

Getting into FPV with SOURCE ONE



1. About SOURCE ONE	3
1.1 The idea	3
1.2 Project links	3
1.3 Project license	4
1.4 Project naming requirements	4
1.5 Revisions	4
2. Building the SOURCE ONE	5
2.1 Bill of Materials (what's in the box?!)	5
2.2 Frame Assembly	5
2.3 3D Printed Components (optional)	5
2.4 Pro Tips	5
3. The tools of a drone pilot	6
3.1 The Community	6
3.2 Try before you buy - Simulators	6
4. A bit of history	7
4.1 Freestyle	7
4.2 Drone Racing	7
4.3 Long Range FPV	7

5. Building your first drone	8
5.1 Parts list	8
Frame	8
Props	8
Motors	9
Typical Motor Kv For Miniquads	9
Electronic Speed Controllers	10
Power Distribution Board (PDB)	11
Receiver (RX)	11
Video Transmitter (VTX)	11
First Person View (FPV) Camera	12
Lithium polymer batteries (LiPo)	13
5.2 Tool list	13
Essentials Tools	13
Optional tools	13
5.3 Shopping list	14
Build Supplies	15
Flight Kit	15
4.4 Safe Work Practices	15
4.5 Starting the build	16
4.6 Resources	16
5. Your first flight	17
5.1 Troubleshooting	17
5.2 The first repairs	17
6. Your first race	18
7 Contributors	19

1. About SOURCE ONE



1.1 The idea

The SOURCE ONE project is a first of its kind collaborative FPV frame project initiated by Team BlackSheep. The frame is donated to the community to empower creators and makers, and integrate best practices and current trends faster into a continuously manufactured product. In return, it allows the local distribution network to have cheap and direct access to a good frame in order to allow them compete in an increasingly predatory marketplace.

The hope is for this frame to enable broad access to FPV thanks to a low price point, great documentation and wide availability of compatible parts and accessories, without violating other people's intellectual property.

1.2 Project links

- Project discussion: <https://discordapp.com/invite/ZJGkHwF>
- Project files: https://github.com/tbs-trappy/source_one

1.3 Project license

The frame files are released under **GNU Public License (GPL) V3**. More information here: <https://www.gnu.org/licenses/gpl-3.0.en.html>

1.4 Project naming requirements

SOURCE ONE is the name of the frame. If you are thinking about manufacturing it, you are expected to prefix the name with a brand name in order to allow customers to distinguish the different manufacturers, e.g. **"TBS SOURCE ONE"**. As a manufacturer you are also expected to denote the version number of the frame files that you have placed as basis of the project, e.g. **"TBS SOURCE ONE V0.1"**.

If you have forked the project, you need to give it another name in order to avoid confusion between SOURCE ONE and your project.

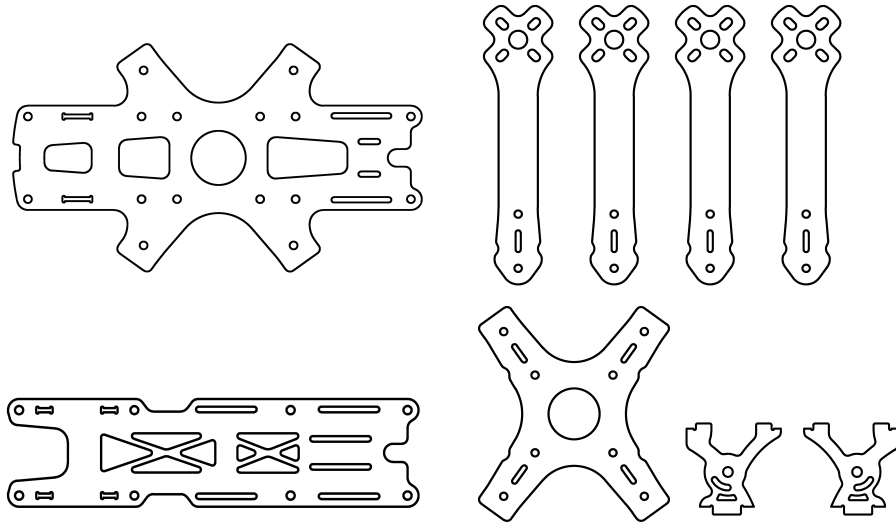
Accessories from the SOURCE ONE project also need to be named with the entire prefix, e.g. **"TBS SOURCE ONE FPV Camera Adapter"**. Unless the file is not compatible with certain versions of the frame, the compatible version number or version range also needs to be included in the name, e.g. **"TBS SOURCE ONE FPV Camera Adapter V0.1 - V2"**

