3D Printed Optical Transceiver Box

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This project started after reading lots of articles on optical receivers and transmitters. After building a few of them I wanted to integrate both functions in a compact enclosure.

- 3D printed.
- Inexpensive optical parts.
- Can be mounted on a tripod.
- Provision for an aiming sight.
- Flexibility of wavelengths (e.g. Stealth).

Entry level system for roving

One application is to collect extra points during a contest. Performance is plenty enough for a minimum QSO (1 km) but it can go much farther.
When roving you need something that can be rapidly deployed, do the QSO and pack up. The unit should be small enough to fit in the car with everything else. In his simplest form only a gaming headset is needed for voice communication. It can do CW with an integrated keyer, or a straight key.

The electronics.

For the receiver I use a design from K0XL [1]. It is derived from KA7AOI V3.10 and uses a PCB made by K7RJ [2]. (See references for the files and schematics). The board was made with ExpressPCB software. When you order from them you can get the Gerber files for future use.

The transmitter is also from K0XL. It uses PWM modulation and has numerous features like an integrated keyer and overmodulation detector. It is built around an ATTINY85 microcontroller and is programmed in the Arduino environment. This is a big plus for future improvements. The source code and schematic are available from K0XL [1].

Free optics!

Serious systems use Fresnel lenses. I wanted something more compact that can survive being tossed around on a contest weekend. A lens would do, but a big one can be expensive, and you need to build something to hold it properly.

On my way home I found the solution. By the curb on my street was an old projection TV waiting to be collected for trash! I went and got my hand truck and hauled the TV into my garage.

These TVs are obsolete, and are discarded for scrap. If you look in ads/Facebook Marketplace you will find at least a dozen of them available for free. The hardest part is to get them home since they are big and heavy! This is the reason they are free.

Inside you will find 3 lenses, one for each color. They are DELTA 77, 78, or Samsung SNI150.

The lens has a very short focal length, typically 1.5 inch. You can adjust the focus, but not by much. It will be used for the receiver. So with one television you can build 3 systems. They are available on the auction site if you don't want to haul a TV home.

LED flashlight.

For the transmitter you need to come up with a narrow beam. K0XL uses the Atomic adjustable flashlight with a Fresnel lens.

To keep things simple I decided to use the flashlight without lens. The footprint is smaller and you can still get a decent beam. At maximum magnification you can see details of the LED internals.

There are lots of Atomic flashlight knockoffs on Amazon. You can have visible or infrared, even ultraviolet.

Important. With these models you cannot use the modulation input circuit from K0XL. The internal regulator is different, and there is no discrete FET that you can drive. So you need to remove the regulator PCB, and use an external FET circuitry to drive the LED.

Stealth

I suggest that you buy both red and 850 nm infrared. The reason is that we now live in interesting times and people will happily dial 911 if they see a red light pointed at the horizon, and flashing morse code. Here you see infrared vs visible red.

For local tests in your backyard and own property you can use red, but for work in public places Infrared will prevent lots of questions from the men in blue (or green, who knows). Just install a connector to the line driving the flashlight so you can swap between the two.

No issue with pointing infrared. You can install a passive aiming sight on top of the box.

The box.

The box was designed using Autodesk Fusion360. This program is very complex and the license for commercial use is expensive but they have a free 3 years renewable licence for personal use [3]. There are a few limitations, like a limit of 10 active files at any time, but you basically have use of the full suite.

The box has two parts, the enclosure and the cover.

