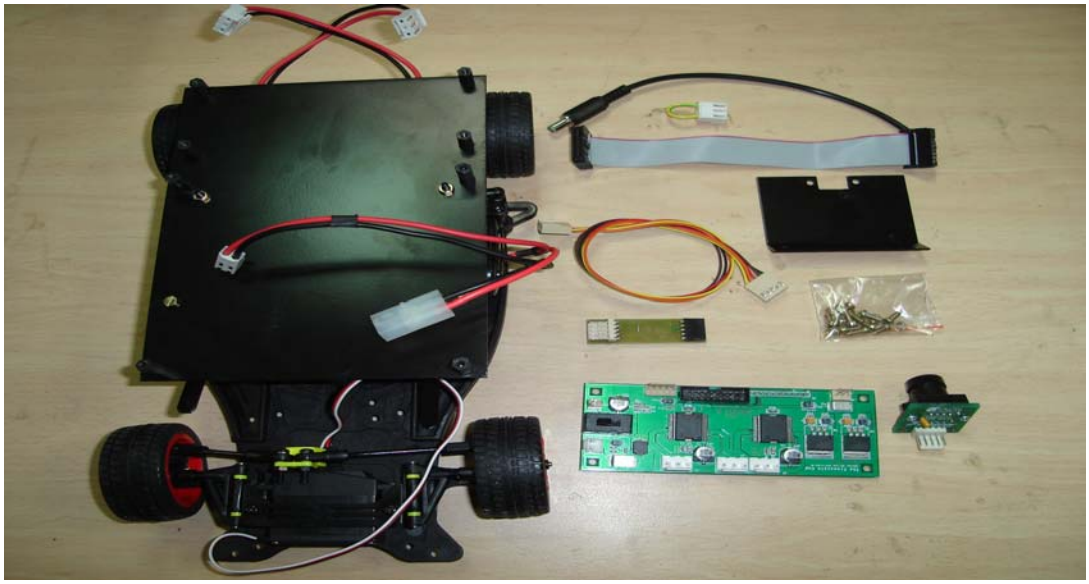
The Freescale Cup

I. Installation instructions

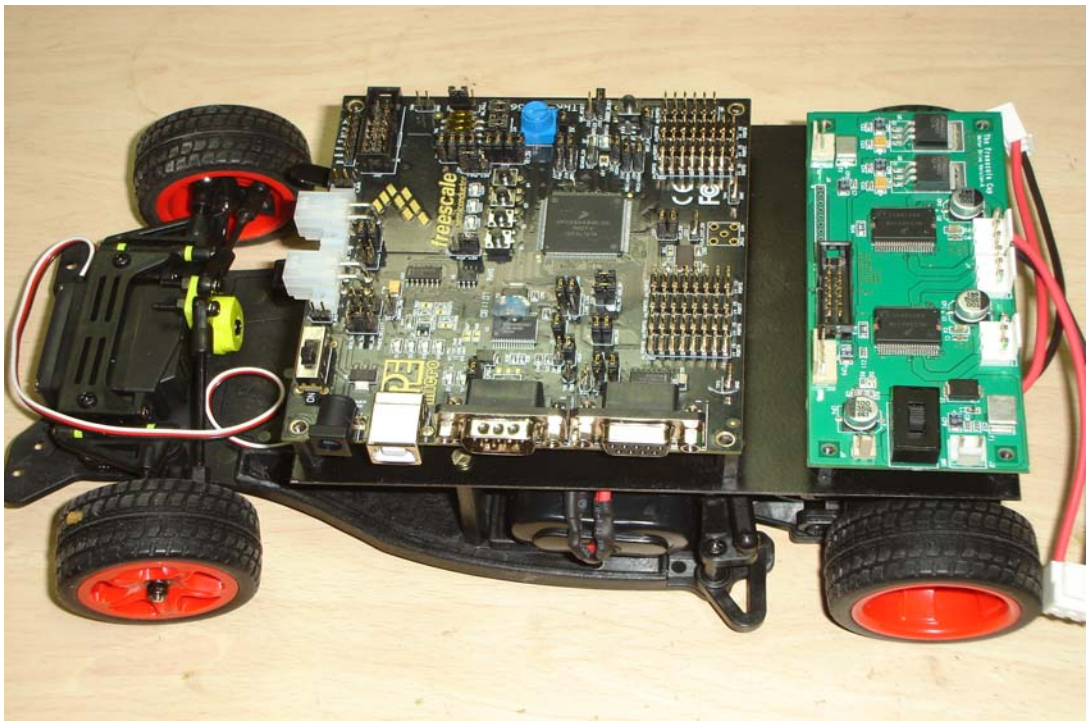
1. Install the CodeWarrior for MPC55xx/56xx MCUs V2.7 using the software compact disk which is inside the TRK-MPC5604B kit.

