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A World-Wide Low-Cost Community-Based Time-of-Arrival Lightning Detection and Lightning Location Network

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(System Blue assembly)

This document will continually change due to further developments and improvements. Please send your remarks to info@blitzortung.org.

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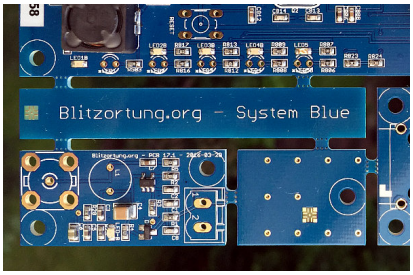
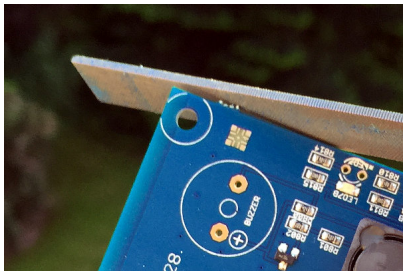
Contents

1 System Blue assembly

The main difference between System Blue and previous systems is that System Blue has partly pre-fabricated circuit boards. All surface-mount devices (SMD) are already soldered. However, there are still some components with leads that have to be inserted into holes drilled in the printed circuit boards and soldered to pads on the back side by manual assembly. For soldering you should use a soldering iron with a 1mm tip and thin solder wire. Do not try to solder these components if you do not have any experiences with soldering.

The System Blue PCB 20.x panel consists of a main board PCB 19.x, an H-field pre-amplifier board PCB 16.x, and an E-fiel pre-amplifier board PCB 17. You can separate the boards manually. After that, you should file off the overhanging edges.





1.1 Main board PCB 19.x

The main board PCB 19.x has the following through-hole technology (THT) components.

3	DA103C - Transformer - Murata Power Solutions
1	Inductor - 3.3 mH - Taiyo Yuden
1	USB Mini-B Connector, PCB mounting, 90°
1	1x4 Header, straight, Pitch 2,54
1	1x5 Header, straight, Pitch 2,54
1	2x3 Header, straight, Pitch 2,54
1	Piezo Audio Indicator
1	Crystal, 8,0000000 MHz
1	Crystal, 25,000000 MHz
3	Pushbutton 6x6mm, height: 4,3mm, vertical
1	RJ45 Modular Connector
1	HanRun RJ45 network connector with integrated magnetics
1	F-Connector, PCB mounting, 90°
1	SMA Connector, PCB mounting, 90°

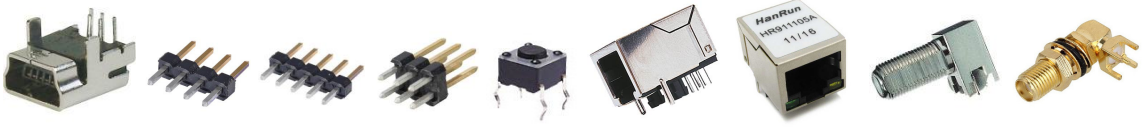
Some of the THT components may have been soldered because they were required to install the initial firmware.

The DA103C Transformers have a white dot at one corner. On the main board, there are white dots printed at the placeholders for the transformers TR1, TR2, and TR3. The white dots at the transformers must match the white dots at the main board.

The 3.3mH inductor is L403.

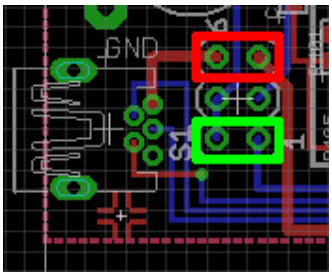
Crystal Q1 has a frequency of 25 MHz, crystal Q2 has a frequency of 8 MHz.

Some Piezo Audio Indicators has a '+'-mark, which should match the '+'-mark on the board. (If there is no '+'-mark, then the orientation is not important.)



All other components can not be soldered at wrong places because of their physical layout.

The main board is supplied with a 5V USB power adapter. The plug must fit into the SUB-B jack. The power supply is not part of the kit. It must be purchased separately. The power consumption is about 350mA. Please use a 1A or bigger power supply. We have made bad experiences with 500mA power supplies.



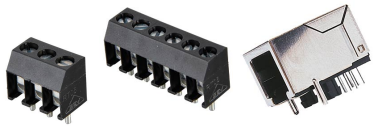
At switch S1 on PCB 19.2 you have to connect pin 5 and pin 6 by a jumper. This turns the board on, if an USB power supply is connected, the red rectangle in the image above. You have also to connect pin 1 and pin 2 by a jumper such that the pre-amplifiers get power, the green rectangle in the image above. Note that these jumper settings are different at the early board PCB 19.1. Please refer to the circuit diagrams.

