

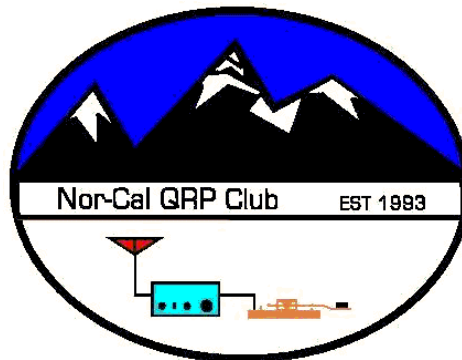
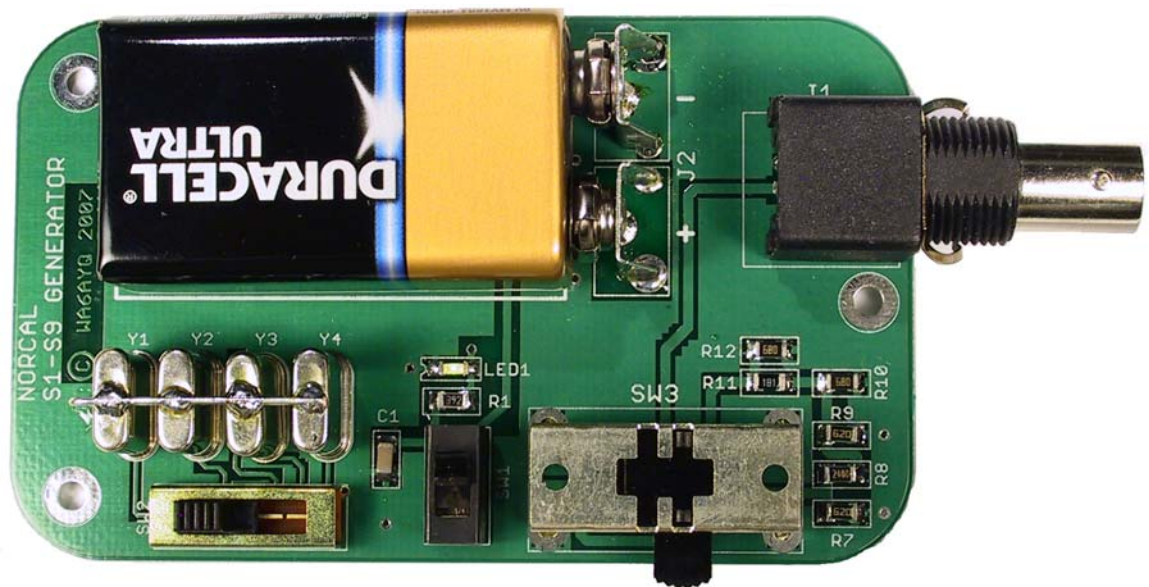
# The NorCal S9 Signal Generator Assembly & Operating Manual

Rev. 1.0

12-5-07

Song Kang, WA6AYQ

Bob Okas, W3CD



Copyright 2007 WA6AYQ, W3CD - All rights reserved

## Contents

1. Introduction.....	3
2. S9 Specifications .....	3
3. Assembly Notes .....	4
3.1 Essential Tools and Supplies .....	4
3.2 SMT Soldering Tips.....	4
3.3 Parts Bag Component Locator .....	5
4. Assembly .....	5
4.1 Bottom Side Assembly .....	5
4.2 Top Side Assembly .....	6
5. Testing.....	8
6. Altoids Tin Installation .....	8
7. Circuit Description.....	11
APPENDIX A. S9 Component Layout – Top .....	12
APPENDIX B. S9 Component Layout – Bottom.....	13
APPENDIX C. S9 Schematic .....	14
APPENDIX D. Parts List.....	15

## Figures

<b>Figure 1. Parts Bag Contents .....</b>	<b>5</b>
<b>Figure 2. SMT Capacitor Color Code.....</b>	<b>5</b>
<b>Figure 3. Completed Bottom Side .....</b>	<b>6</b>
<b>Figure 4. Completed Top Side .....</b>	<b>8</b>
<b>Figure 5. Drilled Altoids Tin.....</b>	<b>9</b>
<b>Figure 6. Prepared Altoids Tin Ready For Board Installation.....</b>	<b>10</b>
<b>Figure 7. S9 in an Altoids Enclosure .....</b>	<b>10</b>

## 1. Introduction

The NorCal S9 signal generator is a crystal-controlled oscillator which produces switchable output levels at selectable frequencies. All of the board-mounted components are included in the kit, all you need to add is a 9V battery. Rubber feet are supplied for enclosure-free operation, or you can easily fit it into an Altoids tin.