2. Download the drivers_10_install.exe from www.cedt.iisc.ernet.in/tfcindia2011/ and install the driver for OSBDM and virtual serial port.

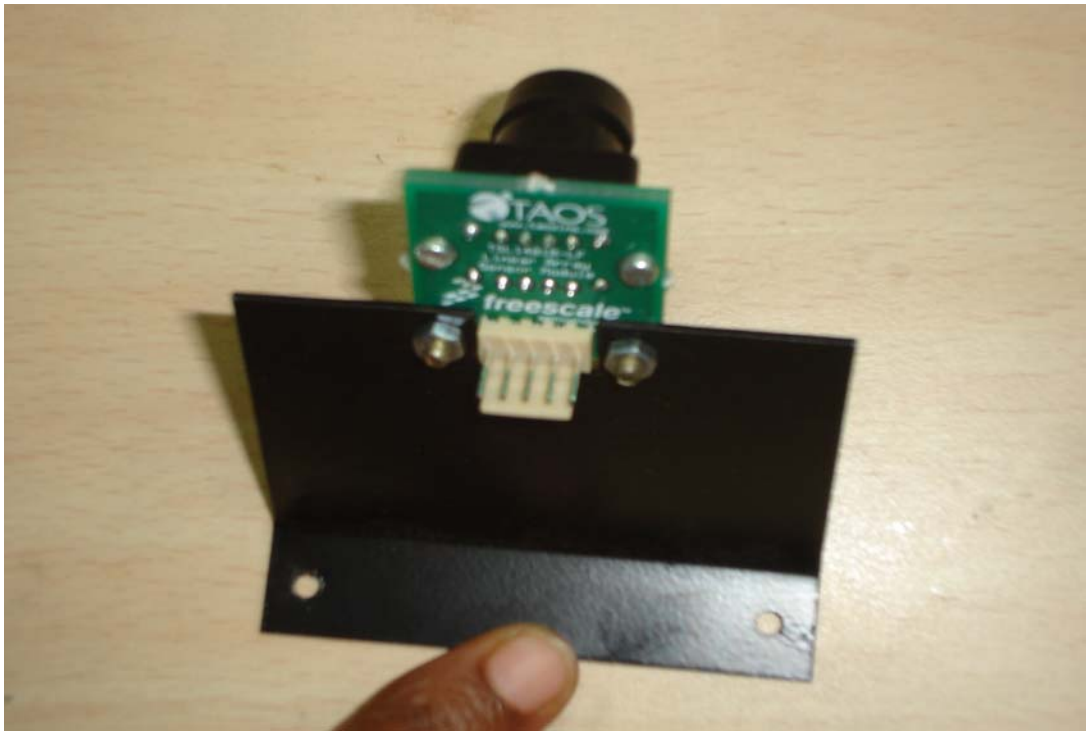
3. The contents of the car kit package are shown below:

