# Blitzortung

## System RED Kit

**Step-by-Step Assembly**
**Instructions**

**Written for the following PCB Versions ONLY**

**Amplifier**
**PCB Ver. 3 * 7/2013**

**Controller**
**PCB Ver. 3b * 8/2013**

REVISED: June 13, 2014

**DISCLAIMER: This document is a personal, private endeavor. It is not being written with the approval or sanction of the Blitzortung group. Use of this document is at your own risk.**

This document is a work in progress. It is being developed as I build my own Blitzortung System RED Lightning Detector. As I build my system, I will add to this document so everyone will be able to follow my way of building my detector. This is my first attempt at soldering SMDs. I have had over 50 years of electronics experience in computers and communications systems and have soldered literally thousands of standard printed circuit board connections but SMD devices are new to my repertoire. I have attempted to collect some of the experiences of others System RED builders as listed in the several Blitzortung forums. I cannot claim any credit for any of the myriad of suggestions, tips and hints. I am only trying to bring many of those ideas into a single document with the hope that many more folks will take interest in the Blitzortung project and build their own systems. Please feel free to suggest changes, corrections or better ways of making this a more usable document for everyone.

There have been numerous requests on the forums for a "step by step" assembly instruction manual. Hopefully, this document will begin to fill some of those requests.


Thanks for taking the time to look this document over.


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**NOTE:** These instructions have not been verified for accuracy. That will happen as I finalize the document at a later time. Use this with caution.

*No guarantees are made. Use it at your own risk…*

These instructions have been put together to assist you in getting started with the assembly of your Blitzortung System RED Lightning Detector.

The first step is to provide you with a listing of suggested tools and supplies you will need during the inventory and assembly phases of the building project. Once you have obtained the recommended tools and supplies, we will begin the process of inventorying and then assembling the kit.

The inventory kit will ensure you have a complete kit and are ready to begin with the assembly phase.

NOTE: As a precautionary measure and before you open and touch any of the components, read the following three paragraphs.

While there have been no reports of System RED components being damaged by electrostatic discharge (ESD) during their handling and installation, it would be wise to take this into account, especially if you live in an area that has very low humidity levels.

Due to the potential of damaging the sensitive components in your kit with an electrostatic discharge (ESD) it is recommended that you take precautions to minimize the ESD possibilities. This can be done by ensuring that you and all of the equipment and components are at the same potential (grounded) through the use of an anti-static mat and an anti-static wristband. Both of these items are attached to a common ground.

If you do not have an anti-static mat or wristband, you can find them on-line at Radio Shack (part number: 276-2370 - http://www.radioshack.com/product/index.jsp?productId=2102871) or other electronics parts outlet. Just Google "anti-static mat" and you will find many resources. Amazon and eBay are also resources.

A complete list of components and a checklist is available on the Internet to help you inventory your kit. It can be found by going to the WXFORUM.NET web-forum at the following URL:

- http://www.wxforum.net/index.php?topic=20037.0

The steps outlined below will help you to complete your inventory, assembly and testing of your new Blitzortung System RED Lightning Detection System. This document is laid-out in the following format:

Section I – Recommended Tools and Accessories

Section II – Inventory your Kit

Section III – Assembly of your RED Kit

 a) Assemble Amplifier PCB components
 b) Assemble Controller PCB components

Section IV – Testing of your completed Kit

Section V – Troubleshooting

Section VI – Reference Information

## SECTION I – RECOMMENDED TOOLS AND ACCESSORIES

a) Anti-static Mat & Wristband

b) Digital Multimeter

c) Soldering Iron - Temperature Controlled w/Fine Tip

d) Solder

   a. Radio Shack 0.015" diameter, 62/36/2, Silver-bearing Solder. Part Number: 64-035, or equivalent http://www.radioshack.com/product/index.jsp?productId=2062725

   NOTE: Lead-free solder is NOT recommended.

e) Desoldering Braid or Solder Pump

   a. Desoldering Braid - Radio Shack Part Number: 64-2090
      http://www.radioshack.com/product/index.jsp?productId=2062744&locale=en_US

   b. Solder Pump – Radio Shack Part Number: 64-210
      http://www.radioshack.com/product/index.jsp?productId=17241906

f) Liquid Solder Flux (optional – helps the solder to flow better. Used only on SMDs)

   a. Radio Shack Part Number: 55047964
      http://www.radioshack.com/product/index.jsp?productId=12580192

g) Small diagonal cutters

   a. Radio Shack Part Number: 64-024
      http://www.radioshack.com/product/index.jsp?productId=3932532

h) High Intensity Lamp

i) Magnifying Glass or Loop (10X to 30X)

   a. A lighted version of these would be helpful too

j) Painter's Tape or Masking Tape to mark components during the inventory phase.

k) Sharpie Marker – Ultra Fine

l) Oscilloscope – optional but can be handy during troubleshooting.

m) Wooden Chop Sticks – used to position and hold the ICs in place during soldering.

