DIY Car
Build Guide using TB67H450FNG

Reference Guide

RD204-RGUIDE-01-E

Toshiba Electronic Devices & Storage Corporation
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1. Outline

This reference guide describes a reference design for operating “DIY Car” using Toshiba’s motor driver IC TB67H450FNG and Arduino Nano microcontroller board. TB67H450FNG has a wide operating voltage range (4.5V to 44V), low power consumption, and a popular pin-assignment, which helps in easy evaluation and development.

In the application example described in this guide, TB67H450FNG is used for the driving left and right wheels via DC motors. While Arduino Nano is used to generate control signals for TB67H450FNG. This guide provides an overview of the hardware and software used in this design.

2. Abbreviation

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCD</td>
<td>Motor Control Driver IC</td>
</tr>
<tr>
<td>MCU</td>
<td>Microcontroller Unit</td>
</tr>
<tr>
<td>BOM</td>
<td>Bill of Materials</td>
</tr>
<tr>
<td>DIY</td>
<td>Do It Yourself</td>
</tr>
<tr>
<td>EVB</td>
<td>Evaluation Board</td>
</tr>
<tr>
<td>RM</td>
<td>Reference model</td>
</tr>
</tbody>
</table>

3. About DIY Car

DIY Car is a reference model based on Toshiba’s general motor driver IC TB67H450FNG. TB67H450FNG allows the motor to be controlled in various ways which further allows the DIY car to move in various patterns.

Figure 3-1 shows the DIY car build based on TB67H450FNG.
4. Hardware Configuration

4.1. BOM

DIY Car is built using following components:

- Base Car Model (Chassis + Motors + Tires) (Refer section 9.1)
- Arduino Nano (Microcontroller Board)
- TB67H450FNG EVB (MIKROE-3982) (Refer to Section 5)
- Li-ion battery (5V)
- Connection Cables
- Switch

*In “DIY Car”, Li-ion battery is being used instead of 4x AA batteries which comes with “Base Car Model”.

Figure 4-2 shows the DIY Car built using above components.

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4.2. Block Diagram

DIY Car’s block diagram is shown in Figure 4-3. Whole system works on 5V Li-ion battery. DIY Car has 2 tires driven by 2 brushed DC motors. And these motors are driven by TB67H450FNG which are controlled using PWM signals generated by Arduino Nano microcontroller board. So overall 4 PWM signals are required.

![Figure 4-3  DIY Car - Block Diagram](image)

4.3. Hardware Connection

Connection between all components of DIY Car is shown in Figure 4-4. Li-ion battery (5V) and GND are connected to Arduino Nano, both TB67H450FNG EVBs and both Motors via VM connector.

2 input pins of a motor are connected to 2 output pins of the TB67H450FNG EVB. The connection of Right side motor pins is opposite to that of left side motor pins. This has been done so that both motors take DIY car forward when forward signal is given to both TB67H450FNG EVBs.

![Figure 4-4  Hardware Connection](image)

Circuit diagrams of TB67H450FNG EVB and Arduino Nano can be checked on their respective websites.

TB67H450FNG EVB (Mikroe-3982) Link: [https://www.mikroe.com/dc-motor-14-click](https://www.mikroe.com/dc-motor-14-click)
Arduino Nano Link: [https://store.arduino.cc/usa/arduino-nano](https://store.arduino.cc/usa/arduino-nano)
5. TB67H450FNG Operation

MIKROE-3982 is Toshiba’s TB67H450FNG motor driver’s evaluation board (EVB).

![TB67H450FNG EVB](MIKROE-3982 Board)

Figure 5-1  TB67H450FNG EVB

TB67H450FNG supports 4 operation modes for brushed DC motor, these are shown in Table 1. Motor operation mode is selected according to the configuration of 2 input signals IN1 and IN2. Speed control of motor can also be performed by sending PWM signals to IN1 and IN2.

<table>
<thead>
<tr>
<th>IN1</th>
<th>IN2</th>
<th>OUT1</th>
<th>OUT2</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
<td>OFF (Hi-Z)</td>
<td>OFF (Hi-Z)</td>
<td>Stop</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Standby mode after 1 ms</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>Forward</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td>L</td>
<td>H</td>
<td>Reverse</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>Brake</td>
</tr>
</tbody>
</table>

Table 1  TB67H450FNG – DC Motor Control Modes

Kindly refer to following links for more information.