The S9 level is useful for testing and calibrating receiver S-meters while S1 level can be used for receiver alignment and sensitivity checks. The oscillator works with most fundamental mode crystals, so you can substitute your favorite frequencies up to 15m. The output harmonics also can be used to reach into the higher bands.

The majority of the components are surface mount technology (SMT), but are easily mounted due to wide component spacing. If this is your first SMT kit, be sure to read the assembly tips section which will guide you to a successful assembly.

## 2. S9 Specifications

Dimensions	3.5" x 2.125" x 0.6" (HWD), excluding connector
Power Requirements	9V battery, less than 2mA typical
Output Frequencies	3.579 MHz, 7.040 MHz, 10.116 MHz, 14.060 MHz
Frequency Accuracy	Within +/- 1KHz
Harmonic Content	2 <sup>nd</sup> : -4dBc +/- 2dB 3 <sup>rd</sup> : -11dBc +/- 3dB 4 <sup>th</sup> : -17dBc +/- 3dB
Output Impedance	50 Ohms
Output Level	1. Low: 1uV (-107 dBm) 2. High: 50uV (-73 dBm)
Amplitude Accuracy:	1. Low Level: +/- 3dB (2 dB typical) 2. High Level: +/- 3dB (1.5 db typical)

### 3. Assembly Notes

#### 3.1 Essential Tools and Supplies

1. .010" (preferred) or 0.015" diameter rosin core solder
2. A temperature-controlled soldering iron. 600F – 700F
3. Soldering iron tip diameter of 1/32" or smaller
4. Round point tweezers
5. A cookie sheet with raised sides is helpful to avoid losing parts
6. Headband or illuminated magnifier
7. Masking tape to hold the board during assembly

#### 3.2 SMT Soldering Tips

Lead-based solder is being phased out, but 60/40 or 63/37 tin/lead rosin-core, .010" to .015" diameter solder is suitable for installing the components in this kit. You can use .025" diameter solder for the thru-hole components. Silver-bearing, "eutectic" solder is also acceptable, but not necessary. ***Do not use solder with an acid-core flux.***

The assembly instructions below are organized to permit ease of component installation. The silkscreen component outlines indicate the component locations and orientation. Appendices A and B contain enlarged views of the Top and Bottom sides, respectively.

### 3.3 Parts Bag Component Locator

Figure 1 shows the bag layout and Figure 2 shows the capacitor color code used in this kit.

Surface Mount Components
Thru-hole Components & Circuit Board

Color	Value
RED	.01uF
YELLOW	18pF
VIOLET	47pF

**Figure 2. SMT Capacitor Color Code**

**Figure 1. Parts Bag Contents**

## 4. Assembly

If you plan to install the S9 Generator in an Altoids tin, skip ahead to Section 6. It's easier to prepare the tin before parts are installed on the board.

When you're ready to start building, secure the S9 board to your work surface using masking tape to prevent movement. We'll start building the board with the bottom side. Refer to Figure 3.