## SECTION II – INVENTORY YOUR KIT

The Blitzortung System RED Kit will arrive in a box that contains several plastic bags. The Amplifier and Controller parts are mixed together so it is a good idea to begin separating the parts as you do your inventory.

a) ☐   Start the inventory with the resistors. Using the component check-list (http://carsonvalleyweather.com/blitzortung/docs/System-RED-Kit-Parts-Amplifier-12-v3.pdf), identify and mark each resistor. It is suggested that you use a digital multi-meter (DMM) to ensure the correct value of each resistor being identified. The resistors used are very small and the color bands are difficult to see.

b) ☐   Inventory the Capacitors next. On some of these you will not see any value stamped, only a number. The inventory check-list shows those items with their identifying numbers. The Blitzortung System RED Manual (http://carsonvalleyweather.com/blitzortung/docs/TOA_Blitzortung_RED-2013-08-23.pdf) also has a parts listing along with a few color images of the individual resistors and capacitors to help you identify the various components.

c) ☐   Inventory the remaining IC's, Transistors and other electronic components.

d) ☐   You will also find numerous other non-electronic parts in the bags. Currently there is no list of these items but they can easily be identified by viewing the images in the above mentioned System RED manual. I would suggest that you simply lay your Amplifier and Controller boards down with the writing facing up and the insert each non-electronic component in its place. Do not force any item. If you have problems inserting the part, check the pin alignment to ensure the pins are not bent.

    a. Please note, there are two single row 10-pin (1 x 10) connectors that are used on the Controller board for the LCD display. You will have to snip or pinch-off the last pin on each of these connectors or they won't fit on the Controller board. See the instructions in the System RED Manual for details (Pg. 22, Item 2, fourth bullet) – see link to the RED manual above. These items will be trimmed during the installation procedure.

e) ☐   Once you have the items separated, put them in a baggy or some container labeled as "Amplifier" or "Controller" components. This will help when you begin assembling the PCBs.

## SECTION III – ASSEMBLY OF YOUR RED KIT

## a) Assembly Sequence – Amplifier PCB

**Check-off each component as you complete it.**

a. **Surface Mount Devices (SMDs)**. We'll start with these items so we have plenty of room on the PCB to work. If you are not familiar with soldering of surface mount devices, there are many good videos available on YouTube. Just search for "surface mount soldering tutorial". A good tutorial I have found that covers the basics for various types of SMD devices is www.youtube.com/watch?v=3NN7UGWYmBY. There are many others too.

☐ **IC2 – Dual op-amp, MCP6292**. The dot on each IC must align with the white dot on the Amplifier PCB. Solder one of the corner pins first to hold the IC in place. Once it is aligned correctly so that all pins are on their corresponding pads, solder the remaining pins.

☐ **IC6 –Dual op-amp, MCP6292**. Follow the instructions as described for IC2 above.

☐ **IC4 – Output driver amplifier, LMH6642**. Follow the instructions as described for IC2 above.

☐ **IC8 – Output driver amplifier, LMH6642**. Follow the instructions as described for IC2 above.

Congratulations! You have completed the most difficult part of assembling the components on the Amplifier board.

We will now begin inserting and soldering the smaller components in their respective positions on the Amplifier board.

**b. Diodes – 1N4148**

The cathode (-) of the diode is marked with a black or white ring on the body of the diode itself. This side is marked white on the PCB along with the component number ie (D1, D2, etc). Bend the leads on each diode by holding each lead next to the glass body with a pair of needle-nose pliers. This will eliminate stressing the diode which may possibly crack it. Insert each diode all the way in until it touches the PCB. Slightly spread the leads on the back-side of the PCB so the diode does not fall-out. Do not solder until all four diodes have been inserted.

☐ **D1 – 1N4148 diode.** Prepare and **i**nsert the diode into the designated holes on the PCB.

☐ **D2 – 1N4148 diode.** Follow the instructions as described above.

☐ **D3 – 1N4148 diode.** Follow the instructions as described above.

☐ **D4 – 1N4148 diode.** Follow the instructions as described above.

☐ Solder all four diodes just inserted.

☐ Clip the leads on the backside of the PCB for all four diodes.

### c. Resistor Installation

We will now begin inserting and soldering the resistors on the Amplifier board.