1.5 Revisions

The cycle of revisions needs to be voted on by the project. It should be regularly so that manufacturers can produce according to demand and don't end up with dead stock (keeps the prices low for everyone). @TBD

2. Building the SOURCE ONE

2.1 Bill of Materials (what's in the box?!)



Carbon Fiber

- Top Frame (2.0mm), 1pc
- Bottom Frame Plate (3.0mm), 1pc
- Center Body Plate (2.0mm), 1pc
- Camera mount (1.5mm), 2pcs
- Arms (4.0mm), 4pcs

Aluminum anodized standoff (black)

- M3x30mm standoffs, 8pcs

Nuts & Bolts (2.0mm button head screws, black):

- M3x8mm, 16pcs (frame body top / bottom)
- M3x14mm, 4pcs (arm to center body plate outside)
- M3 lock nut, 8pcs (arm to center body plate outside)
- M3x16mm, 4pcs (arm to center body plate inside / FC)
- M3x6mm, 16pcs (arm to motor)

Straps

- Battery straps, 2pcs

2.2 Frame Assembly

2.3 3D Printed Components (optional)

2.4 Pro Tips

3. The tools of a drone pilot

3.1 The Community

The “miniquad” or “racing quad” community is an international community made up of people just like you who for whatever reason wanted to fly a quadcopter or “drone” so they set out to learn how to do that. And with their help you will be able to do the same.

And the community will help you.

The community is open, helpful, enthusiastic and very inclusive. A lot more so than many other communities.

The community is your greatest resource for getting into the air. Many of us learnt all of the skills and knowledge required from YouTube videos made by community members and help from community members in places like RC Groups (www.rcgroups.com), Facebook, Insta and now increasingly Discord.

3.2 Try before you buy - Simulators

4. A bit of history

4.1 Freestyle

4.2 Drone Racing

4.3 Long Range FPV

5. Building your first drone

Ok, For some reason you have decided to start burning your money for a hobby. Welcome to FPV! This guide should help you get started with minimal pain and suffering

5.1 Parts list

(Insert exploded picture of quad here)

Frame

The frame of the quad is in many ways the thing that a lot of people think of as the main part of the quad.

The frame provides a structure to hold the other parts of the quad together and to offer some protection to components during flight (and crashes).

The frame like most engineering works is a compromise between strength, rigidity and weight. The most common material for quad frames is currently carbon fibre. Parts often included in the structure of a frame are metal “standoffs” - tubes that are usually threaded for an M3 metric bolt. Some frames also use M2 hardware and a very few use M2.5 hardware, but this is very rare. It is not super common but some frames also include metal parts commonly aluminium, less commonly steel or titanium. These metal parts are cast or machined and are sometimes seen as part of the frame’s camera mounts or antenna mounts.

Propellers

These things are fairly important, typically 5in, but some quads have 1in props and others 10in, larger props are typically more efficient as they can spin slower to generate the same amount of thrust.

At the time of writing the most popular prop size in mini quad hobby is without doubt 5”.

5in props are typically 3 bladed, but 2 and 4 blade variants do exist.

Props like lots of other things in the miniquad hobby are described by numbers.

There are 2 numbers that are always used to describe props, the prop diameter and the prop “pitch”.

Diameter and pitch are both described in inches. The diameter is exactly what you would expect, it is the diameter of the circle made by the tips of the stationary prop.

The pitch is how far the prop travels through air in a single rotation.

When written or spoken the diameter and the pitch are often combined into a single number with the diameter written first followed by the pitch. E.g. a 5” prop with a 3” pitch would be written as 5030 and spoken as a “fifty thirty”.