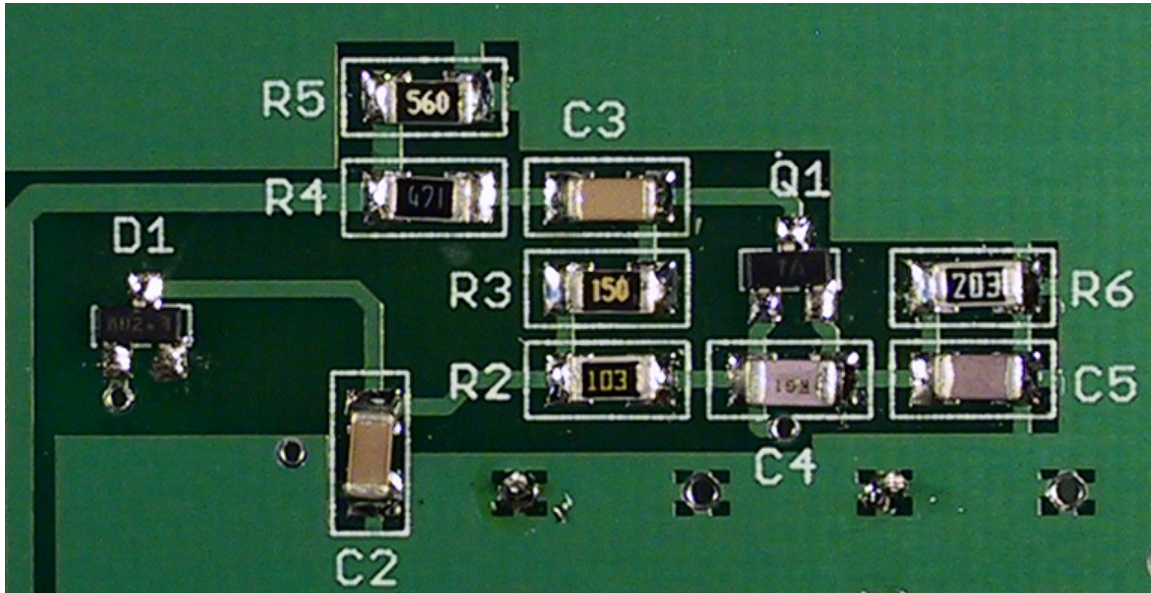
### 4.1 Bottom Side Assembly

In the following order, install:

- ☐ D1, marked either 5D or 5H
- ☐ C2, Strip color RED
- ☐ R4, marked 471
- ☐ R5, 560
- ☐ R2, 103
- ☐ R3, 150

- ☐ C3, Strip color RED
- ☐ C4, Strip color YELLOW
- ☐ Q1, marked 1A
- ☐ C5, Strip color VIOLET
- ☐ R6, 203

Inspect the solder joints and touch up as required. Figure 3 shows the completed component installation.



**Figure 1. Completed Bottom Side**

## 4.2 Top Side Assembly

This side includes both SMT and thru-hole components. We will install the SMT components first. Refer to Figure 4.

In the following order, install:

- ☐ LED1, no marking. Make sure Black band is on the left.
- ☐ R1, marked 392
- ☐ C1, Strip color RED
- ☐ R7, 620
- ☐ R8, 241
- ☐ R9, 620
- ☐ R10, 750
- ☐ R11, 121
- ☐ R12, 750

Double check your work, especially LED1's orientation. Now it's time to install the crystals. The kit is supplied with popular QRP frequency crystals, feel free to substitute your favorites, up to 21 MHz.

In the following order, install:

- ☐ Y1 – 3.579 MHz
- ☐ Y2 – 7.040 MHz
- ☐ Y3 – 10.116 MHz
- ☐ Y4 – 14.060 MHz
- ☐ Rough up the tops of the crystals. Use fine sandpaper or an emery board.
- ☐ Bend a piece of buss wire to form an “L” shape.
- ☐ Insert one end into the ground pad just to left of Y1 and solder the other end to the top of Y4. Trim the excess.
- ☐ Solder the wire to the remaining crystals.
- ☐ Solder the lead to the ground pad at Y1.

Switch installation is next. SW1 can be installed either way. SW2 fits in only one orientation. The handle of SW3 should protrude beyond the edge of the board. It's important to solder all of the tabs on SW3 to obtain proper signal attenuation in the S1 position.

- ☐ SW1 – Set switch handle to the bottom position
- ☐ SW2 – Set switch handle to the far left position
- ☐ SW3 – Be sure to solder the 4 switch mounting tabs!