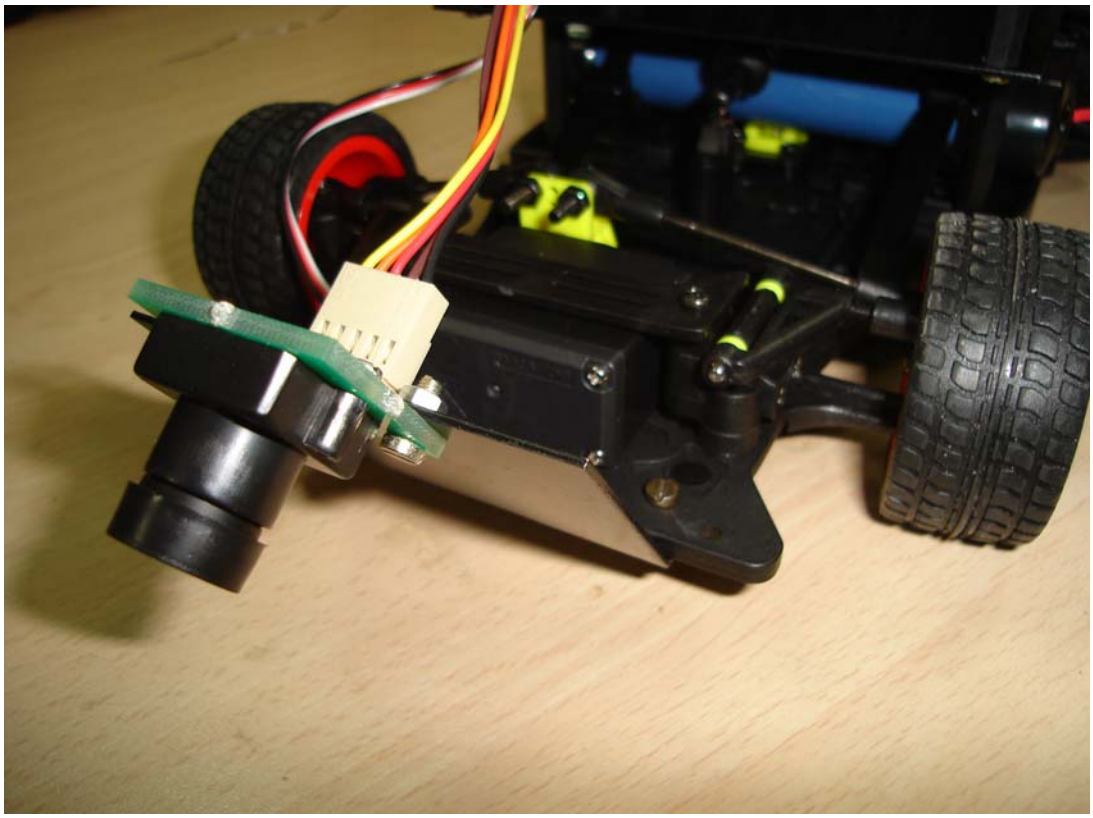


4. Mount the drive board and TRK-MPC5604B board on the car as shown below:

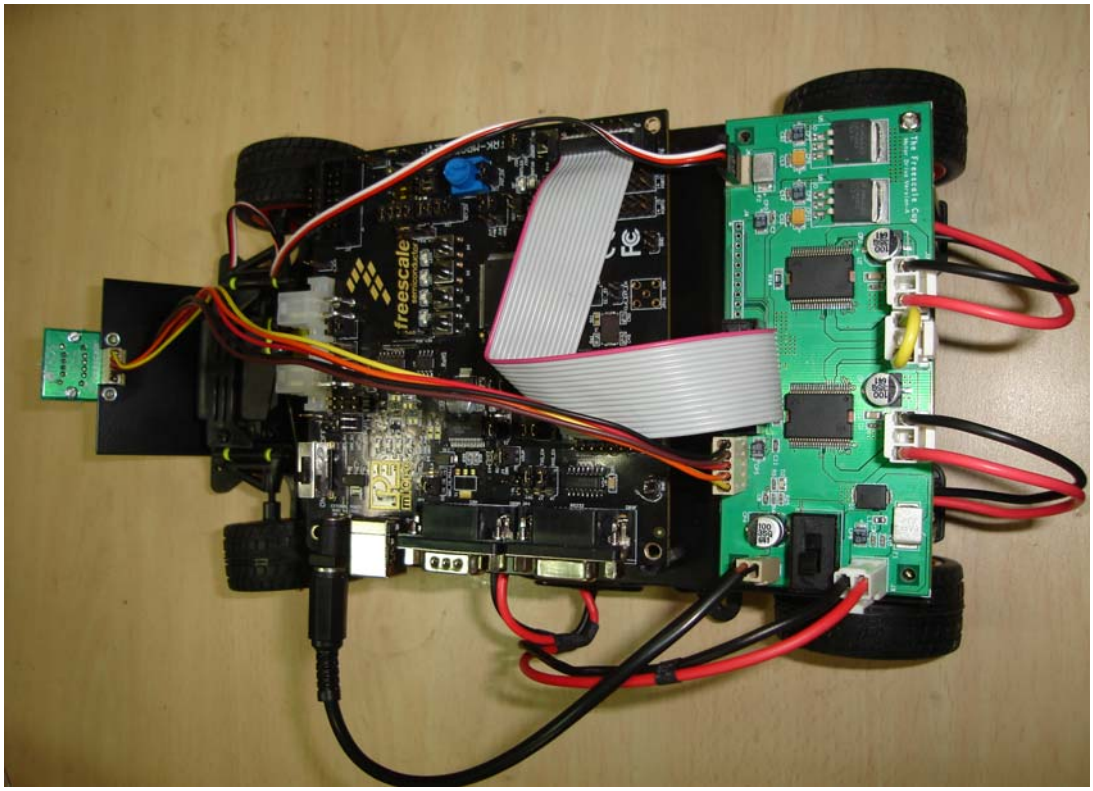


Use 6 mm long screws to fix the drive board and 8 mm long screws to fix TRK-MPC5604B.
5. Mount the camera on the camera plate and fix the camera plate to the car as shown below:

