Shoot to the Sky with CAN-Enabled Drones

Introduction

The roles of the drone are so numerous, it is hard to imagine what drones will be doing in the future. Some of today's applications are military, precision crop inspections, aerial photography, law enforcement and yes, delivery of goods to customer door steps. The drone market forecasts are very aggressive with 2020 estimates at approximately $900M. Is there anything impeding this drone revolution (Figure 1)?

Figure 1. Drones Delivering Goods in Formation

Power management is the primary challenge that drone developers need to grapple with as they fly towards the future.

Today's drones have limited flight time and payload capacity. Drones can only fly about 15 to 30 minutes before requiring a battery recharge or replacement. There are drones that can carry payloads up to twenty pounds, but more typically, the payload weight is five or less pounds.

This article will provide an answer to the drone's power dissipation issues, while at the same time show how to preserve the drone circuit's reliability and robustness.

So, let the race begin.

Basics of Drone Design

The drone design presents interesting design challenges. The fundamental electronics include:

- Navigation
  - Global Positioning System (GPS)
  - Maneuverability
- Motor control
  - Propellers
  - Camera
- Gimbal function
  - Autonomous operation
  - Auto-stabilization

Two banks of highly efficient brushless DC motors (BLDC) communicate with the main controller, which impacts the drone's location and camera position. In the background, the onboard sensors, such as GPS, accelerometer, and gyroscope, provide the direction information to the drone's controller.

The propeller and camera stability motors require a reliable, communication physical backbone with a robust protocol. The highly reliable and rugged controller area network (CAN) bus structure is an excellent candidate for this function.

Motor Control Board

The propeller motor control electronics include the physical layer of serial CAN bus communication devices, BLDC motors, and their drivers. The CAN protocol supports real-time control, high-level error handling, and multi-master/multi-slave communications (Figure 2).

The flight control circuit in Figure 2 is the heart of the drone system. Each motor works independently, yet also in concert with the others as the main board communicates through the CAN bus network.

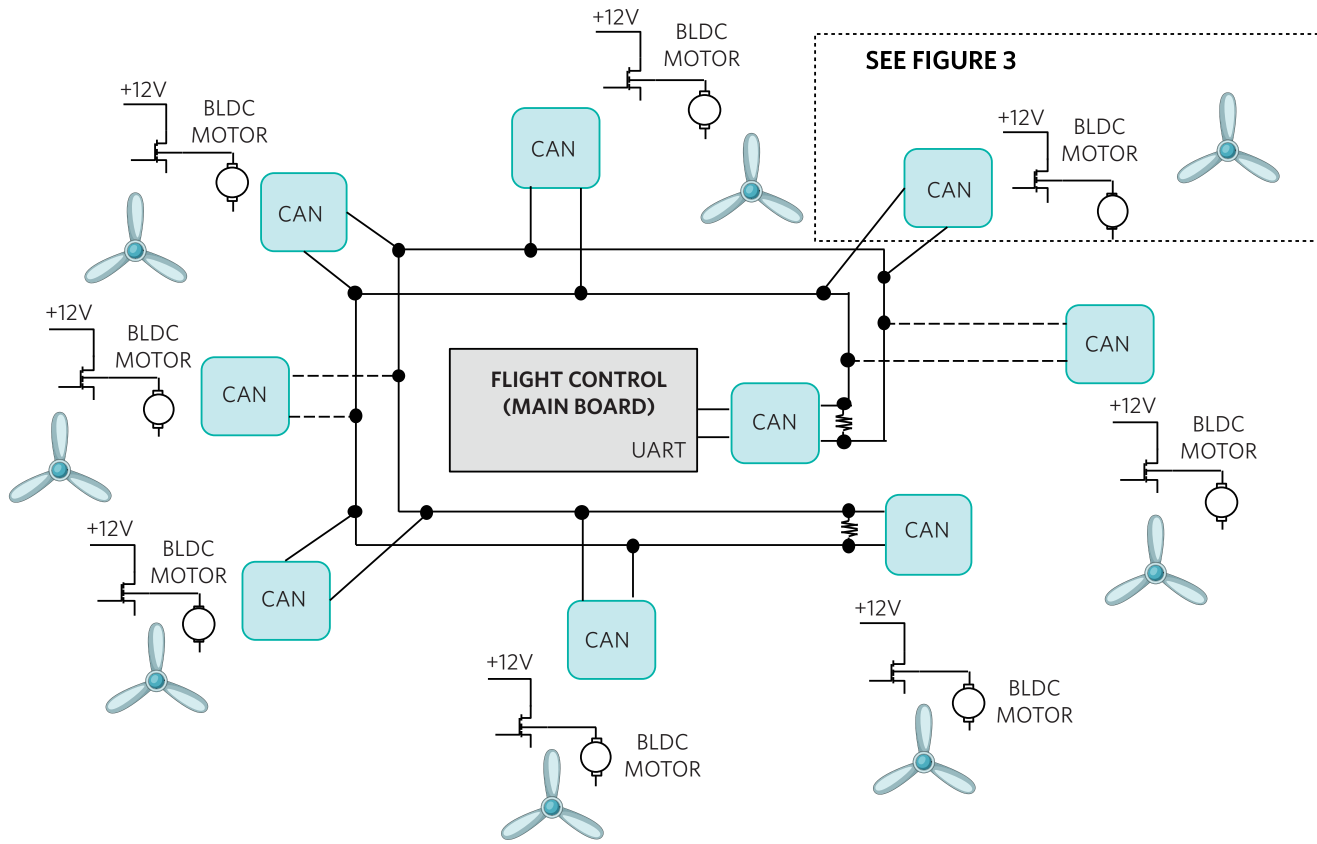

Figure 2. The Drone's Flight Control Board Sends Messages from Four to Eight Propeller Motors