TB67H450FNG EVB (MIKROE-3982) Link: [https://www.mikroe.com/dc-motor-14-click](https://www.mikroe.com/dc-motor-14-click)

6. Software Configuration

6.1. Software Development Environment

- Arduino IDE (1.8.10)
- Windows 10 PC

Arduino website Link: https://www.arduino.cc

6.2. Two Motor Operation

Eight Operation modes for DIY car are created by configuring various operation modes for 2 motors are shown in following table and Figure 6-1.

<table>
<thead>
<tr>
<th>DIY Car Operation Mode</th>
<th>Left Motor Operation Mode</th>
<th>Right Motor Operation Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward</td>
<td>Forward rotation</td>
<td>Forward rotation</td>
</tr>
<tr>
<td>Reverse</td>
<td>Reverse rotation</td>
<td>Reverse rotation</td>
</tr>
<tr>
<td>Brake</td>
<td>Brake</td>
<td>Brake</td>
</tr>
<tr>
<td>Standby</td>
<td>Standby</td>
<td>Standby</td>
</tr>
<tr>
<td>Turn Right</td>
<td>Forward rotation</td>
<td>Reverse rotation</td>
</tr>
<tr>
<td>Turn Left</td>
<td>Reverse rotation</td>
<td>Forward rotation</td>
</tr>
<tr>
<td>Circle Right</td>
<td>Forward rotation (Fast)</td>
<td>Forward rotation (Slow)</td>
</tr>
<tr>
<td>Circle Left</td>
<td>Forward rotation (Slow)</td>
<td>Forward rotation (Fast)</td>
</tr>
</tbody>
</table>

Figure 6-1  DIY Car – Operation Modes
6.3. Software Function Hierarchy
In order to move DIY car in various operation modes as described in Section 6.2, following software function hierarchy has been created.

- **Level 1**: Functions to generate PWM by configuring Hardware (Timer) settings.
- **Level 2**: Functions to control a single motor by using the hardware configuration functions of Level 1.
- **Level 3**: Functions to control DIY Car by controlling two motors via functions of Level 2.

DIY car can be moved in many complex patterns by using the combination of DIY control functions of Level 3.

**Figure 6-2  Software Function Hierarchy (Block Diagram)**

**Figure 6-3  Hierarchy of all Functions used**

Refer to section 9.2 for sample code.

### 6.3.1. PWM Signal Control Functions (Level 1)

PWM [1-4] signals (shown in Figure 4-3) for TB67H450FNG are generated by using hardware timers (Timer 1 & 2) of ATmega328(*) microcontroller available on Arduino Nano board.

(*) For more information on Arduino Nano and ATmega328 microcontroller kindly refer to following links.

- Arduino Nano: [https://store.arduino.cc/usa/arduino-nano](https://store.arduino.cc/usa/arduino-nano)
Following two functions are used to generate PWM signals:

- `timer_out_enDi(pin, enable)` : This function is used to Enable/Disable PWM on individual pins.
- `pin_duty_set(pin, duty)` : This function is used to set Duty cycle for PWM signals on individual pins.

### 6.3.2. Motor Control Functions (Level 2)

TB67H450FNG supports following four operation modes (Refer to Section 5):

- Forward (Rotation speed can be controlled)
- Reverse (Rotation speed can be controlled)
- Brake
- Standby

Following are Level 2 functions which are used to control individual motor operation:

Functions to operate individual motor are as follows: (also shown in Figure 6-4)

- `forward(x)` : Generate signals for TB67H450FNG to rotate the motor in forward direction. Input “x” can is used to set motor rotation speed.
- `reverse(x)` : Generate signals for TB67H450FNG to rotate the motor in reverse direction. Input “x” can is used to set motor rotation speed.
- `brake()` : Generate signals for TB67H450FNG to apply brake to the motor.
- `standby()` : Generate signals for TB67H450FNG to apply Hi-Z across motor terminals.

![Figure 6-4  Functions to control each motor individually](image)

### 6.3.3. DIY Car Control Functions (Level 3)

Operating left and right motors together, seven of the following DIY car control functions are created (Level 3). Each of these functions utilizes Level 2 functions to control individual motors.