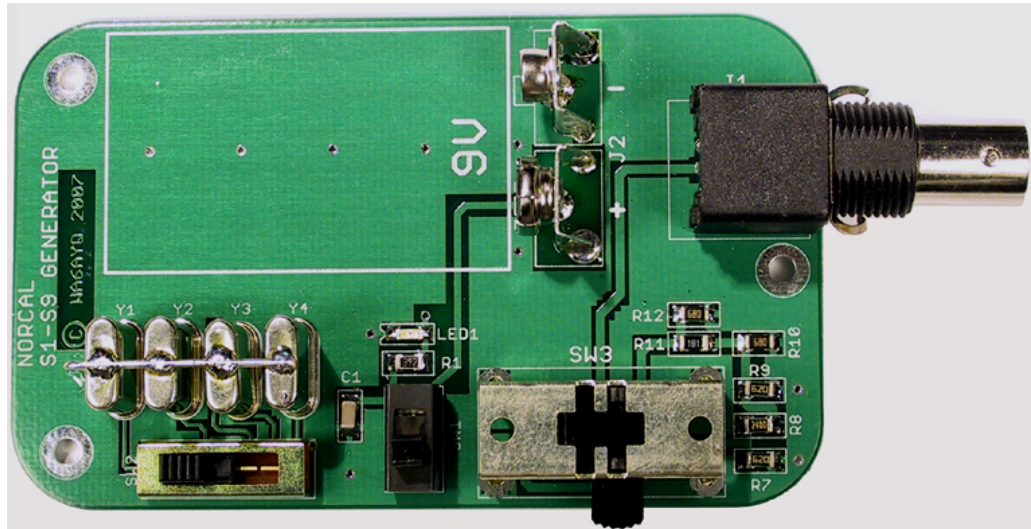
The battery terminals are up next. Make sure that SW1 is set to “Off”: Handle at the bottom position. The terminals have some wiggle room, so a battery is used to orient these properly.

- ☐ Plug the positive and negative terminals into a 9V battery. Be careful not to short them!
- ☐ Using the silkscreen as a guide, mount the battery & terminals into the board. The female positive terminal, or “cup” is installed closest to SW3 while the male negative terminal is closest to the top edge of the board.
- ☐ When you are satisfied with the alignment, solder the 3 tabs on each terminal.
- ☐ Remove the battery.

Lastly, the output connector.

- ☐ J1 – solder all tabs

If you plan to operate the S9 Generator unenclosed, install the four rubber feet at the corners. Smile, you're done! If you're going to install it in an Altoids tin, wait until testing is complete.



**Figure 2. Completed Top Side**

## 5. Testing

Move SW2 and SW3 to their far left positions. Move SW1 to the down position and install a fresh 9V battery. Flip up SW1 and check if LED1 is lit. If not, check R1 and LED1. Make sure the battery clips were installed in the correct locations.

Next, connect a cable from J2 to a CW/SSB receiver tuned to 3.579 MHz. You should hear a loud tone. Note the receiver's S-meter indication. Flip SW3 to the other position and observe the S-meter. It should have dropped substantially. Repeat this procedure for the remaining bands.

If you are unable to hear any signal on any band, double-check all of the components on the bottom of the board and SW2. If the S1 level is very weak, check R7-R12.

## 6. Altoids Tin Installation

Mark the mounting holes on the inside bottom of the tin using the bare board. Make sure the top side is facing up. Drill three holes. The board mounting holes are sized for 4-40 screws, so use a 1/8" drill bit.



Align the bare board to the holes and mark the location for BNC jack and output level switch. You can eyeball the locations and be fairly accurate. A step-bit works very well for medium to large holes. For the level switch, first drill a hole and then file to rectangular shape. Frequent alignment checks produce the best results.

The top cover will need to be notched to allow clearance for the BNC jack. You can snip the metal using wire cutters and file to shape and remove the burrs.