The BLDC motors have permanent magnets mounted on the rotor hubs and inductor windings on the stator arms. These motors use the concept of attraction or repulsion between magnetic poles (Figure 3).

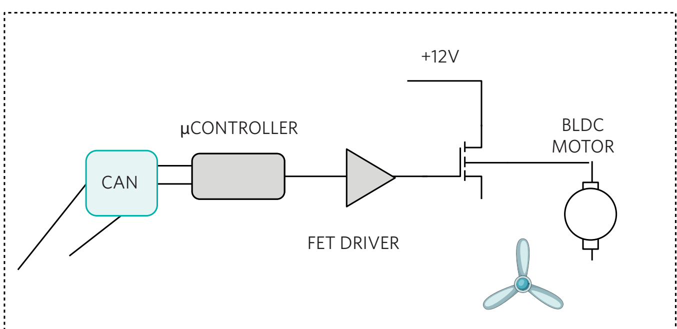

Figure 3. From Figure 2, a detailed block diagram of the drone's motor node

The motor movement starts when a current flow in the inductor windings generates a magnetic pole, which attracts the closest permanent rotor magnet of the opposite magnetic charge. The rotor, which has a shaft connected to the hub, moves while the current switches to an adjacent coil. This sequence of charging each winding requires the rotor to continually follow.

The flight control system manages messages from sensors and the pre-programmed flight plan or from the user on the ground. The motors receive the interpretation of these instructions, which entails a probable change in individual motor speeds.

Gimbal Function

The drone gimbal has its own bank of motors to keep the camera in the same position with respect to the horizon. The gimbal pivots the camera mounts that rotate about the x, y, and z axes. This provides stabilization and the pointing of cameras or other sensors.

The gimbal motor electronics, which are similar to the propeller motor electronics, receive and transmit information from the flight controller board by way of the CAN bus network.

CAN as the Drone's Backbone

The commonality across the drone system is the CAN bus transceiver. The drone flight time and distance are solely dependent on the power requirements of its electronics and battery capacity. It is paramount that the CAN bus transceivers dissipate as little power as possible. The MAX3051 +3.3V CAN transceiver is a low-power solution that meets all standard CAN bus requirements (Figure 4).

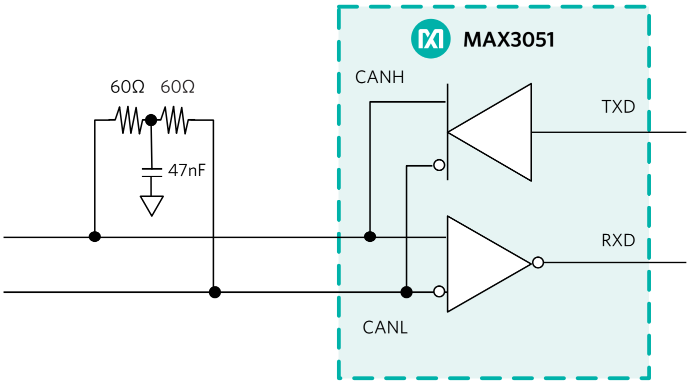

Figure 4. Multiple Receivers Connected to the CAN Bus

With a low-supply voltage of 3.3V and an average typical operating current of 18.5mA, the MAX3051 generates only 61mW (typ) during transmission with a 60Ω load.

The drone's physical layer requires robust devices as well. The MAX3051 provides a reliable structure with a ±12kV ESD protection. The CAN bus requires a common-mode range (CMR) of -2V to +7V, which the MAX3051 exceeds with a CMR of -7V to 12V. Additional features also map well to drone applications in terms of differential signal terminals and error check capability.

More Battery Life for the Drone

CAN bus networks have been around for over thirty years. Initially, the product focus of this bus was for automotive applications that required predictable and error-free communications. Relying on low-power CAN transceivers with low power dissipation, the CAN bus network now enables leading-edge communications for the battery-powered drone army.

Glossary

CAN: Control area network

GPS: Global Positioning System

CANbus: Physical communication standard including hardware and protocol

Gimbal: An instrument that aligns with the horizon with predictable stability

BLDC: Brushless DC motor

Learn more:

MAX3051 +3.3V, 1Mbps, Low-Supply-Current CAN Transceiver

Application Note 3967: Selecting a Serial Bus

FAA Modernization and Reform Act of 2012, Conference Report 112–381, 112th Congress (2012)

Design Solutions No. 79

Rev 0; January 2018

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