![Figure 6-5  DIY Car Control Functions](image)
7. DIY Car Operation

Various car movement patterns as shown in Figure 7-1 can be created by combining Level 3 Car control functions described in section 6.3.3.

Figure 7-1  DIY Car Operation Pattern created using Motor Driver IC
8. Advantages of using TB67H450FNG

Four operation modes of TB67H450FNG allows the DC motor to be operated in various patterns. Merits of using TB67H450FNG are described in following table.

<table>
<thead>
<tr>
<th>Merits of using TB67H450FNG</th>
<th>Base Car model (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Both Forward &amp; Reverse operation can be performed with single battery configuration</td>
<td>• Only one direction operation can be performed with single battery configuration</td>
</tr>
<tr>
<td>• Brake Operation can be performed</td>
<td>• Brake cannot be applied, however power supply can be disconnected so that the car stops slowly because of friction</td>
</tr>
<tr>
<td>• Speed regulation is possible</td>
<td>• Speed regulation is not possible</td>
</tr>
</tbody>
</table>
| • Various complex car movements are possible:  
  ➢ Forward, Reverse, Turn Left/Right, etc | • Complex car movements are not possible |

* For more information on Base Car Model, kindly refer to section 9.1.
9. Appendix

9.1. Base Car Model Description

Base Car Model consist of following components:

- Rubber Tires 2
- Castor Wheel 1
- DC Motor 2
- Chassis 1
- Switch 1
- Battery box for AA cells 1

Figure 9-1 Base Car Model

Figure 9-2 shows the block diagram of Base Car Model.

Figure 9-2 Base Car Block Diagram

In Base Car, power supply can be turned ON/OFF using the switch. Car operation according to switch condition is as follows:

- Switch ON: Base car moves forward.
- Switch OFF: Base car stops slowly because of friction
9.2. Software Code
Software code for DIY Car written in Arduino IDE is as follows.

9.2.1. Initial Definitions

```c
#define pinLin1 9  // Left motor MCD IN1
#define pinLin2 10 // Left motor MCD IN2
#define pinLin3 11 // Right motor MCD IN2
#define en 1
#define di 0

//Initial third wheel status (during power up)
char third_wheel='B'; //Back 'B', Front 'F', Left 'L', Right 'R' //Status of which side the third wheel is protruding.

//Function Definitions
//Car movement functions (Level 3)
void car_forward(int spd); // Move Car Forward[Left_Motor-Fw, R_Motor-Fw]  spd(%):0-100
void car_reverse(int spd); // Move Car Reverse[Left_Motor-Bw, R_Motor-Bw] spd(%):0-100
void car_brake(); // BRAKE Car movement[Left_Motor-BRAKE, R_Motor-BRAKE]
void car_standby(); // STANDBY Car motors [Left_Motor-Standy, R_Motor-Standy]
void car_turn_left(int deg); // Turn Car Left[Left_Motor-Fw, R_Motor-Bw] deg: rotation angle
void car_turn_right(int deg); // Turn Car Right[Left_Motor-Bw, R_Motor-Fw] deg: rotation angle
void car_turn_circle(int L_spd, int R_spd); //Turn car in circle L_spd & R_spd are speed of left & R wheels

//Motor control functions (Level 2)
void L_forward(int spd); // Move Left motor forward[LIN1-H, LIN2-L] spd(%):0-100
void L_reverse(int spd); // Move Left motor reverse[LIN1-L, LIN2-H] spd(%):0-100
void L_brake(); // Brake Left motor [LIN1-H, LIN2-H]
void L_standby(); // Standby Left motor [LIN1-L, LIN2-L]
void R_forward(int spd); // Move Right motor forward[RIN1-H, RIN2-L] spd(%):0-100
void R_reverse(int spd); // Move Right motor reverse[RIN1-L, RIN2-H] spd(%):0-100
void R_brake(); // Brake Right motor [RIN1-H, RIN2-H]
void R_standby(); // Standby Right motor [RIN1-L, RIN2-L]

//Timer, pin functions (Level 1)
void timer_out_enDi(int pin, int enable); //pin: 9,10,11,3 enable: en:Output_Enable, di:Output_Disable
void pin_duty_set(int pin, int duty); //pin: 9,10,11,3 duty(%):0-100

//Car movement functions (Level 2)
void pin_duty_set(int pin, int duty); //pin: 9,10,11,3 duty(%):0-100

//Car movement functions (Level 3)
void car_forward(int spd); // Move Car Forward[Left_Motor-Fw, R_Motor-Fw]  spd(%):0-100
void car_reverse(int spd); // Move Car Reverse[Left_Motor-Bw, R_Motor-Bw] spd(%):0-100
void car_brake(); // BRAKE Car movement[Left_Motor-BRAKE, R_Motor-BRAKE]
void car_standby(); // STANDBY Car motors [Left_Motor-Standy, R_Motor-Standy]
void car_turn_left(int deg); // Turn Car Left[Left_Motor-Fw, R_Motor-Bw] deg: rotation angle
void car_turn_right(int deg); // Turn Car Right[Left_Motor-Bw, R_Motor-Fw] deg: rotation angle
void car_turn_circle(int L_spd, int R_spd); //Turn car in circle L_spd & R_spd are speed of left & R wheels

//Motor control functions (Level 2)
void L_forward(int spd); // Move Left motor forward[LIN1-H, LIN2-L] spd(%):0-100
void L_reverse(int spd); // Move Left motor reverse[LIN1-L, LIN2-H] spd(%):0-100
void L_brake(); // Brake Left motor [LIN1-H, LIN2-H]
void L_standby(); // Standby Left motor [LIN1-L, LIN2-L]
void R_forward(int spd); // Move Right motor forward[RIN1-H, RIN2-L] spd(%):0-100
void R_reverse(int spd); // Move Right motor reverse[RIN1-L, RIN2-H] spd(%):0-100
void R_brake(); // Brake Right motor [RIN1-H, RIN2-H]
void R_standby(); // Standby Right motor [RIN1-L, RIN2-L]

//Timer, pin functions (Level 1)
void timer_out_enDi(int pin, int enable); //pin: 9,10,11,3 enable: en:Output_Enable, di:Output_Disable
void pin_duty_set(int pin, int duty); //pin: 9,10,11,3 duty(%):0-100
```