We'll start on the left-side of the PCB with it oriented so the antenna input section is on the left. R1 will be in the upper left-side of the PCB. The resistors can be inserted in any direction. I suggest inserting only a few at a time so it is easier to solder and clip the leads as you go. Bend the leads as you did with the diodes earlier.

| | | | |
|---|---|---|---|
| ☐ | **R1** | **2.2KΩ** | Prepare and **i**nsert the resistor into the designated holes on the PCB. |
| ☐ | **R2** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R3** | **100KΩ** | Follow the instructions as described above. |
| ☐ | **R16** | **2.2KΩ** | Follow the instructions as described above. |
| ☐ | **R17** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R18** | **100KΩ** | Follow the instructions as described above. |
| ☐ | **R5** | **22KΩ** | Follow the instructions as described above. |
| ☐ | **R20** | **22KΩ** | Follow the instructions as described above. |
| ☐ | **R4** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R7** | **22KΩ** | Follow the instructions as described above. |
| ☐ | **R9** | **2.2KΩ** | Follow the instructions as described above. |
| ☐ | **R19** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R22** | **22KΩ** | Follow the instructions as described above. |
| ☐ | **R24** | **2.2KΩ** | Follow the instructions as described above. |
| ☐ | **R8** | **6.8KΩ** | Follow the instructions as described above. |
| ☐ | **R6** | **68KΩ** | Follow the instructions as described above. |

| | | | |
|---|---|---|---|
| ☐ | **R23** | **6.8KΩ** | Follow the instructions as described above. |
| ☐ | **R21** | **68KΩ** | Follow the instructions as described above. |
| ☐ | **R10** | **1KΩ** | Follow the instructions as described above. |
| ☐ | **R25** | **1KΩ** | Follow the instructions as described above. |
| ☐ | **R11** | **1KΩ** | Follow the instructions as described above. |
| ☐ | **R26** | **1KΩ** | Follow the instructions as described above. |
| ☐ | **R31** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R12** | **22KΩ** | Follow the instructions as described above. |
| ☐ | **R27** | **22KΩ** | Follow the instructions as described above. |
| ☐ | **R32** | **2.2KΩ** | Follow the instructions as described above. |
| ☐ | **R33** | **2.2KΩ** | Follow the instructions as described above. |
| ☐ | **R13** | **100KΩ** | Follow the instructions as described above. |
| ☐ | **R14** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R28** | **100KΩ** | Follow the instructions as described above. |
| ☐ | **R29** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R15** | **47Ω** | Follow the instructions as described above. |
| ☐ | **R30** | **47Ω** | Follow the instructions as described above. |
| ☐ | **R34** | **330Ω** | Follow the instructions as described above. |
| ☐ | **R35** | **330Ω** | Follow the instructions as described above. |

Go back over all of the resistors to be certain they have been soldered and have their excess leads clipped from the back of the PCB.

### c. Non-Electrolytic Capacitor Installation

We will now begin inserting and soldering the non-polarized capacitors on the Amplifier board.

We'll start on the left-side of the PCB as we did with the resistors. The only difference in the process is that you will not have to pre-bend the leads. They should fit nicely into the PCB as they are. You will still have to spread the leads on the backside of the PCB to hold the capacitors into place for soldering. As with the resistors, I suggest inserting only a few at a time so it is easier to solder and clip the leads as you go.

| | | | | |
|---|---|---|---|---|
| ☐ | **C3** | **22nF** | **(223)** | Insert the capacitor into the designated holes on the PCB. |
| ☐ | **C1** | **100nF** | **(104)** | Follow the instructions as described above. |
| ☐ | **C18** | **22nF** | **(223)** | Follow the instructions as described above. |
| ☐ | **C16** | **100nF** | **(104)** | Follow the instructions as described above. |
| ☐ | **C2** | **100nF** | **(104)** | Follow the instructions as described above. |
| ☐ | **C17** | **100nF** | **(104)** | Follow the instructions as described above. |
| ☐ | **C35** | **100nF** | **(104)** | Follow the instructions as described above. |
| ☐ | **C4** | **10nF** | **(103)** | Follow the instructions as described above. |
| ☐ | **C19** | **10nF** | **(103)** | Follow the instructions as described above. |
| ☐ | **C5** | **4.7nF** | **(472)** | Follow the instructions as described above. |
| ☐ | **C6** | **10nF** | **(103)** | Follow the instructions as described above. |
| ☐ | **C20** | **4.7nF** | **(472)** | Follow the instructions as described above. |
| ☐ | **C21** | **10nF** | **(103)** | Follow the instructions as described above. |
| ☐ | **C7** | **100nF** | **(104)** | Follow the instructions as described above. |
| ☐ | **C22** | **100nF** | **(104)** | Follow the instructions as described above. |

☐    **C8**      **470pF**      **(471)**      Follow the instructions as described above.