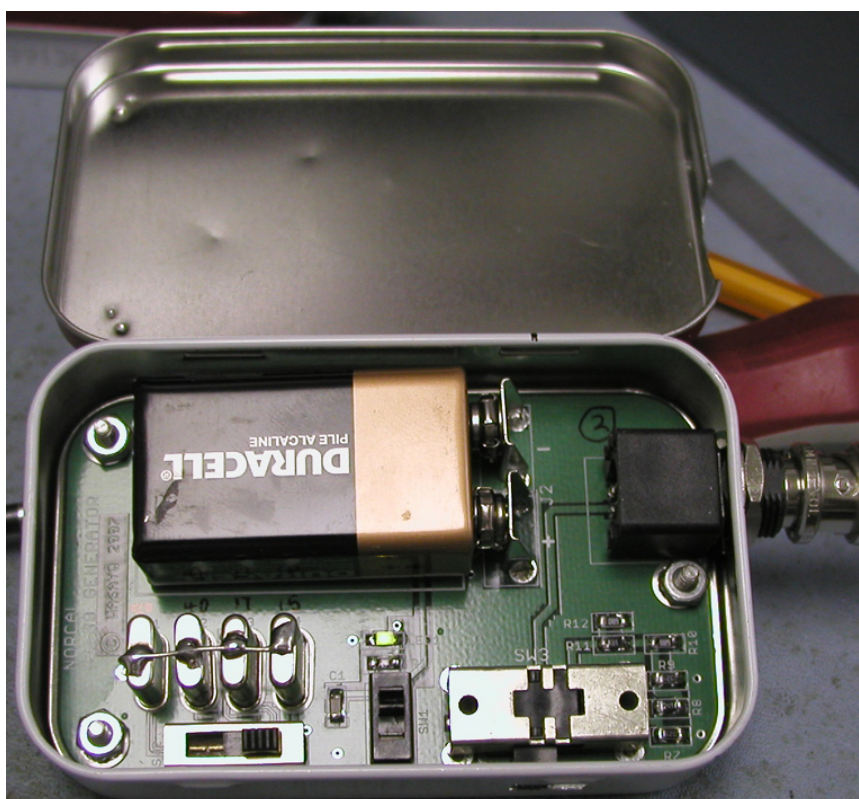


**Figure 3. Drilled Altoids Tin**

You will need three very short spacers to raise the board off the bottom of the tin. A height of 0.1" is ideal. You can add an adhesive to hold them in place. A few layers of electrical tape on the bottom will help insulate the components, as shown in Figure 6. Figure 7 shows the completed assembly.



**Figure 4. Prepared Altoids Tin Ready For Board Installation**



**Figure 5. S9 in an Altoids Enclosure**

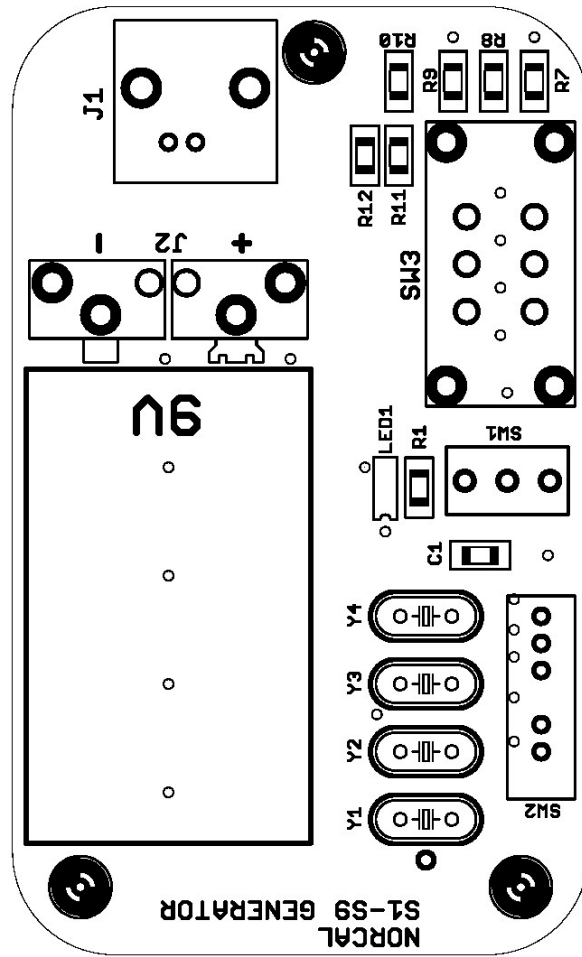
## 7. Circuit Description

The S9 is powered by a 9V battery which should provide long service life because less than 2 mA are required during operation. R1 drops the battery voltage and supplies current to LED1, which serves as a voltage regulator and power-on indicator. The voltage across LED1 is 1.88V +/- 10mV. D1 also serves a dual purpose: it provides a further voltage drop and provides reverse polarity protection for the rest of the circuit. The voltage between the cathode and ground is about 1.4V, since the drop across D1 is about 0.5V due to the low oscillator current. C2 decouples the power supply.