9.2.2. Arduino Setup Function

```c
void setup()
{
  Serial.begin(9600);

  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
  pinMode(pinLin1, OUTPUT);
  pinMode(pinLin2, OUTPUT);
  pinMode(pinLin3, OUTPUT);
  pinMode(pinLin1, OUTPUT);
  pinMode(pinLin2, OUTPUT);
  pinMode(pinLin3, OUTPUT);

  digitalWrite(pinLin1, LOW);
  digitalWrite(pinLin2, LOW);
  digitalWrite(pinLin3, LOW);
  digitalWrite(pinLin1, LOW);
  digitalWrite(pinLin2, LOW);
  digitalWrite(pinLin3, LOW);

  // TIMER 1 (8bit, fixed top value-255)
  TCCR1A = _BV(WGM10) | _BV(CS12); //Prescaler 1/256 (For changing frequency) // 24kHz
  TCCR1B = _BV(WGM12) | _BV(CS11) | _BV(OS10); //Prescaler 1/64 (For changing frequency) // 1kHz
  TCCR1B = _BV(WGM12) | _BV(CS11); // Prescaler 1/8 (For changing frequency) // 7.8kHz
  TCCR1B = _BV(WGM12) | _BV(CS11); // Prescaler 1/1 (For changing frequency) // 62kHz
  OCR1A = 63; //Counter for pin9
  OCR1B = 128; //Counter for pin10

  // TIMER 2
  TCCR2A = _BV(WGM21) | _BV(WGM20); //Fast PWM mode
  TCCR2B = _BV(CS22) | _BV(CS21); //Prescaler 1/256 (For changing frequency) 24kHz 40%
  TCCR2B = _BV(CS22); //Prescaler 1/64 (For changing frequency) 1kHz 50%
  TCCR2B = _BV(CS21); //Prescaler 1/8 (For changing frequency) 7.8kHz 70%
  TCCR2B = _BV(CS20); //Prescaler 1/1 (For changing frequency) 62kHz
  OCR2A = 140; //PWM on Pin 11 (Duty OCR2A/255)
  OCR2B = 250; //PWM on pin 3 (Duty OCR2B/255)

  car_standby(); // STANDBY Car motors [Left_Motor-Standy, R_Motor-Standy]
  if((third_wheel=='B' || third_wheel=='F')){
    digitalWrite(LED_BUILTIN, HIGH);
  }else{
    digitalWrite(LED_BUILTIN, LOW);
  }
  delay(1000);
  