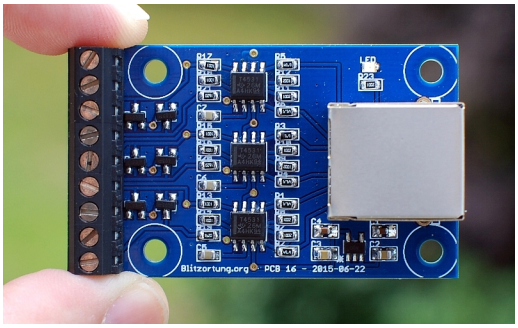
The router is connected at the RJ45 network port with a shielded twisted pair network cable (FTP, STP, S/STP, or S/FTP).

1.2 H-field pre-amplifier PCB 16.x

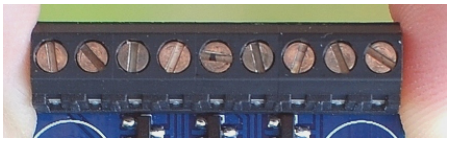
The H-field pre-amplifier board PCB 16.x has the following THT components whose placement is obvious.

1 Header 3-pin, Pitch 3,5
1 RJ45 Modular Connector
1 Header 6-pin, Pitch 3,5
alternatively
3 Header 3-pin, Pitch 3,5



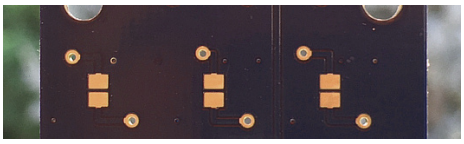


A-1	A-2	GND	B-1	B-2	GND	C-1	C-2	GND



The antennas are connected to the pre-amplifier as shown above.

The H-field pre-amplifier is connected with a shielded twisted pair cable (FTP, STP, S/STP, or S/FTP) to the main board. This cable should not be placed next to the network cable. Please keep a distance of at least 10 cm. The cable may have a length of up to 30 meters.



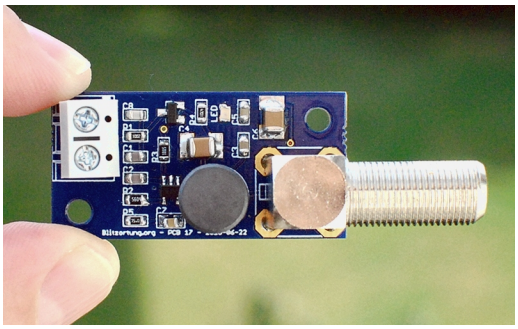
If you use loop antennas, than you should close (solder) the jumper for the corresponding channels at the back side of the board.

If the pre-amplifier is powered, the red LED should light.

1.3 E-field pre-amplifier PCB 17.x

The E-field pre-amplifier board PCB 17.x has the following THT components whose placement is obvious.

1 Inductor - 3.3 mH - Taiyo Yuden
1 Header 2-pin, Pitch 5,08
1 F-Connector, PCB mounting



At PCB 20.1 and subsequent boards the free board space at PCB 20.x next to PCB 17.x is used as an experimental electrical antenna. This antenna is designed only for testing purposes. You can also break off this aerial and connect a wire antenna at the two pin header. The external connection point is ground, the central connection point is the antenna. Note that any electrical antenna must be placed outside far away from from buildings and electrical interference sources.

The E-field pre-amplifier is connected with 75 Ω double shielded coaxial cable to the main board. The cable may have a length of up to 100 meters. The ends are attached to F-connector.

When the pre-amplifier is powered, the red LED should light. At the early pre-amplifier board 16.1 a green LED probably lights very weak at a supply voltage of 3.3 volts. However, this is not a defect but normal.

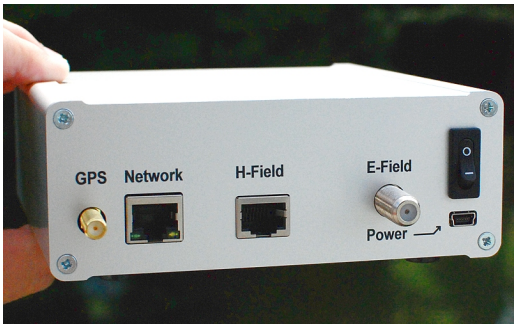
1.4 GPS antenna

You can use any GPS antenna operating with 3.5 Volts. The Antenna is connected via an SMA connector with the main board. The built in GPS module is very sensitive and works with antennas connected by lines of up to 10 meters.