The reason that 5” prop with the 3” pitch is not written as a 53 is that by multiplying the diameter and pitch by 10 there is room for fractions of an inch in the description.

E.g. a 5.1” prop with a 4.8” pitch can be written 5148.

Sometimes a third number is used to describe props, which is the number of blades.
If the number of blades not written the prop is probably a tri blade as that is the most common number of blades used now.
If the number of blades is included then a tri blade 5048 would be written 5x4.8x3.
Yes it's a bit crazy that one form uses a decimal point and the other multiplies the decimal out, but that is the convention.

Motors

These spin the props. Most quads except the ultra micro quads use electric brushless motors. These brushless motors need an electronic speed controller (ESC) to drive them. One ESC per motor so a quadcopter needs 4 ESCs.

In the quadcopter hobby electric motors are described by three numbers.

Two of the numbers describe the size of the motor and the third number describes how fast the motor spins.

The size of the motor is described by the diameter of the motor's stator and the height of the motor's stator. The numbers describing the size of the motor are usually written as one combined, long digit, with the diameter being written first and the stator height following

A typical quadcopter motor size at the time of writing is a 2306.

Using 2306 as our example, 23 is the diameter of the stator and the 06 is the height of the stator both expressed as millimeters.

The speed of the motor is not an absolute speed. Instead the speed of the motor is expressed as Kv where K is notation for "constant" and "v" stands for volt.

Kv describes how many RPM the motor will spin per volt of power applied.

So if you have a 2300Kv motor and it has 16.8v applied to it then it would spin 2300×16.8 or 38640 RPM.

Motor speed is tested with an unloaded motor - i.e. a motor with no prop. This makes the measurement more useful for comparing motors as there is no standard prop size/pitch that is used for testing.

If you're wondering why we are using 16.8 volts in the example, 16.8v is the typical voltage of a fully charged 4 cell - 4s - battery, which is the most commonly used battery on 5" and 6" quadcopters, however in the real world the voltage will drop under load.

Typical Motor Kv For Miniquads

The table below describes some *indicative* **typical** ranges of Kvs for different sized props commonly used in miniquads. These min and max values are not absolute and people can and do fly outside these ranges for a given size.

As a general rule typically people who race will fly higher Kv for a given prop size than people who fly freestyle.

Prop Size	Min Kv	Max	Comment
2"	4000	6000	2s-4s
3"			
4"			
5"	1900	2800	4s
6"	1700	2400	4s
7"	1400	1900	4s

Electronic Speed Controllers

The electronic speed controllers or ESCs are the components which provide power to the different magnets in the motors in the right order to make them spin.

There are two broad styles of ESC, single ESCs and 4in1 or 2in1 ESCs.

Single ESCs are normally mounted on the arm of the quad adjacent to the motor they will drive.

4in1 and 2in1 ESCs are normally mounted in the body of the quad under the flight controller.

Speed controllers are driven by firmware. ESCs are normally designed to run a particular family of firmware.

Common firmware families in use today is BLHeli S, BLHeli 32 and KISS.

Older firmware families include Simon K and BLHeli - these should probably be avoided.

To confuse things further in addition to the different families of ESC firmware, ESCs communicate with the flight controller with different protocols. Some example ESC protocols include:

- DShot 150
- DShot 300
- DShot 600
- DShot 1200
- Dshot 2400
- Multishot
- Oneshot42
- Oneshot
- Proshot
- Pulse width modulation (PWM)

Probably these days one of the DShots or Multishot would be the ESC protocol of choice.

DShot is significantly different to most of the other protocols as it is digital as opposed to analog.

Amongst the advantages of DShot is that it does not need to be calibrated.

Other non digital ESC protocols require calibration when set up and periodically afterwards. Proshot and PWM are basically no longer commonly used and are mentioned here just to give a more complete picture of ESCs.

Power Distribution Board (PDB)

The power distribution board does exactly what it sounds like - it distributes power to the different components of the quad that need power. It is normally a printed circuit board that has pads ("contacts") for the battery leads and a positive and ground pad for each motor. The PDB distributes the power from the battery to each of the motors. The voltage delivered to the PDB is the full battery voltage, which is distributed to each of the motor pads.

