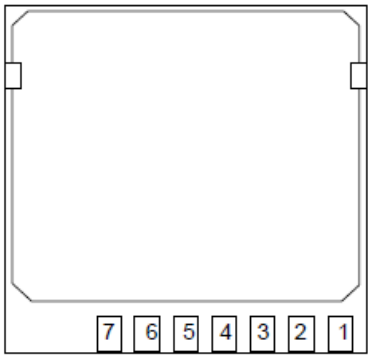
SkyTrac ST22:

While the price and size of this GPS module are very attractive, there are a few drawbacks:

- There is no on board LED that indicates a fix. Having one is especially helpful during initial setup.
- There is no on board battery backup to hold the last fix position. This means longer searches at startup.
- I was not able to get a fix indoors with this unit while I often can with the EM 406A. (YMMV)

More information on this GPS can be found at http://www.mr-lee-catcam.de/pe_cc_i6.htm .
From this diagram on the data sheet . . .

Pinout (Bottom View)



Pin	Name	Description
1	RXD	UART Serial data input
2	TXD	UART Serial data output
3	GND	Ground
4	VIN	Voltage supply (3 to 5.5V)
5	VBAK	Backup voltage supply (1.5 to 5.5V). If not used connect to VIN.
6	1PPS	One pulse per second output (available after position lock)
7	MODE	Search engine mode selection input: 1: Low power acquisition mode (default), acquisition current approx. 50mA 0: Enhanced acquisition mode, acquisition current approx. 70mA

- Pin 1 (RXD) to Tx on the shield
- Pin 2 (TXD) to Rx on the shield
- Pin 3 (GND) to GND on the shield
- Pin 4 (VIN) to Vcc on the shield
- Pin 5 (VBAK) jumper to VCC on the GPS
- Pin 6 (1PPS) not connected
- Pin 7 (MODE) jumper to GND on the GPS