☐    **C9**      **2.2nF**      **(222)**      Follow the instructions as described above.

☐    **C23**      **470pF**      **(471)**      Follow the instructions as described above.

☐    **C24**      **2.2nF**      **(222)**      Follow the instructions as described above.

☐    **C10**      **6.8nF**      **(682)**      Follow the instructions as described above.

☐    **C11**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C25**      **6.8nF**      **(682)**      Follow the instructions as described above.

☐    **C26**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C12**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C27**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C13**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C28**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C32**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C14**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C29**      **100nF**      **(104)**      Follow the instructions as described above.

☐    **C31**      **100nF**      **(104)**      Follow the instructions as described above.

Go back over all of the capacitors to be certain they have been soldered and have their excess leads clipped from the back of the PCB.

### d. Inductors

| | | | |
|---|---|---|---|
| ☐ | **L1** | **1.5mH** | Insert the inductor into the designated holes on the PCB. |
| ☐ | **L3** | **1.5mH** | Follow the instructions as described above. |
| ☐ | **L2** | **3.3mH** | Follow the instructions as described above. |
| ☐ | **L4** | **3.3mH** | Follow the instructions as described above. |
| ☐ | **L5** | **470/330µH** | Follow the instructions as described above. |

### e. IC Sockets

| | | |
|---|---|---|
| ☐ | **IC1** | Align the notch on the socket body with that on the PCB. |
| ☐ | **IC5** | Follow the instructions as described above. |
| ☐ | **IC3** | Follow the instructions as described above. |
| ☐ | **IC7** | Follow the instructions as described above. |
| ☐ | **ATMEGA8** | Follow the instructions as described above. |

### f. Miscellaneous Components

| | | | |
|---|---|---|---|
| ☐ | **P1** | **Potentiometer** | Align the notch on the socket body with that on the PCB. |
| ☐ | **RESET Button** | | Align pins with those on the PCB. |
| ☐ | **Out-A** | **Test Pin** | Remove center pin, if any, and insert the shorter leads into the designated holes on the PCB. |
| ☐ | **Out-B** | **Test Pin** | Remove center pin, if any, and insert the shorter leads into the designated holes on the PCB. |
| ☐ | **C15** | **2.2µF** | Electrolytic Capacitor. Long lead is +. |

| | | | |
|---|---|---|---|
| ☐ | **C30** | **2.2µF** | Electrolytic Capacitor. Long lead is +. |
| ☐ | **C33** | **470µF** | Electrolytic Capacitor. Long lead is +. |
| ☐ | **C34** | **470µF** | Electrolytic Capacitor. Long lead is +. |

☐ **Mini USB Connector**   Install in designated holes on the PCB.

☐ **Antenna Connector**   Align with markings on the PCB. Ensure it is fully seated against the board when soldered.

NOTE: This connector is delicate and easy to break. DO NOT over-tighten the screw lugs.

☐ **RJ45**   Amp to Controller Ethernet Cable Connector

☐ **RN1**   **1KΩ**   **(A102)** Resistor Network. Align so dot is next to Red power LED.

g. **LEDs**

| | | | |
|---|---|---|---|
| ☐ | **Red** | Power | Align long lead with white mark on PCB. |
| ☐ | **Yellow** | Gain Index | Follow the instructions as described above. |
| ☐ | **Yellow** | Gain Index | Follow the instructions as described above. |
| ☐ | **Yellow** | Gain Index | Follow the instructions as described above. |
| ☐ | **Yellow** | Gain Index | Follow the instructions as described above. |
| ☐ | **Green** | Auto Gain Indicator | Follow the instructions as described above. |

Congratulations – You have now finished the soldering portion of your System RED Amplifier PCB! The last steps will be to insert the IC's into their sockets. But first, go back over your newly assembled board and check all solder joints to make sure you have soldered all of them and look for any solder bridges between pins.

We will now insert the IC's into their sockets.

NOTE: Ensure all pins on the IC's are straight and not bent. You will not be able to insert them if any of the pins are not lined-up with the socket.

☐ **IC1** **MCP6S91** **DIP8** Insert the IC into the designated socket.

☐ **IC5** **MCP6S91** **DIP8** Follow the instructions as described above.

☐ **IC3** **MCP6S91** **DIP8** Follow the instructions as described above.

☐ **IC7** **MCP6S91** **DIP8** Follow the instructions as described above.

Microprocessor Controller

☐ **ATMEGA8** Insert the IC into the designated socket.

You have now completed the assembly of the Amplifier PCB. We will now perform a short test to see if things look okay.