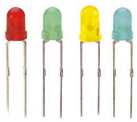
1.5 Housing option

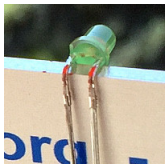
The housing option consists of the following parts.

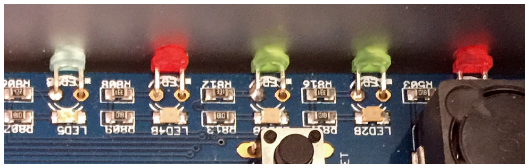
1 aluminum enclosure
1 front panel
1 back panel
1 rocker switch
8 screw M3 10mm
4 rubber feet
3 LED red
2 LED green
1 LED yellow
1 LED blue



The housing is made for boards of size 130.0 mm x 140.0 mm. The main board PCB 19 has the dimension 130.0 mm x 138.5 mm. It is slightly shorter than the housing. The LEDs on the front panel are soldered with an angle of 90 degrees. The overlapping edge of the LED housing closes the gap between the board and the front panel. In this construction, the LED can not be crushed by pressure from outside at the front panel. That's the reason for the difference in size between the housing and the main board.







The connecting wires of the LEDs can easily be bend 90 degrees using the front panel that has a width of 2 mm. On the main board there are white stars printed near the LEDs. In these holes the short ends of the wires have to be inserted. This is the cathode (-) of the diodes.

At the back panel, the rocker switch can be inserted to turn the power on and off. It has to be connected to pin 5 and 6 of S1.

q can be stuck under the housing.

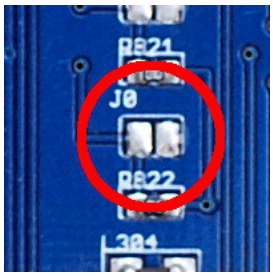
1.6 Digital filter option

The complete digital filter option consists of

4 digital filter ICs (LTC1569-7)

In general, it is not necessary to install the digital filter ICs. The system also operates without them. However, if you want to experiment, or if you have extremely strong interferences at frequencies above 20kHz, you can try to get better signals with the digital low pass filter ICs. Since the digital filter ICs are relatively expensive, you should test one filter IC at one channel, preferably at the E-Field channel. If the desired effect is achieved, the other channels can be upgraded.

The digital filter ICs have a point at one corner of the housing. This point identifies Pin 1. It must match the white dot on the main board. You need a soldering iron with a small tip to solder the SOIC-8 package.



You have to close (solder) Jumper J0, otherwise the firmware will not recognize the filter ICs, and thus will not offer you the possibility to adjust them.

All inputs and outputs of the amplifiers are passed via buffer amplifiers to SMA connectors. If these connectors are installed, then the signals can easily be monitored with an oscilloscope or an FFT analyzer. There are various programs for signal analysis, if the output of the preamplifier is passed in via a sound card.

1.7 Firmware

The firmware of the controller is preinstalled. When the device is turned on and is connected to a router, then it gets an IP address via DHCP. You must check your router which IP address this is. Typically, the detector gets the same IP address after a reboot.

The firmware can be updated in three different ways,

1. via the web interface of the firmware,
2. via the Single Wire Debug (SWD) interface using a programming device, and
3. via the USB interface using the Device firmware upgrade STMicroelectronics Extension) (DfuSe) interface.

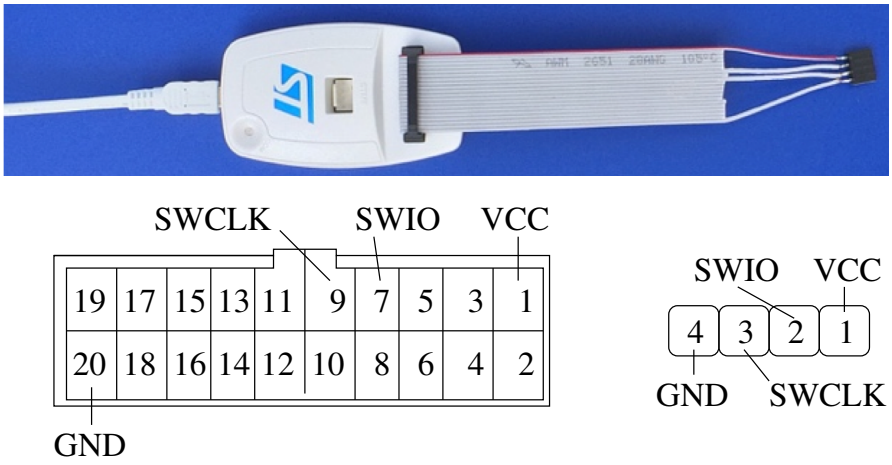
1.7.1 Web Interface

To upgrade the firmware via the web interface, follow the menu prompts in the web interface.