- 130 by 150mm footprint, with tripod mount.
- Side mount for the Atomic flashlight.
- Hole drilled to fit the TV lens.
- Integrated receiver PCB mount, at the proper focal distance, centered to the lens.
- Mounting posts for a transmitter pcb, predrilled.
- Hardware holes predrilled for K0XL TX-RX, with lettering.
- Top cover with Picatinny scope mount.
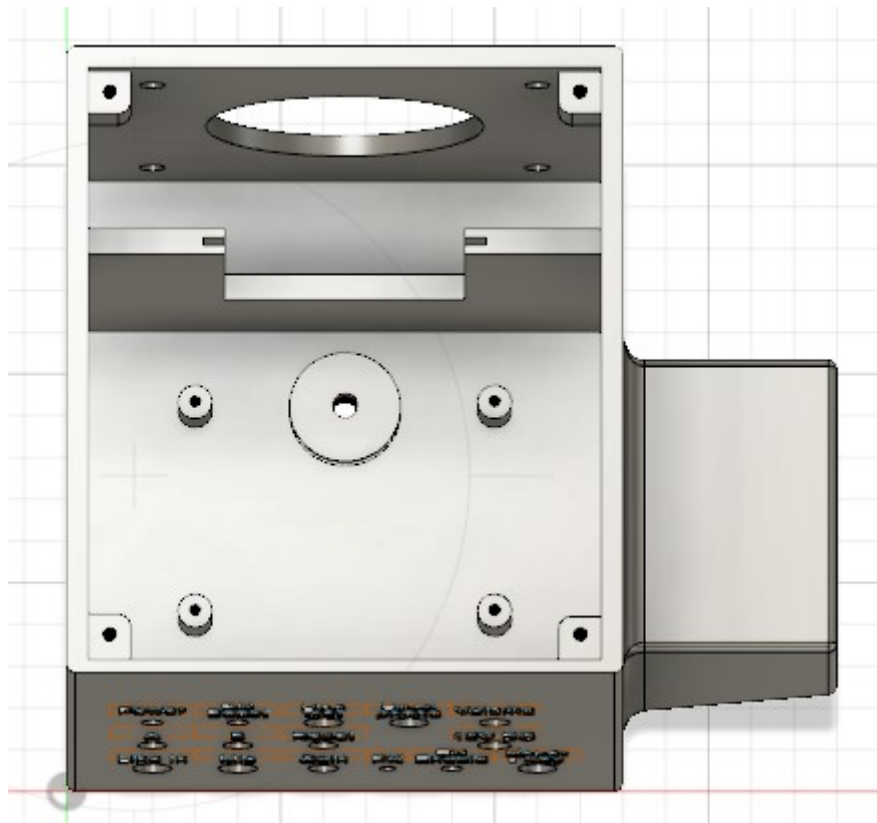
Tripod mount.

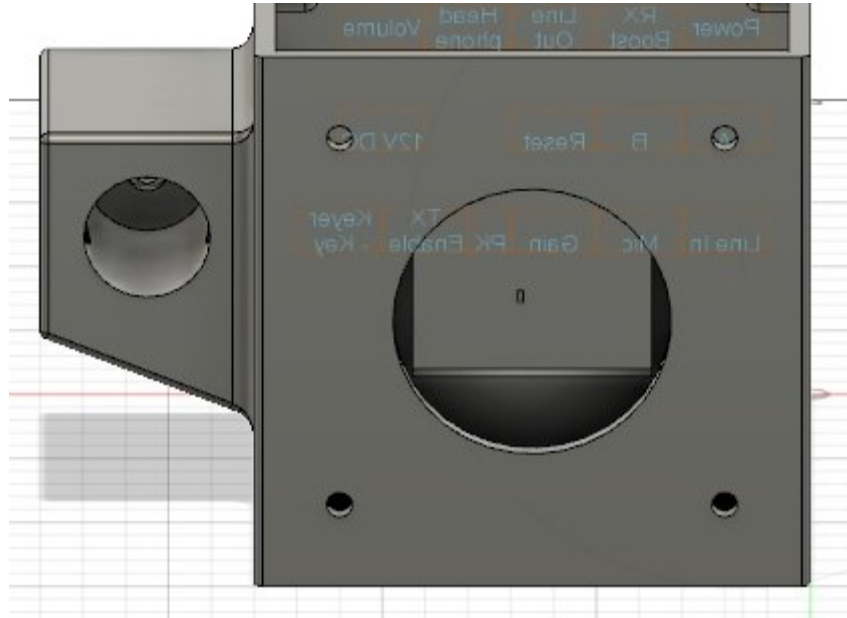The mounting hole is located near the center of gravity of the box. It is predrilled to 1/4-20.
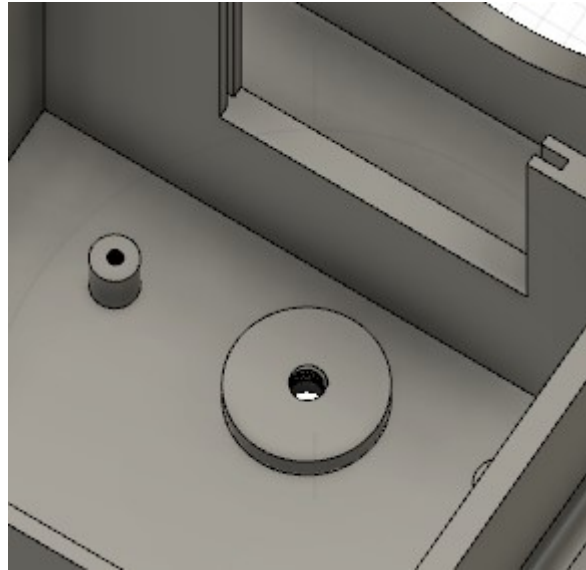
Side mount for Atomic flashlight