```
9.2.3. Arduino Loop Function

```c
void loop()
{
    // The loop function runs over and over again forever

    // FW-Rotate [R]180-FW-Rotate [R]180
    delay(2000);
    for(int i=0;i<4;i++)
    {
        // FW
        car_forward(50); // Move Car Forward[Left_Motor-Fw, R_Motor-Fw]  spd(%):0-100
        delay(2000);
        car_brake();
        delay(2000);
        car_turn_right(180); // Turn Car Right[Left_Motor-Fw, R_Motor-Rw]  deg: rotation angle
        delay(500);
        // Return
        car_forward(50); // Move Car Forward[Left_Motor-Fw, R_Motor-Fw]  spd(%):0-100
        delay(2000);
        car_brake();
        delay(2000);
        car_turn_right(180); // Turn Car Right[Left_Motor-Fw, R_Motor-Rw]  deg: rotation angle
        delay(500);
    }

    // Rotate 90deg [L]x4
    delay(2000);
    for(int i=0;i<4;i++)
    {
        car_turn_left(90); // Turn Car Left[Left_Motor-Rw, R_Motor-Fw]  deg: rotation angle
        delay(500);
    }

    // Rotate 90deg [R]x4
    delay(2000);
    for(int i=0;i<4;i++)
    {
        car_turn_right(90); // Turn Car Right[Left_Motor-Fw, R_Motor-Rw]  deg: rotation angle
        delay(500);
    }

    // FW & RW (without rotation & without acceleration)
    delay(2000);
    for(int i=0;i<4;i++)
    {
        car_forward(50); // Move Car Forward[Left_Motor-Fw, R_Motor-Fw]  spd(%):0-100
        delay(2000);
        car_brake();
        delay(2000);
        car_reverse(50); // Move Car Reverse[Left_Motor-Bw, R_Motor-Bw]  spd(%):0-100
        delay(480);
        car_brake();
        delay(2000);
    }

    // Rotate 180deg [R]x2
    delay(2000);
    for(int i=0;i<2;i++)
    {
        car_turn_right(180); // Turn Car Right[Left_Motor-Fw, R_Motor-Rw]  deg: rotation angle
        delay(500);
    }

    // normal Square
    delay(2000);
    for(int i=0;i<4;i++)
    {
        // FW (1st side of square)
        car_forward(50); // Move Car Forward[Left_Motor-Fw, R_Motor-Fw]  spd(%):0-100
        delay(2000);
        car_brake();
        delay(2000);
        for(int i=0;i<4;i++)
        {
            // (2nd, 3rd, 4th side of square)
            car_turn_right(90); // Turn Car Right[Left_Motor-Fw, R_Motor-Rw]  deg: rotation angle
            delay(2000);
            // FW
            car_forward(50); // Move Car Forward[Left_Motor-Fw, R_Motor-Fw]  spd(%):0-100
            delay(7000);
            car_brake();
            delay(2000);
        }
        // Rotate Right
        car_turn_right(90); // Turn Car Right[Left_Motor-Fw, R_Motor-Rw]  deg: rotation angle
        delay(2000);
    }

    // Circle
    delay(2000);
    car_turn_right(90); // Turn Car Right[Left_Motor-Fw, R_Motor-Rw]  deg: rotation angle
    delay(2000);
    car_turn_circle(40,100); // Turn Car in circle L_spd & R_spd are speed of left & R wheels
    delay(950);
    car_brake();
    delay(2000);
    car_turn_left(90); // Turn Car Left[Left_Motor-Rw, R_Motor-Fw]  deg: rotation angle
    delay(2000);
}
```
9.2.4. DIY Car Control Functions (Level 3)