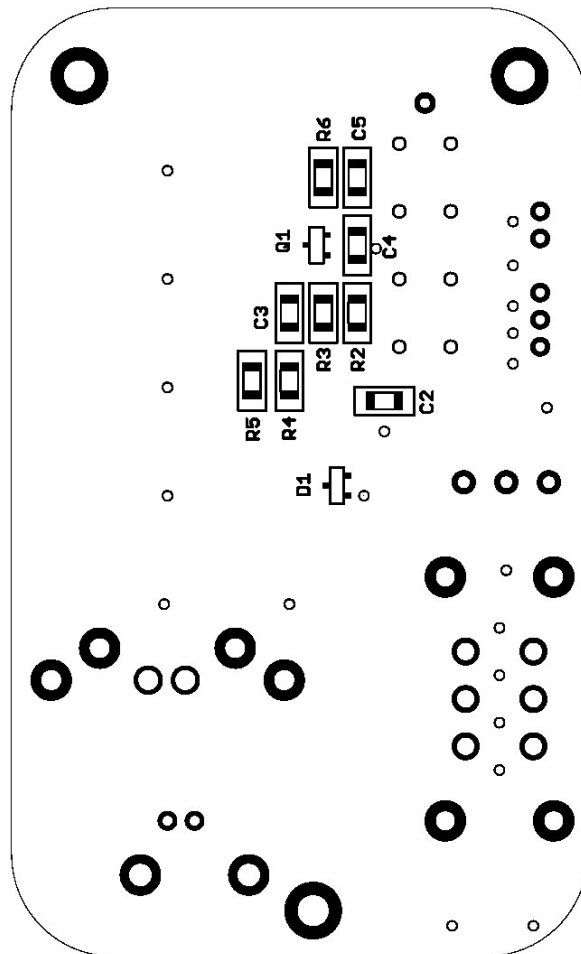
Q1, R2, R3, R6, C4, C5 and one of the switch-selected crystals form a low power Colpitts oscillator. The oscillator output is taken from the collector through C3 and supplied to an attenuator composed of R4 and R5. The attenuator output is nominally 50uV into a 50  $\Omega$  load. SW3 selects between the S9 and S1 output levels. A 34dB attenuator comprised of R7 through R12 provides the 1uV signal output. Two separate pi networks were used to provide accuracy.

The oscillator output contains harmonics of the fundamental frequency. This is useful for checking higher bands, but the signal level will be less than the fundamental. You can install other crystals in Y1 through Y4 at frequencies up to 21 MHz.