1.7.2 Single Wire Debug (SWD)

The firmware can be upgraded via the SWD interface with the ST-LINK/V2 in-circuit debugger/programmer. This programming devices is also contained at the STM32F4DISCOVERY board used for System Red. It is connected to the SWD interface as follows.

ST Link V2



ST Link Connector

SWD Connector

The software (STM32 ST-LINK Utility) for programming the controller with ST-LINK/V2 can be found on the website of STMicroelectronics.

http://www.st.com

The board additionally must be powered via the USB power supply during programming. The latest version of the firmware can be loaded from

http://tracker.blitzortung.org/firmware

Please never flash a firmware for System Red on a System Blue and never flash a firmware for System Blue on a System Red. This can damage the hardware.

1.7.3 Device Firmware STMicroelectronics Extension (DfuSe)

You can also flash a new firmware over the USB connector via the DfuSe of the processor as follows.

1. Load the DfuSeDemo software for the Windows operating systems from the website of STMicroelectronics

   http://www.st.com

   or from the following site (the ZIP-file "stsw-stm32080.zip"):

   https://tracker.blitzortung.org/firmware/dfu

   For non-Windows operating systems you can use the following software.

   http://dfu-util.sourceforge.net

2. Install the application.

3. Download a DFU firmware file for System Blue from the following site.

   https://tracker.blitzortung.org/firmware/dfu

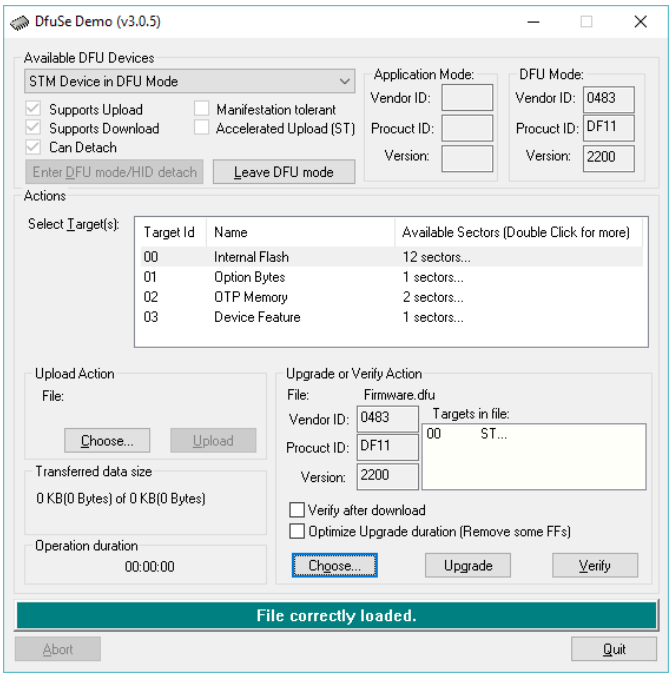
4. Connect the System Blue controller board via USB with your computer.

5. Start the System Blue controller in DFU-mode: Push and hold both, the RESET button and the BOOT0 button, at the same time. Then first release the RESET button before you release the BOOT0 button.

   You Windows PC should now recognize a new device and install a driver for the new device during the DFU setup.

6. Open the DfuSeDemo application. You should see the message "STM Device in DFU Mode". If not, then something went wrong. Try again Step 5 (driver reinstall, check cable).

7. Keep all setting as they are and click the "Choose..." button on the bottom. Select the DFU firmware file from above. Now it should look like in the following screenshot.



8. Next push the "Upgrade" button.

9. After the upgrade is done, you can push the RESET button or "Leave DFU mode" in the application.

10. Now you should be able to access the web interface and to upgrade a more recent firmware.

The DFU mode is a feature of the processor itself and not a feature of our firmware. It's not possible to overwrite/destroy the DFU-bootloader thus it should always be possible to recover the firmware after a failed web-interface firmware update. A DFU file can be created from a BIN file with the DFU file manager.