void car_forward(int spd){ // Move Car Forward[Left_Motor-Fw, R_Motor-Fw] spd(%):0-100
  L_forward(spd); // Move Left motor forward[LIN1-H, LIN2-L] spd(%):0-100
  R_forward(spd); // Move Right motor forward[RIN1-H, RIN2-L] spd(%):0-100
  third_wheel='B'; //Back 'B', Front 'F', Left 'L', Right 'R' //Status of which side the third wheel is protruding.
  digitalWrite(LED_BUILTIN, HIGH);
}

void car_reverse(int spd){ // Move Car Reverse[Left_Motor-Bw, R_Motor-Bw] spd(%):0-100
  L_reverse(spd); // Move Left motor reverse[LIN1-L, LIN2-H] spd(%):0-100
  R_reverse(spd); // Move Right motor reverse[RIN1-L, RIN2-H] spd(%):0-100
  third_wheel='F'; //Back 'B', Front 'F', Left 'L', Right 'R' //Status of which side the third wheel is protruding.
  digitalWrite(LED_BUILTIN, HIGH);
}

void car_brake(){ // BRAKE Car movement[Left_Motor-BRAKE, R_Motor-BRAKE]
  L_brake(); // Brake Left motor [LIN1-H, LIN2-H]
  R_brake(); // Brake Right motor [RIN1-H, RIN2-H]
}

void car_standby(){ // STANDBY Car motors [Left_Motor-Standby, R_Motor-Standby]
  L_standby(); // Standby Left motor [LIN1-L, LIN2-L]
  R_standby(); // Standby Right motor [RIN1-L, RIN2-L]
}

void car_turn_left(int deg){ // Turn Car Left[Left_Motor-Rw, R_Motor-Fw] deg: rotation angle
  int extra = 0;
  //Turn Left
  R_forward(60); // Move Right motor forward[RIN1-H, RIN2-L] spd(%):0-100
  L_reverse(60); // Move Left motor reverse[LIN1-L, LIN2-H] spd(%):0-100 //motor speed cant be super slow
  if(third_wheel == 'F' || third_wheel == 'B') { //90deg different from desired direction (left)
    extra = 0;
  } else if (third_wheel == 'R') { //180deg different from desired direction (left)
    extra = 14;
  }
  if(deg<120){
    delay((27.*((deg/90.0)+extra)));
  } else {
    delay((49.*((deg/180.0)+extra)));
  }
  car_brake();
  third_wheel='L'; //Back 'B', Front 'F', Left 'L', Right 'R' //Status of which side the third wheel is protruding.
  digitalWrite(LED_BUILTIN, LOW);
}

void car_turn_right(int deg){ // Turn Car Right[Left_Motor-Fw, R_Motor-Rw] deg: rotation angle
  int extra = 0;
  //Turn Right
  L_forward(60); // Move Left motor forward[LIN1-H, LIN2-L] spd(%):0-100
  R_reverse(60); // Move Right motor reverse[RIN1-L, RIN2-H] spd(%):0-100
  if(third_wheel == 'F' || third_wheel == 'B') { //90deg different from desired direction (right)
    extra = 0;
  } else if (third_wheel == 'L') { //180deg different from desired direction (right)
    extra = 14;
  }
  if(deg<120){
    delay((28.*((deg/90.0)+extra)));
  } else {
    delay((50.*((deg/180.0)+extra)));
  }
  car_brake();
  third_wheel='R'; //Back 'B', Front 'F', Left 'L', Right 'R' //Status of which side the third wheel is protruding.
  digitalWrite(LED_BUILTIN, LOW);
}