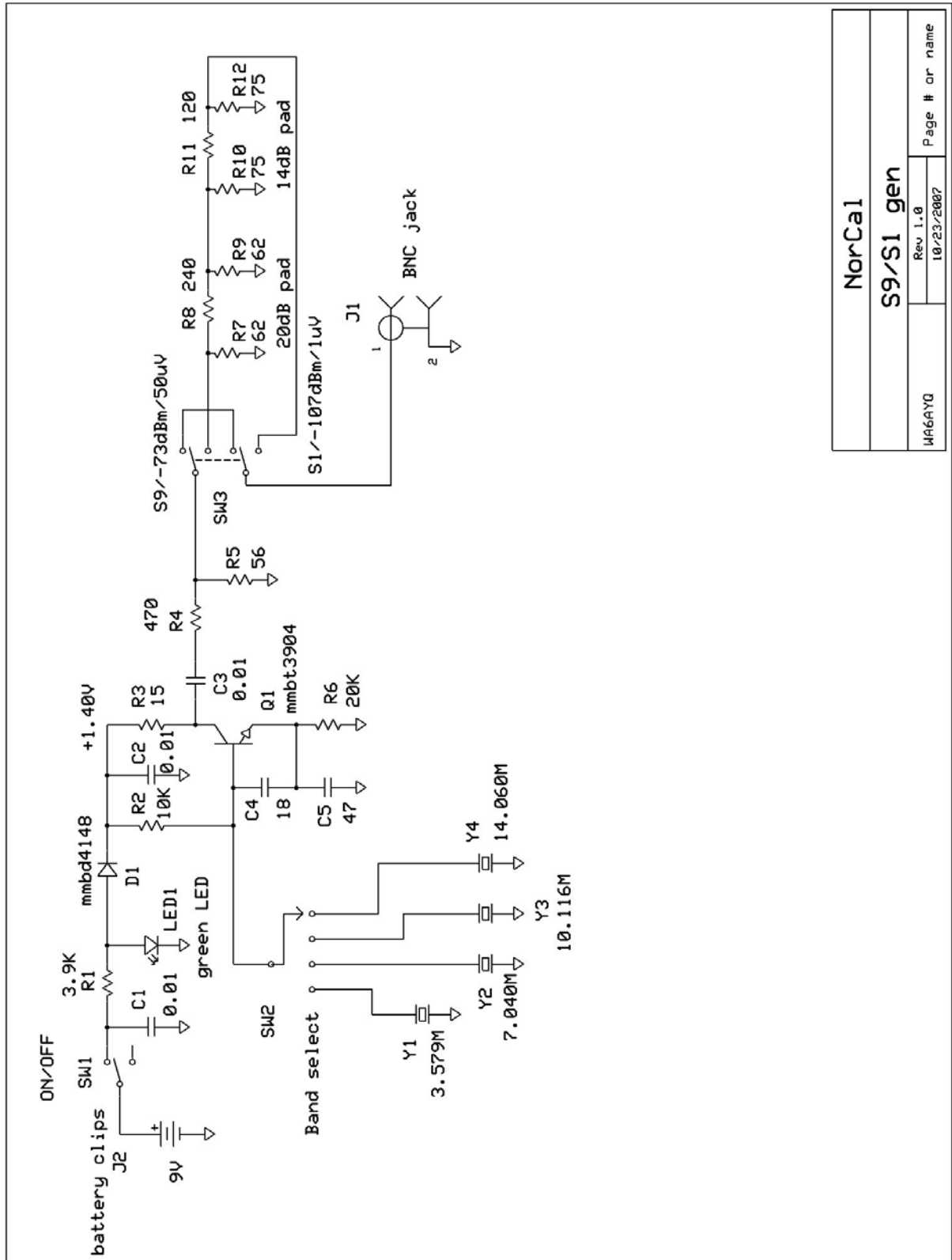
## APPENDIX A. S9 Component Layout – Top



## APPENDIX B. S9 Component Layout – Bottom



# APPENDIX C. S9 Schematic



NorCal	
S9/S1 gen	
UA6AYQ	Rev 1.0
	10/23/2007
Page # or name	

## APPENDIX D. Parts List

Item	Qty	Ref. Des.	Value	Description	Color /Marking
1	3	C1, C2, C3	0.01uF	1206 Ceramic Cap	RED
2	1	C4	18pF	1206 NP0 Ceramic Cap	YELLOW
3	1	C5	47pF	1206 NP0 Ceramic Cap	VIOLET
4	1	D1	MMBD4148	SOT23 Diode	“5D” or “5H”
5	1	J1	N/A	PC mount BNC jack	
6	1	J2	N/A	9V battery clips	
7	1	LED1	Green	1206 LED	
8	1	Q1	MMBT3904	SOT23 Transistor	“1A”
9	1	R1	3.9K	1206 5% Resistor	392
10	1	R2	10K	1206 5% Resistor	103
11	1	R3	15 Ohms	1206 5% Resistor	150
12	1	R4	470 Ohms	1206 5% Resistor	471
13	1	R5	56 Ohms	1206 5% Resistor	560
14	1	R6	20K	1206 5% Resistor	203
15	2	R7, R9	62 Ohms	1206 5% Resistor	620
16	1	R8	240 Ohms	1206 5% Resistor	241
17	2	R10, R12	75 Ohms	1206 5% Resistor	750
18	1	R11	120 Ohms	1206 5% Resistor	121
19	1	SW1	N/A	SPDT Slide Switch	
20	1	SW2	N/A	SP4T Slide Switch	
21	1	SW3	N/A	DPDT Slide Switch	
22	1	Y1	3.579 MHz	HC-49 Fundamental Xtal	
23	1	Y2	7.040 MHz	HC-49 Fundamental Xtal	
24	1	Y3	10.116 MHz	HC-49 Fundamental Xtal	
25	1	Y4	14.060 MHz	HC-49 Fundamental Xtal	
26	4	N/A	N/A	Rubber Feet	