IPT Summer Workshop Project Overview

2021 Summer Workshop Teams

December 2021

1 Introduction

In this project, the hardware and firmware required for the running of an RC car on a track using inductive power transfer (IPT) technology. The RC car used is the TAMIYA 1/10 TT-02 SUBARU IMPREZA MONTE CARLO '99 RC CAR.

2 Track

The track will have a length l and width w as shown in Figure 1.

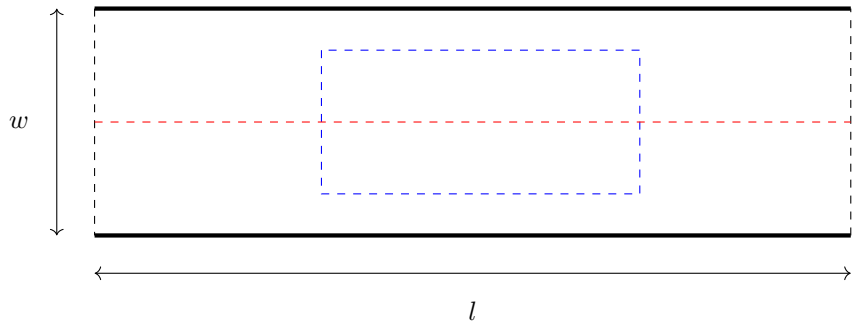

Figure 1: Simplified sketch of track top view; blue dashed rectangle represents car.

For this project, the specifications are:

- $l > 1000$mm.
- $w = 300$mm.
- Tolerance of car alignment[1]: ± 50mm.

3 System diagrams

Our design can be partitioned into three main sections:

1. The primary side.
2. The secondary (pick-up) side.
3. The motor driver.

[1]This is the maximum deviation of the center of the car from the center line (red in Figure 1) of the track.

3.1 Primary side

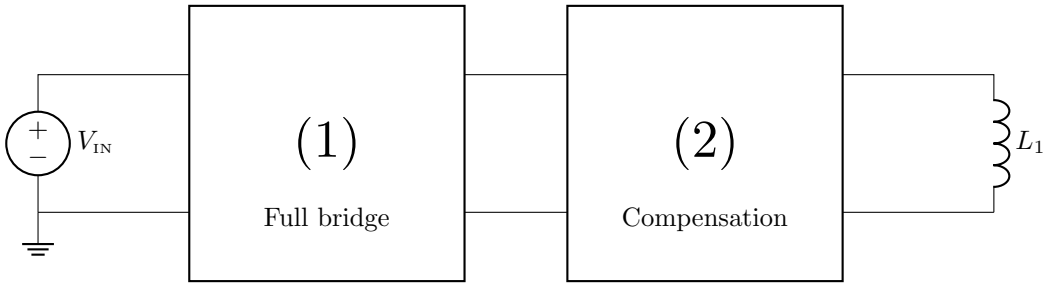

Figure 2: System diagram for the primary side

Figure 2 outlines the hardware of our primary side. A DC voltage $30\text{V} \leq V_{\text{IN}} \leq 45\text{V}$[2] is used as the input. As we must have AC for IPT to work[3], a **full-bridge inverter** (1) transforms the DC voltage to a high-frequency AC voltage. An **LCL** compensation network (2) with partial series compensation follows it. L_1 is the primary coil.

3.2 Secondary side

Unlike the primary, the secondary employs **parallel** compensation via the capacitor C_{st}. A rectifier followed by a voltage regulator (3) generates a DC voltage which is stepped up to V_{OUT} via a **boost converter** (4). V_{OUT} is optimally 10V[4] but can drop as low as 4V depending on the alignment of the car with the center of the track.

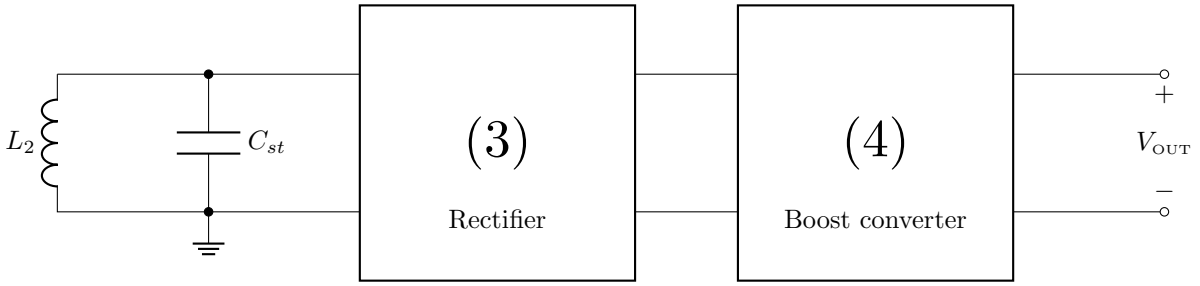

Figure 3: System diagram for the secondary side

L_2 is the secondary coil.

3.3 Motor driver

A pulse-width modulated (PWM) signal v_{PWM} used to drive the motor is produced via a full-bridge inverter (5)[5]. Depending on its duty cycle, the average power delivered to the motor will vary accordingly.

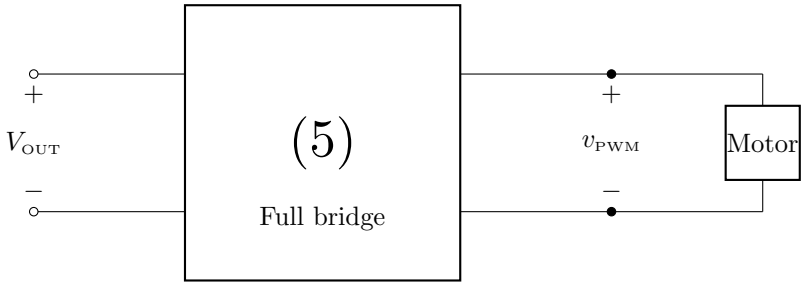

Figure 4: System diagram for the motor driver

[2]Duleepa recommends 30V as the benchtop power supply in the labs can be used to supply this voltage. The upper limit on V_{IN} ensures that it does not exceed about 48V above which we cannot operate them in the labs.

[3]As a changing current is required for a changing magnetic flux in the primary coil L_1, a DC current will not cause any changing flux and hence voltage induced in the secondary. Only AC will suffice.

[4]This is because the car's operating voltage is 10V. It can be operated down to 4V but it will have inferior performance.

[5]The microcontroller and hence firmware play a major role in this.