It is equipped with a 1/4-20 setcrew to secure the light. There is a path for the wiring going inside.

TV lens mount

The pattern is 90mm square. You can fit a DELTA78, DELTA77, or SAMSUNG SNI150.

Integrated receiver PCB mount.

It is designed for the K7RJ board. You don't need to adjust the focal distance. Just slide the board and it will sit facing the center of the lens. The picture shows the size of the focused light vs photodetector. I wasn't centered to the source for picture clarity.
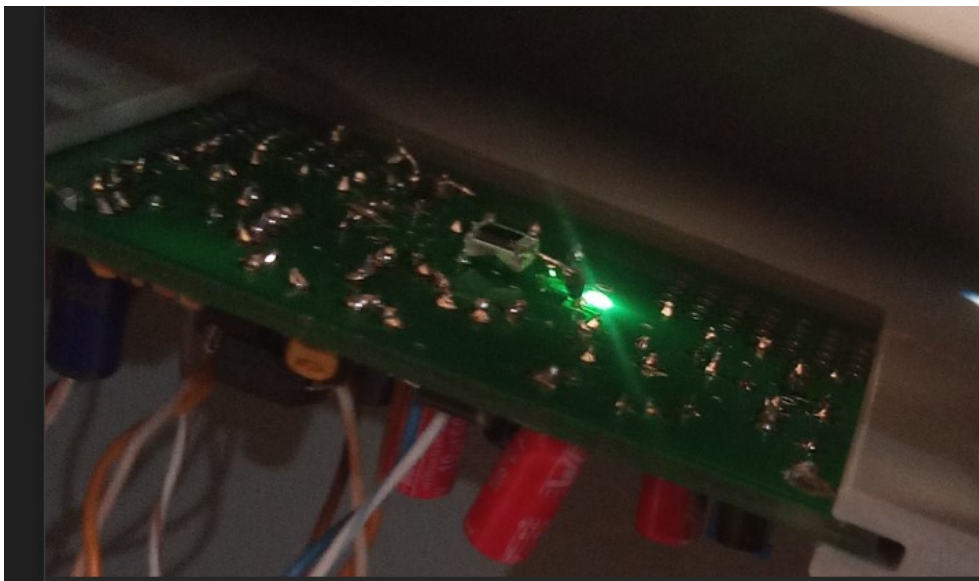
Mounting posts for transmitter board.

