

ANATOMY OF A QUADCOPTER

THE INSIDE SCOOP ON HOW MULTIROTORS WORK

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In addition to fun and recreational purposes, multirotor aircraft are also being used for all sorts of applications, from shooting airborne photography and videos to carrying payloads. But how do these unique machines actually fly? Of all the multirotors available today, the simplest is the quadcopter (quad) arrangement. A quad is a fairly uncomplicated system and its various components are what allow it to hover and maneuver. Though relatively simple, a quad's construction and components can be a little confusing for new pilots. This overview explains the main parts found in most quads and explains their specialized functions.

Propellers/Rotors

The propellers produce the downward thrust required for the quad to fly and hover. Each is attached directly to one of four individual motors (where the quadcopter gets its name). Usually made of lightweight plastic or other composite materials, quads usually come with a spare set of propeller/rotor blades in case one is damaged. **The blades come in clockwise and counter-clockwise pairs.**

Frame/Body

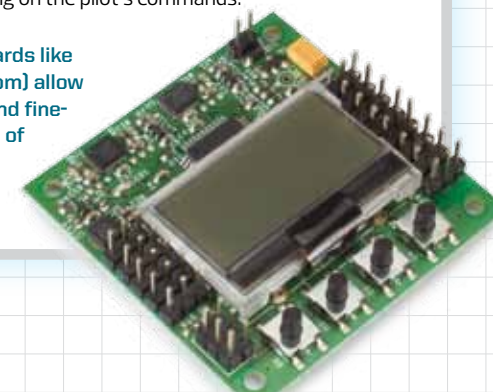
Like any vehicle, the quadcopter has a frame or molded body to support and enclose its various parts and systems. **Frames must be lightweight, strong and rigid** and can be made out of aluminum, molded plastic and flat carbon-fiber plate or molded material. Quadcopters have four arms or outrigger extensions that rigidly support the power units. The center section of the frame is where the airborne equipment and battery are located. If the quadcopter is designed to lift a payload such as a camera, it is usually located under the center section to keep the quadcopters balanced.

TECH FACT The four propeller/motor power units are installed so that two rotate clockwise and two rotate counter-clockwise. This arrangement is used to balance the torque produced by each power unit, which would otherwise rotate or yaw the quadcopter and cause it to spin. When the four units are turning at the same power settings, the quadcopter remains in a fixed, stable hover in the air. Increasing or decreasing the power makes the quad move up or down vertically. By adjusting the power relative to the clockwise and counter-clockwise motor pairs, the torque is altered and this causes the model to yaw, or turn to the left or right.

To move forward or backward and side to side, the power to the front and rear units or the left and right power units is adjusted so the quad leans in the direction of flight commanded. All flight commands for altitude, speed and direction are controlled by varying the speed to the four power units.

Control Board A typical flight control board is the brains of the quadcopter and is what makes stable controlled flight possible. Its circuitry contains gyroscopes, accelerometers and, in some cases, incorporates the radio system's receiver, all on one circuit board. The circuit board can include other functions, **including barometric pressure sensing so it can determine the quadcopter's altitude.** The circuit board's main job is to manage all the minute adjustments and command motor power as well as the feedback for flight angle and speed, as well as other factors depending on the pilot's commands.

Aftermarket control boards like the KK2.0 (hobbyking.com) allow custom programming and fine-tuning for various types of multirotors, including tri, quad, hex and octocopters.



Motors Most medium to large quadcopters use efficient brushless motors to spin the propellers/rotors. Smaller micro and indoor quads use less expensive brushed motors. The brushed motors tend to wear out more quickly and consume power more quickly, leading to shorter flight times. **Higher-end brushless motors last longer and produce more power** while consuming less battery power; they also have increased payload lifting capability.

LANDING GEAR

Similar to a full-size helicopter, quadcopters have landing gear systems to support them when they are not airborne. Most consist of vertical structures that connect to the frame/body assembly and horizontal skids at the bottom to give it stability while at rest. They are sturdy and somewhat flexible to absorb shock and side loads during takeoffs and landings.

Battery Pack

The battery is used to power the quadcopter's radio system, motors, and control board. **Lithium polymer (LiPo) batteries are the most powerful batteries available today** and they provide ample voltage to power the quad's systems while being much lighter than other types of battery packs.



RECEIVER

This is the part of the system that "hears" the radio signals sent from the pilot's controller (transmitter). There are various types of controllers available and some use Wi-Fi, iPhone Bluetooth, and infrared for control. The majority of transmitters operate on a radio frequency of 2.4GHz and use different types of signal modulation to match the quadcopter's receiver.



GPS Guidance

With some advanced designs, GPS guidance is also incorporated into the quadcopter's on-board systems. This Global Positioning System uses the same satellites as your car's navigation system and helps quadcopters know where they are relative to the pilot and their start position. Advanced systems keep track of altitude, speed, and location of waypoints with the use of a personal computer and navigational programs.

TECH FACT GPS guidance systems also give some quadcopters a feature called "Return to Home," where the quad will automatically return to its start point and safely land if the radio signal is lost or the pilot loses sight of the aircraft.

Cameras

Camera and camera mounts with gimbals to move the camera are usually the first upgrade a quadcopter pilot adds to his flying machine. With these add-on systems, you can take digital aerial photographs and video you can later download to your computer. With other accessories, you can even experience in-flight First-Person View imagery as if you were in the cockpit. There's a whole world of accessories for this kind of quadcopter experience.

The more you know about multirotors, the more you can appreciate their design and ease of use. For most, ready-to-fly quadcopters are the perfect first step into this interesting and exciting new form of entertainment and a way to explore your world like never before. ✈

Illustration of a NASA Global Positioning System satellite in Geosynchronous orbit above the earth.



Shown here is a stable hover, a camera-equipped Blade 350QX quadcopter, (used as our example), makes a steady aerial platform for shooting video and digital photographs.