☐ Plug-in the 5V USB power supply using the cable with the mini USB connector. The cable plugs into the mini USB connector on the RJ45 end of the PCB and is marked +5V.

You should see the Red LED lit indicating power is being supplied to the PCB and the four Yellow LEDs should blink four times in unison. After the Yellow LEDs stop blinking, they will stay in a random pattern that is dependent on the position of P1, the manual gate adjustment potentiometer. The Green LED should not be on during this initial test. Pressing the RESET button next to the Green LED will cause the Yellow LEDs to blink four times with each press.

If you do not get the above results,

☐ Check all solder joints again,

☐  Check all ICs to ensure they are fully seated in their sockets and that none of the pins are bent,

☐  Ensure there are no solder bridges between circuit components. Use a bright lamp and magnifying glass, if necessary.

**This concludes the assembly of the System RED Amplifier V3 PCB.**

You may use Denatured Alcohol to clean off any solder flux residue on the PCB. Be certain to wipe it off and remove any debris on the board afterwards.

## a) Assembly Sequence – Controller PCB

**Check-off each component as you complete it.**

We'll start with the power supply circuitry first and test it before moving on to the other components.

☐ **L41** **10µH** **(223)** Insert the inductor into the designated holes on the PCB and solder.

☐ **C46** **100nF** **(104)** Insert the capacitor into the designated holes on the PCB and solder.

☐ **C47** **100nF** **(104)** Follow the instructions as described above.

☐ **C48** **100uF** This is an electrolytic capacitor. The longer lead is positive and is inserted into the hole marked with a **+** next to it. NOTE: This component must lay down so it does not interfere with the board to be inserted above it. Just bend the leads so the capacitor will lay flat against the PCB.

☐ **C45** **470uF** This is an electrolytic capacitor. The longer lead is positive and is inserted into the hole marked with a **+** next to it. NOTE: This component can be upright.

☐ **LF33CV** This is the voltage regulator. Line up the hole in the part so it matches the hole on the PCB and lies flat on the PCB. You will have to bend the leads to make it lie flat. Before you install the part to be solder, apply a small amount of solder on the large pad with the hole in it. Then install the regulator component and with the holes aligned-up, solder the tab. Then solder the three remaining pins.

☐     **USB Connector**          Insert this part and solder the pins.

Go back over all of the components installed to be certain they have been soldered and have their excess leads clipped from the back of the PCB.

Now we'll check the 5V power circuitry. Plug the 5V USB Power Supply into the USB Connector and check for any warm or hot components. All should be relatively cool to the touch. If this is not the case, investigate to ensure all of the components were installed and soldered correctly.

Next, assuming you have a voltmeter or other suitable measurement device, check the voltage on the outer pins of the voltage regulator. NOTE: Be careful not to short out adjacent pins. Connect the negative lead of your meter to the large ground/heat sink on the LF33CV (it's the large tab on the part). Then touch the outer pins with your voltmeter. One should read approximately 5 volts and the other should read approximately 3.3 volts.

Next we will place the4 GPS surface mount device (SMD) on the PCB.

☐     **GTPA013**          **GPS SMD Module**

> NOTE: The alignment of this component is very critical. You may want to initially apply a very small amount of solder to the pads on the PCB prior to beginning this process. You may also want to apply some liquid flux to the PCB to help with the soldering.

> Position the SMD so pin 1 (marked with a 1 on the bottom of the SMD) is aligned with the white mark on the PCB. Lightly solder pin 1 and then make certain all other pins are aligned on the PCB. Adjust as necessary until alignment is achieved. Next, solder a pin on the opposite side of the GPS module so the unit is held in place while soldering the remaining pins. Solder remaining pins.

Once all pins are soldered, carefully inspect each pin to verify that you do not have any solder bridges between pins.

**Now we'll begin installing the shorter components on the PCB, starting with the resistors.**

| | | | |
|---|---|---|---|
| ☐ | **R57** | **680Ω** | Prepare and insert the resistor into the designated holes on the PCB. |
| ☐ | **R55** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R56** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R59** | **330Ω** | Follow the instructions as described above. |
| ☐ | **R58** | **330Ω** | Follow the instructions as described above. |
| ☐ | **R64** | **1KΩ** | Follow the instructions as described above. |
| ☐ | **R65** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R52** | **2.2KΩ** | Follow the instructions as described above. |
| ☐ | **R53** | **2.2KΩ** | Follow the instructions as described above. |
| ☐ | **R54** | **470Ω** | Follow the instructions as described above. |
| ☐ | **R63** | **1KΩ** | Follow the instructions as described above. |
| ☐ | **R62** | **1KΩ** | Follow the instructions as described above. |
| ☐ | **R47** | **10KΩ** | Follow the instructions as described above. |
| ☐ | **R45** | **49.9Ω** | Follow the instructions as described above. |
| ☐ | **R44** | **49.9Ω** | Follow the instructions as described above. |
| ☐ | **R40** | **680Ω** | Follow the instructions as described above. |

☐ **R41** **680Ω** Follow the instructions as described above.