It is possible to not use a PDB and instead connect the motor wires directly to the battery leads, however this would take more space and be far less tidy.

In addition some PDBs will offer other functionality, for example 5v or 12v power regulators to provide power to the flight controller, VTX, receiver and other components that need power but don't need or can not take full battery power.

Another function that used to frequently be seen in some PDBs was an onscreen display that displayed the battery's current voltage and maybe the amps used. This is less common now as the OSD is now often included on the flight controller.

Increasingly the PDB is a redundant component and the PDB's functions are more commonly being included in the flight controller. Flight Controller

Receiver (RX)

There are a number of receivers in an FPV system, but when people just say "receiver" or "rx" they mean the radio control receiver. The receiver is a small radio that receives the control signals from the "radio" (the remote control radio) that the pilot uses to control the aircraft, and relays the control signals to the flight controller using a protocol that both the receiver and the flight controller are configured to use.

The name "receiver" is a bit misleading because many, maybe most receivers also transmit a signal back to the radio. This data from the aircraft back to the radio is called "telemetry" and can include information such as RSSI (Relative Signal Strength Indicator) an indication of the quality of the radio signal, the voltage of the battery on the aircraft and other useful information.

Video Transmitter (VTX)

The video transmitter is a radio transmitter that takes the video signal (and sometimes an audio signal) from the FPV camera and transmits it to a video receiver for display to the pilot.

Most video transmitters in used in FPV quads transmit on the 5.8ghz band, although 2.4ghz and 1.3ghz VTXs are also reasonably available.

Most VTXs will operate on a variety of bands with 40 or more channels commonly available on a VTX. However these bands often overlap and the channel spacing is such that even if pilots stick to channels on a single band it is not uncommon for other pilots to encounter interference with each other.

In addition when a VTX is first powered up it may radiate on more than one channel for a brief period of time and cause interference for other pilots in the area.

For this reason it is highly recommended to stick with very well known brand name VTXs - because your choice of VTX not only affects you it also affects other pilots you fly with and in the worse case, issues with your VTX can cause another pilot to crash his quad.

First Person View (FPV) Camera

The FPV or flight camera is a camera that is built into the quad and connected to the VTX - this is the camera that supplies the picture the pilot uses to fly the craft.

There are 3 major size classes of FPV cameras full size, mini and micro.

In addition to being different sizes of cameras there are two different sensor technologies, Complementary Metal Oxide Semiconductor (CMOS) and Charged Couple Device (CCD). What these technologies mean is not that important, what is important is that each technology has benefits the other doesn't, so you will need to choose which benefits and features are important to you when you choose an FPV camera.

The sensor technology of the camera is important as the different technologies look at behave differently.

The first property to consider is latency. Older CMOS cameras introduced higher latency than CCD cameras of the same generation. This latency was noticable for some pilots.

The difference in latency is far less noticeable in current generation CMOS cameras, but people considering older cameras might want to take latency in account,

Another important property of an FPV camera is the "aspect ratio" which is the proportions of the image the camera produces. The two widely seen aspect ratios are 4:3 and 16:9.

4:3 is a squarer image like an old school film based photo. 16:9 is a wider rectangular image the same shape as a modern TV screen or movie image.

The physical size of the camera (full size, mini or micro) is important mainly because some frames will only accept cameras of a certain size, though some frames can be adapted for cameras of different sizes and 3D printed mounts and adapters are widely used to allow different camera models and sizes to different frames.

CCD camera images are generally of a lower resolution and lower “dynamic range” than a CMOS camera.

The aspect ratio is important as different goggles also come in different aspect ratios, so having mismatched aspect ratios between your camera and your goggles may result in a distorted image. That sounds bad but in reality a lot of people fly with mis-matched aspect ratios and do not notice the distortion after a few flights.

Where the aspect ratio can be very important is when landing and flying low, as the 4:3 aspect ratio is a taller image so you can see more of what is below you with a 4:3 image.