void car_turn_circle(int L_spd, int R_spd){ //Turn car in circle L_spd & R_spd are speed of left & R wheels
  L_forward(L_spd); // Move Left motor forward[LIN1-H, LIN2-L] spd(%):0-100
  R_forward(R_spd); // Move Right motor forward[RIN1-H, RIN2-L] spd(%):0-100
}
9.2.5. Motor Control Functions (Level 2)

```c
void L_forward(int spd) { // Move Left motor forward[LIN1-H, LIN2-L] spd(%):0-100
    //pin L in1
    timer_out_enDi(pinLin1, en); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    pin_duty_set(pinLin1, spd); //pin:9,10,11,3 duty(%):0-100
    digitalWrite(pinLin1, LOW); //pin L in2
    timer_out_enDi(pinLin2, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinLin2, LOW); };

void L_reverse(int spd) { // Move Left motor reverse[LIN1-L, LIN2-H] spd(%):0-100
    //pin L in1
    timer_out_enDi(pinLin1, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    pin_duty_set(pinLin1, spd); //pin:9,10,11,3 duty(%):0-100
    digitalWrite(pinLin1, LOW); //pin L in2
    timer_out_enDi(pinLin2, en); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinLin2, LOW); };

void L_brake() { // Brake Left motor [LIN1-H, LIN2-H]
    //pin L in1
    timer_out_enDi(pinLin1, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinLin1, HIGH); //pin L in2
    timer_out_enDi(pinLin2, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinLin2, HIGH); };

void L_standby() { // Standby Left motor [LIN1-L, LIN2-L]
    //pin L in1
    timer_out_enDi(pinLin1, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinLin1, LOW); //pin L in2
    timer_out_enDi(pinLin2, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinLin2, LOW); };

void R_forward(int spd) { // Move Right motor forward[RIN1-H, RIN2-L] spd(%):0-100
    //pin R in1
    timer_out_enDi(pinRin1, en); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    pin_duty_set(pinRin1, spd); //pin:9,10,11,3 duty(%):0-100
    digitalWrite(pinRin1, LOW); //pin R in2
    timer_out_enDi(pinRin2, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinRin2, LOW); };

void R_reverse(int spd) { // Move Right motor reverse[RIN1-L, RIN2-H] spd(%):0-100
    //pin R in1
    timer_out_enDi(pinRin1, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinRin1, HIGH); //pin R in2
    timer_out_enDi(pinRin2, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinRin2, HIGH); };

void R_brake() { // Brake Right motor [RIN1-H, RIN2-H]
    //pin R in1
    timer_out_enDi(pinRin1, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinRin1, HIGH); //pin R in2
    timer_out_enDi(pinRin2, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinRin2, HIGH); };

void R_standby() { // Standby Right motor [RIN1-L, RIN2-L]
    //pin R in1
    timer_out_enDi(pinRin1, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinRin1, LOW); //pin R in2
    timer_out_enDi(pinRin2, di); //pin: 9,10,11,3 enable: en:Output_En, di:Output_Di
    digitalWrite(pinRin2, LOW); }
```
void pin_duty_set(int pin, int duty){ //pin:9,10,11,3      duty(%):0-100
switch(pin){
  case 9://Pin9 - OC1A - Timer1
          OCR1A = (duty*255)/100;
          break;
  case 10://Pin10 - OC1B - Timer1
           OCR1B = (duty*255)/100;
           break;
  case 11://Pin11 - OC2A - Timer2
           OCR2A = (duty*255)/100;
           break;
  case 3://Pin3 - OC2B - Timer2
           OCR2B = (duty*255)/100;
           break;
}

void timer_out_enDi(int pin, int enable){ //pin: 9,10,11,3     enable: en:Output_En, di:Output_Di
  switch (pin){
    case 9: //Pin9 - OC1A - Timer1
          if(enable==1){
              TCCR1A |= _BV(COM1A1); //Timer output on pin 9 ON
          }
          else if(enable==0){
              TCCR1A &=~ _BV(COM1A1); //Timer output on pin 9 OFF
          }
          break;
    case 10: //Pin10 - OC1B - Timer1
             if(enable==1){
                 TCCR1A |= _BV(COM1B1); //Timer output on pin 10 ON
             }
             else if(enable==0){
                 TCCR1A &=~ _BV(COM1B1); //Timer output on pin 10 OFF
             }
             break;
    case 11: //Pin11 - OC2A - Timer2
             if(enable==1){
                 TCCR2A |= _BV(COM2A1); //Timer output on pin 11 ON
             }
             else if(enable==0){
                 TCCR2A &=~ _BV(COM2A1); //Timer output on pin 11 OFF
             }
             break;
    case 3: //Pin3 - OC2B - Timer2
             if(enable==1){
                 TCCR2A |= _BV(COM2B1); //Timer output on pin 3 ON
             }
             else if(enable==0){
                 TCCR2A &=~ _BV(COM2B1); //Timer output on pin 3 OFF
             }
             break;
    default:
             break;
  }
}
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