☐ **R43** **49.9Ω** Follow the instructions as described above.

☐ **R42** **49.9Ω** Follow the instructions as described above.

☐ **R46** **2.2KΩ** Follow the instructions as described above.

☐ **R50** **2.2KΩ** Follow the instructions as described above.

☐ **R51** **10Ω** Follow the instructions as described above.

☐ **R48** **47Ω** Follow the instructions as described above.

☐ **R49** **10Ω** Follow the instructions as described above.

☐ **R60** **330Ω** Follow the instructions as described above.

☐ **R61** **330Ω** Follow the instructions as described above.

**That's all for the small resistors. Go back and check your solder connections before moving on to the next step.**

Now we'll begin installing the small ceramic capacitors.

☐ **C61** **100nF** **(104)** Insert the capacitor into the designated holes on the PCB.

☐ **C40** **100nF** **(104)** Follow the instructions as described above.

☐ **C43** **100nF** **(104)** Follow the instructions as described above.

☐ **C57** **100nF** **(104)** Follow the instructions as described above.

☐ **C58** **100nF** **(104)** Follow the instructions as described above.

☐ **C59** **100nF** **(104)** Follow the instructions as described above.

☐ **C60** **100nF** **(104)** Follow the instructions as described above.

There are now six more of the 100nF capacitors to be installed. Since it is very difficult to read, find the location marked for the RN41 resistor network. The six caps will be inserted just below this row which also has a white line the entire width of the board.

☐     **C49**     **100nF**     **(104)**     Follow the instructions as described above.

☐     **C50**     **100nF**     **(104)**     Follow the instructions as described above.

☐     **C51**     **100nF**     **(104)**     Follow the instructions as described above.

☐     **C52**     **100nF**     **(104)**     Follow the instructions as described above.

☐     **C53**     **100nF**     **(104)**     Follow the instructions as described above.

☐     **C54**     **100nF**     **(104)**     Follow the instructions as described above.


Next will be the crystal and two capacitors next to it.

☐     **Crystal 25MHz**     Insert the crystal and solder.

☐     **C41**     **18pF**     **(18)**     Prepare and **i**nsert the resistor into the designated holes on the PCB.

☐     **C42**     **18pF**     **(18)**     Follow the instructions as described above.


Next we'll install the remaining inductances.

☐     **L42**     **10μH**     **(223)**     Insert the inductor into the designated holes on the PCB and solder.

☐     **L40**     **10μH**     **(223)**     Follow the instructions as described above.

Next we'll install the small diodes on the PCB.

### a. Diodes – 1N4148

The cathode (-) of the diode is marked with a black or white ring on the body of the diode itself. This side is marked white on the PCB along with the component number ie (D40, D41, etc). Bend the leads on each diode by holding each lead next to the glass body with a pair of needle-nose pliers. This will eliminate stressing the diode which may possibly crack it. Insert each diode all the way in until it touches the PCB. Slightly spread the leads on the back-side of the PCB so the diode does not fall-out. Install and solder a few at a time.

| | | | |
|---|---|---|---|
| ☐ | **D40** | **1N4148** | Prepare and **i**nsert the diode into the designated holes on the PCB. |
| ☐ | **D41** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D42** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D43** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D44** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D45** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D46** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D47** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D48** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D49** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D50** | **1N4148** | Follow the instructions as described above. |
| ☐ | **D51** | **1N4148** | Follow the instructions as described above. |

### b) Diodes – 1N5818

These diodes are prepared and installed the same as the 1N4148 diodes.

| | | | |
|---|---|---|---|
| ☐ | **D52** | **1N5818** | Prepare and **i**nsert the diode into the designated holes on the PCB. |
| ☐ | **D53** | **1N5818** | Follow the instructions as described above. |
| ☐ | **D54** | **1N5818** | Follow the instructions as described above. |
| ☐ | **D55** | **1N5818** | Follow the instructions as described above. |
| ☐ | **D56** | **1N5818** | Follow the instructions as described above. |
| ☐ | **D57** | **1N5818** | Follow the instructions as described above. |

Next we'll install the Resistor Network components.

