E-Skateboard

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Introduction

This DIY tutorial helps you to build an e-electric skateboard in a step by step fashion. We purchased a sturdy skateboard from the market and modified it to make it electric. The motor shaft is mechanically coupled to one of the rear wheels through a belt and a 3 phase GaN based inverter(TAPAS from Siemens) powers the motor. More details of the TAPAS board is available here.
The skateboard consists of :

Components

1. TAPAS
2. LiPo battery x 2 (11.1V nom). This is the one we used.
3. Skateboard with wheels
4. BLDC motor- Turnigy aerodrive SK3-5055-280KV
5. cables to interconnect, fuse, fuse holder and mechanical parts
6. Remotefrom Hobby King

All the source code for the project is available here. The code was tested on CCS v7.1.

We will discuss the mechanical construction of the skateboard first , then the hardware modifications to the TAPAS board to suit the system and then in detail about the software(based on TI InstaspinFOC).

1 Mechanical construction

We started with the skateboard shown below .

After reviewing some of the electric skateboards available online we decided to go for a single wheel drive as a first try. We took apart one of the rear wheels , drilled four holes to connect a pulley, attached another pulley to the motor side and connected it using a belt .

This DIY parts kit can be used as a reference for all the mechanical parts you may need .

Now we have a skateboard with a one wheel belt drive. We built an Aluminium housing for our skateboard(the dimensions of our housing is here), considering the dimensions of our board, the ground clearance needed and the components that had to be fitted in(The idea was to include the TAPAS board, the two LiPo batteries and the connecting cables all inside the Aluminium housing and only the three cables needed to power the motor should come out). Some fine adjustments maybe needed later on to adjust the belt tension and special care should be taken to ensure that the belt does not rub the wheel during rotation(which may damage the belt very easily).

Figure 1: Skateboard

2 Electrical construction

Here we discuss the electrical connections and cabling(the TAPAS board is discussed in a separate section). The electrical connection scheme is as below,

2.5 sq mm red and black cables , along with suitable connecters are used for the entire system. The two LiPo batteries are connected in series along with A 30A fuse for safety (the fuse also serves as the ON/OFF switch). A

The Siemens SDI TAPAS is a 48V GaN(Gallium Nitride) based three phase inverter board with on board filters, expected to change the way people approach power electronics. This design choice allows for a high switching frequency, while producing a smooth output waveform. The unique combination of high bandwidth and smooth output makes TAPAS to some degree universal, giving rise to applications ranging from robotics to power conversion, making the inverter truly software configurable.

As part of my internship at Siemens AG I developed an electric skateboard using commercial off the shelf components and the TAPAS board . GaN FETs are relatively new in the market (in comparison to Si MOSFETs) and technology adoption has not been upto the mark. The team at Siemens wanted to develop different applications based on TAPAS without making any fundamental changes to the hardware but only changing the software thus demonstrating the software configurable inverter. The e-skateboard is one of the products that was developed as a result of this thought process.

Traditionally , manufacturers demonstrate the capability of an inverter platform with a motor control solution, typically with a flag attached to a motor. This is nowhere close to any real world application with high currents, torques and high board operating temperatures. e-Skateboard is an attempt to demonstrate a software defined inverter working in real world conditions.

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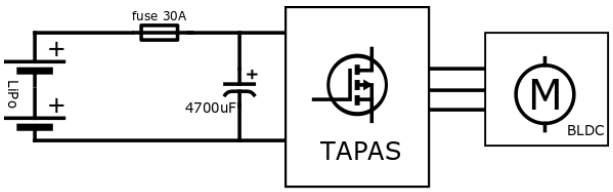

Figure 4: electrical schematic

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Code Description by Line

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Arduino Code

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Write the code in lstlisting

```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  Most Arduinos have an on-board LED you can control. On the Uno and
  Leonardo, it is attached to digital pin 13. If you're unsure what
  pin the on-board LED is connected to on your Arduino model, check
  the documentation at http://arduino.cc

  This example code is in the public domain.

  modified 8 May 2014
  by Scott Fitzgerald
 */


// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin 13 as an output.
  pinMode(13, OUTPUT);
```

```
21 }

23 // the loop function runs over and over again forever
   void loop() {
25   digitalWrite(13, HIGH);   // turn the LED on (HIGH is the voltage level)
     delay(1000);              // wait for a second
27   digitalWrite(13, LOW);    // turn the LED off by making the voltage LOW
     delay(1000);              // wait for a second
29 }
```

Listing 1: Blink.ino

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Take code directly from *.ino file

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