Four mounting posts are included. The pattern is 70 by 50mm, 10mm high. They are predrilled for 4-40 screws. Since the ATTINY85 can be either a 8-DIP chip, a dongle or board you will have to come up with a PCB design. For one or two systems a Veroboard would do. For the schematic please refer to K0XL website [1].
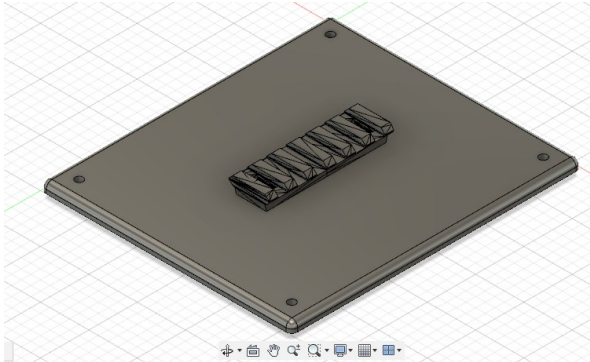
Hardware holes with lettering.

All holes are predrilled, and closed with 0.5mm of film. Depending on the application you drill only the ones you need. This will keep the box airtight.
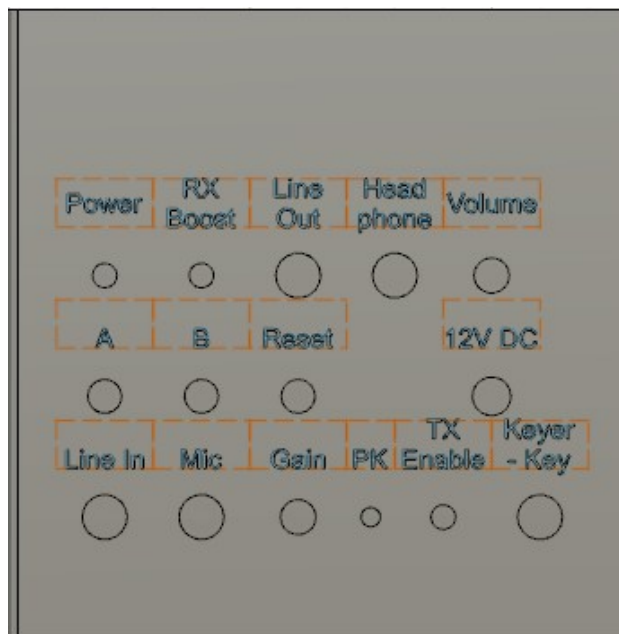
Item	Description	Part #
Power, RX Boost, TX Enable	SPST toggle switch	Digikey 2057-SW-T3-2B-A-A3-S1-ND
Line Out, Headphone, Line In, Mic, Keyer/Key	3.5mm stereo jack	Digikey 839-1411-ND
Volume, Gain	Potentiometer, Log, 10K 1/10W	Digikey PDB181-E420K-103A2-ND
PK LED	LED panel indicator 5V, 12ma	Digikey 350-2118-ND
12V DC	5.5mm x 2.1mm Power Jack Solder Lug	N/A

Cover with picatinny rail.

The box has 6-32 holes to secure the cover. When using Infrared you can mount a generic red dot gun sight. There is no light coming out like a laser. It works in any light condition. They are available at low cost on Amazon.

Notes on printing.

There are 2 files:

Optical_TXRX.stl
Cover.stl

They are available on my Google folder [4]. (See references).

For material you can get away with PLA, but there is a risk if you forget the box in a hot car during summer. It will soften and almost melt! (Been there with my 3D printed 122G radio).
PETG is better, melt temperature is 20C higher, but more difficult to do a quality print.
ABS has the highest temperature resistance, but smelly! This is definitely something to print in the garage, not inside.

The end.

I hope it will spur activity on the Terahertz bands!

I haven't tested the transceiver in the field, but the receiver with lens was successfully tested in the backyard. A very dim led transmitter was received with strong signals a hundred feet away.

If you have questions you can reach me at my email.

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References:

(1)   K0XL Google Site – 3D part files, build pictures, Arduino code for modulators
        https://sites.google.com/view/k0xl

(2)   K7RJ's Version of the KA7OEI Version 3 Optical Detector
        https://www.modulatedlight.org/optical_comms/k7rj/k7rj_rxv3.html

(3)   Fusion 360 for personal use
        https://www.autodesk.com/products/fusion-360/personal

(4)   STL Files
         https://sites.google.com/view/ve2ug-microwave-projects