NOTE: There are two identical RN41 items. While they can be installed in any position, it is suggested the dot be placed towards the top of the PCB for consistency. The RN41 items are located immediately next to the group of six 100nF capacitors. For the RN40 & RN42 networks, install them so the dot aligns next to the white mark on the PCB.

| | | | | |
|---|---|---|---|---|
| ☐ | **RN41** | **1KΩ** | **(B102)** | Follow the instructions as described above. |
| ☐ | **RN41** | **1KΩ** | **(B102)** | Follow the instructions as described above. |
| ☐ | **RN40** | **100Ω** | **(A101)** | Follow the instructions as described above. |
| ☐ | **RN42** | **10KΩ** | **(A103)** | Follow the instructions as described above. |

Next we'll install the LED and some miscellaneous components.

| | | |
|---|---|---|
| ☐ | **Green** | **LED** GPS Lock Indicator |

The long lead is inserted in the hole marked with a white mark. Solder this LED before moving on to the next item.

| | | | |
|---|---|---|---|
| ☐ | **T40** | **Transistor** | Install the BC338 transistor in its socket so the flat-side aligns with the marking on the PCB. Solder the pins. NOTE: This transistor must lay flat on the PCB bending away from the edge of the board. Bend the pins so the flat-side faces downward. The display board sits above this component. |
| ☐ | **T41** | **Transistor** | Install the BC338 transistor in its socket as instructed above. Solder the pins. NOTE: This transistor must also lay face-down so it does not interfere with the Discovery board which goes above it. |
| ☐ | **GPS** | **SMA Connector** | Install the GPS SMA connector. Position the connector so the threaded portion points away from the PCB. Solder the center pin first and then make certain the connector is fully seated on the PCB. Solder remaining pins. |
| ☐ | **IC Socket** | | Install and solder the IC socket for the ENC28J60 IC. |
| ☐ | **IC** | **ENC28J60** | Insert the IC into the socket. Ensure that all pins are straight. |
| ☐ | **Ground Connector** | | Insert the ground connector. Ensure it is aligned with the wire connectors facing outward from the PCB. |
| ☐ | **Serial Connector** | | Insert the Serial Interface connector. The short pins go in the holes. NOTE: Solder the middle pin first and then position the connector so it is flush with the PCB and the output pins are parallel with the PCB. You have to reheat the center pin to get this alignment correct. Then solder the remaining pins. |

| | | |
|---|---|---|
| | **Display Mounting Sockets** | These are shipped as 1x10 sockets. You will have to snip off the last pin of each socket. Be careful that you do not snip too much off. Smooth the rough edge with a file. NOTE: You may want to score between the last two pins on each socket with a sharp knife before snipping them. This may result in a cleaner break. |
| ☐ | **Socket 1** | Insert the socket into its holes. Solder the pins. |
| ☐ | **Socket 2** | Insert the socket into its holes. Solder the pins. |
| ☐ | **JP1      Jumper** | Install this jumper into its holes and Solder the pins. |

We'll now install the sockets for the Discovery Board. First, insert the discovery board into the two sockets before you place them on the controller board. This will ensure correct pin alignment.

☐ Insert the sockets, with the Discovery board attached, into the holes on the Controller board. Lightly solder one of the end pins and then check to ensure the socket is fully seated on the Controller board. Do this for both sockets. Then solder a pin on the opposite end of the sockets you just soldered. This will hold the sockets in position while soldering the remaining pins.

☐ Remove the discovery board now for the final component assembly of the Controller board.

☐ **RJ45 Connector   HanRun HR911105A**

Remove the discovery board now for the final component assembly of the Controller board.

☐ **RJ45 Connector   Amp     Input-A**

Install the RJ45 connector and solder.

☐ **RJ45 Connector   Amp     Input-B**

Install the RJ45 connector and solder.

☐ Before installing the buzzer, you may clean the PCB with Denatured Alcohol. This will remove any solder flux and debris left over from the soldering process.

☐ **Buzzer**                    Install the Buzzer and solder.

☐ **Final Inspection of the Controller Board**

- Ensure all components have been soldered.
- Check for any solder bridges or debris left on the PCB.

## INITIAL TESTING OF THE CONTROLLER BOARD

**First Hardware Check:**

☐ If installed, remove the STM32F4DISCOVERY board and the Display as well.

☐ Connect the 5V USB power supply to the mini USB connector on the Controller board. If you are using the Global Top PAGH GPS module, the Green GPS LED should start blinking.

☐ Disconnect the 5V USB Power supply.

☐ Mount the STM32F4 Discovery board. Ensure it is fully seated on both sides. This may take some effort and going from side to side to accomplish.

☐ Mount the Display board. Align the display so the pins marked 10-18 are closest to the RJ45 LAN connector. Fully seat the display.

☐ Plug-in the 5V USB Power supply to the Controller board mini USB connector.

NOTE: Do not plug it into the discovery board. That connector will be used only for programming the discovery board in later steps.