Lithium polymer batteries (LiPo)

The most popular power sources for quads are lithium polymer batteries, also known as Lipo's. They don't have the highest energy density (Charge contained for the weight or size), Lithium ion batteries, most typically 18650 cells have a higher energy density, but they cannot provide much current, whereas a good LiPo can deliver hundreds of amps. A single LiPo cell has a maximum voltage of 4.2v, nominal voltage of 3.7 and a discharged voltage of around 3v, any lower and you risk permanently damaging the cell. You can also damage a battery by over charging it or by pulling too much current out of it. All these things basically create heat, which is the real killer of batteries.

To create higher voltages you chain the cells together, you need cells of an identical capacity for it to chain properly, or you might have issues. This is how the name of a “4 cell” or “6 cell” battery is created. You can also chain the batteries together to increase either voltage or capacity. Batteries have 2 connectors, the main discharge connector with only a positive and negative, designed to draw the full current, and a balance connector specifically for charging to keep the cells at equal voltage, or else there will be fire eventually

All cells have something called “internal resistance” which you can think of as a resistor in line with the cell. This will decrease the voltage as the amp draw increases and will also cause heat buildup. This is what causes the phenomenon known as voltage sag

Battery Strap

This holds your battery to your quad, not much more to say really, made of velcro usually

5.2 Tool list

Essentials Tools

- M1.5 hex tool
- M2 hex tool
- M2.5 hex tool
- M8 socket or spanner (for prop nuts)
- Side cutters for cutting wire
- Soldering Iron
- Tweezers or Haemostats (or both)
- Scissors

Optional tools

Tools marked ** are optional but highly recommended

- Smoke Stopper** - see <https://www.rcgroups.com/forums/showthread.php?2327875-DIY-SAVE-YOUR-ELECTRONICS!-BUILD-A-SmokeStopper%C2%99-!>
Other people sell devices intended to offer similar protection - normally a fuse of some kind, but these do not offer the same protection or functionality as a proper smoke stopper.
- Multimeter** - technically you can get away without a multimeter - but they are extremely handy and can save you a lot of money in blown parts.
- Pliers - needle nose are good
- Heat gun** - to shrink heat shrink
- Hot Glue gun - cheap dollar store type is fine - myriad of uses.
- File - cleaning up the fit and finish of carbon parts (beware of carbon dust)
- Helping hands - clamps on a stand that will hold wire and components for you while you solder
- Jig for soldering.

5.3 Shopping list

Build Supplies

- Solder - rosin core solder
- Heat shrink
- electrical/insulation tape
- Wire - silicon insulated wire is preferred as silicon insulation does not melt when soldering and is more flexible and generally easier to work with.
 - 24-28 AWG - for connecting signal pads
 - 16-18 AWG- for connecting power to electronic speed controllers (ESCs).
 - 12 OR 14 AWG for battery leads
- Assorted M3 bolts - most frames mainly use M3 diameter bolts as the main fasteners
- Assorted M2 bolts - useful for FPV cameras and some frames
- Double sided tape such as 3M VBS or Gorilla Tape
- Flux pen
- De-soldering tape or suction tube
- Self adhesive velcro

Flight Kit

In addition to the tools and supplies you need to build and maintain your quad you need additional kit to fly your quad.

Essential

- Radio - the most commonly used radios in the hobby are FrSky series such as the X-9D and the X7. Flysky is a reliable low cost entry and Spektrum is also quite common.
- FPV Goggles
- Video receiver
- VTX and VRX antenna
- Batteries
 - Quad batteries
 - Goggle batteries
 - Radio batteries

Optional

- Go Pro or other HD cam
- SD Cards for goggle DVR and HD Cam

4.4 Safe Work Practices

- Wear a shirt to protect your body from solder spatters
- Safety glasses are a good idea to protect against wire ends when snipping wire, solder spatter and other hazards

- Wear a mask when cutting or filing carbon or work with the carbon under water - the dust is not good for your when breathed.

4.5 Starting the build

4.6 Resources

5. Your first flight

5.1 Troubleshooting

5.2 The first repairs

6. Your first race

7 Contributors

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