☐ You should now see the green GPS LED on the controller board blinking as well as other LEDs on the discovery board. The small Red LED on the Discovery board nearest to the mini USB connector should be on steady indicating the board is getting power.

**This is the END of the initial testing phase.**

Next, we'll begin installing the firmware on the Discovery board.

**NOTE: IMPORTANT - DO NOT connect either the Discovery or the Controller board to your computer until instructed to do so in the following steps. Doing so may cause unforeseen problems with software and firmware installation.**

**STM32F4DISCOVERY BOARD FIRMWARE INSTALLATION**

NOTE:

1. You must have purchased a Blitzortung Lightning Detection System **and** have an Account ID **BEFORE** you will be able to perform any of the following steps. If you have not purchased a system go to the main Blitzortung website and view the information posted under the "Cover You Area" tab. There are instructions on how to get further information in that section.

2. If you have purchased a system but do not have an Account ID, send a short email requesting a new user account from the Blitzortung Administrator at:

    [blitzortung@gmx.org](mailto:blitzortung@gmx.org)

Assuming you have already purchased a system and have an active Blitzortung account:

☐ Connect to the Blitzortung Website via your web browser:

    [http://www.blitzortung.org](http://www.blitzortung.org)

Select the "Services" tab on the top of the screen.

Log-in to your account using your account id and password.

Once logged-in, click on the "Miscellaneous" tab on the left-side of your screen. This will open a webpage with some links you will use to download the STM32F4DISCOVERY board firmware. The section is labeled:

**Firmware for System RED**
- STM32F4DISCOVERY: Firmware Directory

Click on the "Firmware Directory" link to get a list of available BIN files.

Select the latest firmware version. Click on the desired file and save this file to your computer for later use (don't forget where you put it).

☐ Connect to the following website via your web browser to download the program that will be used to flash your Discovery board:

http://www.st.com/web/en/catalog/tools/PF258168

Click on the download button at the bottom of the page and save the file to your computer.

Unzip/extract the file you just downloaded and then run the STM32 ST-LINK Utility_v3.1.0.exe file. This will install the program on your computer. Follow the on-screen instructions and use the default values presented. This downloaded file also includes the drivers you will need when you connect the discovery board to your computer in later steps.

NOTE: The exact file name will vary as new versions of the software are released. This particular version in this example was v3.1.0.

We are now ready to connect your STM32F4DISCOVERY board to your computer so you can install the firmware.

☐ Connect the 5V USB Power Supply cable to the Discovery board. It is NOT necessary to remove the Discovery board from the controller board for this procedure.

☐ Connect a USB to mini-USB cable from your computer to the Discovery board.

The computer should automatically detect the new device and install the device driver that was just installed on your computer during the installation of the ST-Link Utility program. This may take some time so be patient and watch your screen for any messages. It should tell you when it is done installing the driver.

Once the driver is successfully installed, you can continue with the following steps.

☐     Find the "STM32 ST-LINK Utility" link on your desktop and double-click it to start the program.

☐     Select the "Target" tab then, select the "Program" item

☐     From the menu, click Browse and select the Firmware…bin file you saved earlier.

☐     Check if the Start address is 0x08000000 and click on Start. This will begin the flashing process. The process will take several seconds to complete.

☐     Reset: If the CPU (on the Discovery board) doesn't reset after flashing, simply press the black button on the Discovery board.

This completes the flashing process.

Disconnect the 5V USB power supply and the computer USB cable from the Discovery board.

You may now connect your controller board to your LAN connection (router) and install the GPS antenna, if needed, along with the 5V USB power supply connected to the Controller board (not the Discovery board).

If all goes well you should see information displayed on your display which will allow you to set up your system with your own unique System ID and IP address.

More details on this part of the installation is being developed and will be added to this document when it is completed. In the meantime, see the "Operating Instructions" listed in the Blitzortung manual which can be found at http://www.blitzortung.org/Webpages/index.php?lang=en&page=2&region=3&subpage_0=30.

This web location will always have the latest version of the official Blitzortung documentation.

**SPECIAL NOTE:** There appears to be a difference in the way the green LED works when a GPS lock in attained. Earlier RED boards have this LED remaining ON when a lock occurs. Later versions of the RED board now have the LED turn OFF when a lock occurs. In both versions, the green LED blinks upon power up and while the

GPS module is searching for satellites. This was a design change that has just now been revealed.

**Sections yet to be written:**

**Section IV – Testing of your complete Kit**

**Section V – Troubleshooting**

**Section VI – Reference Information**

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**Revision History:**

- o June 13, 2014
  - ▪ Updated cover page Blitzortung image to current people version.