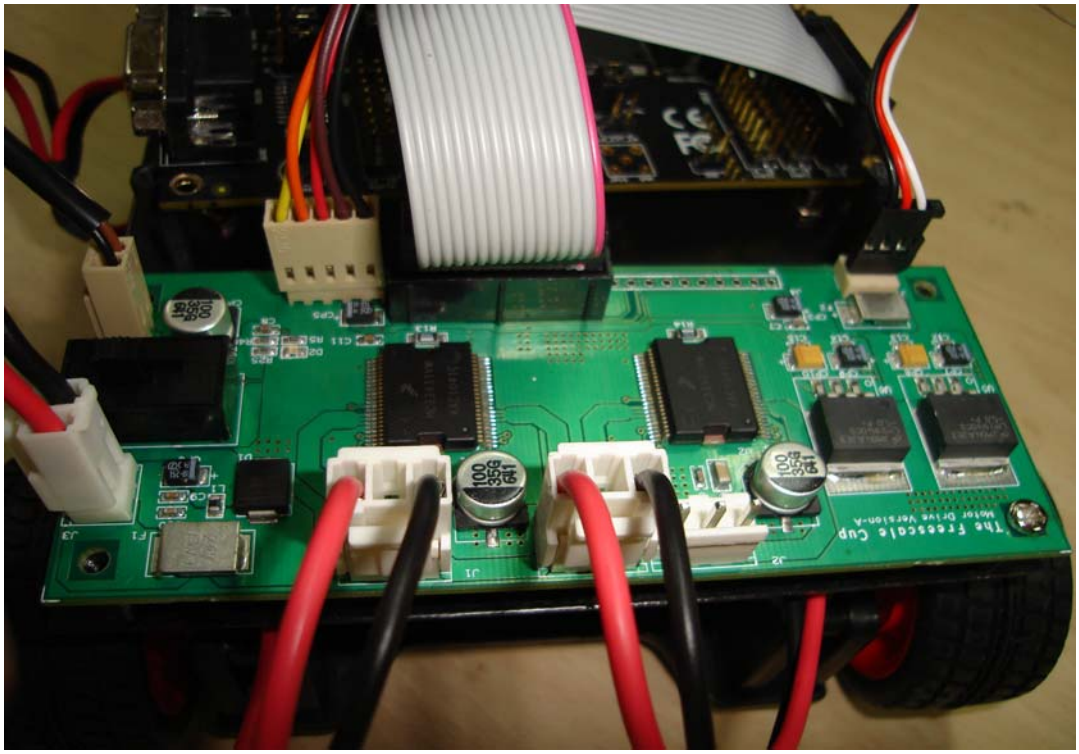




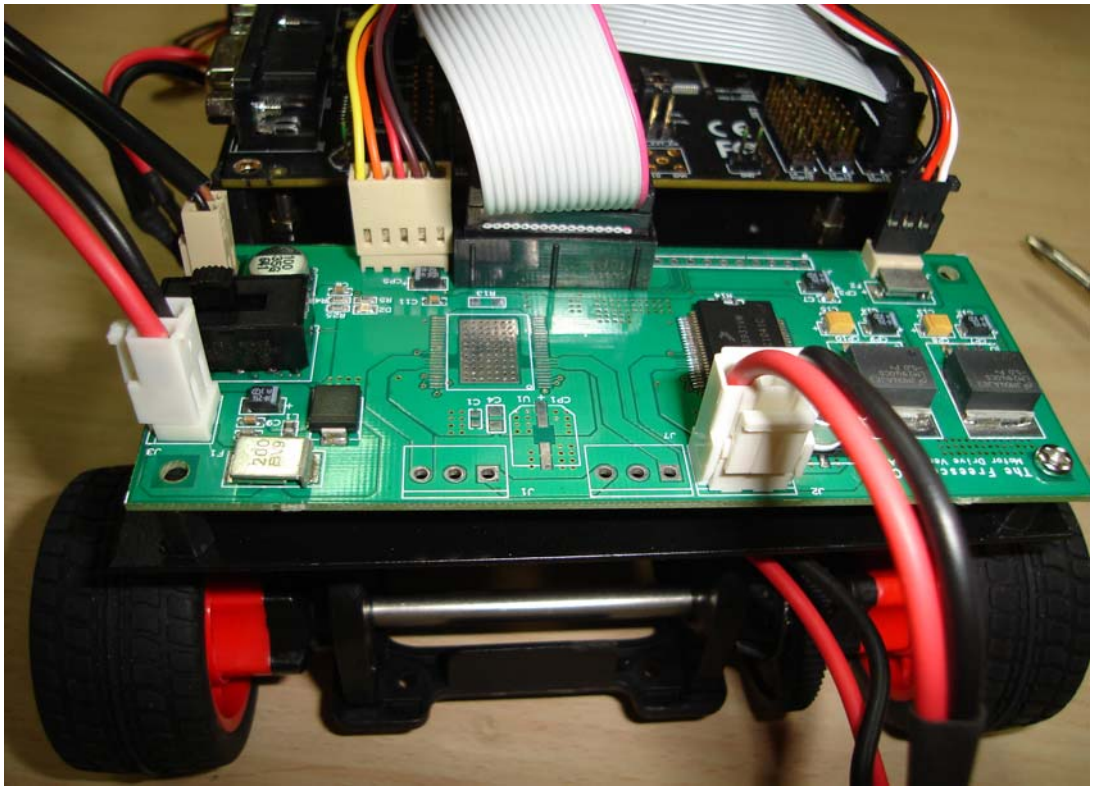
6. Make the cable connections as shown below for dual motor with independent drive connection



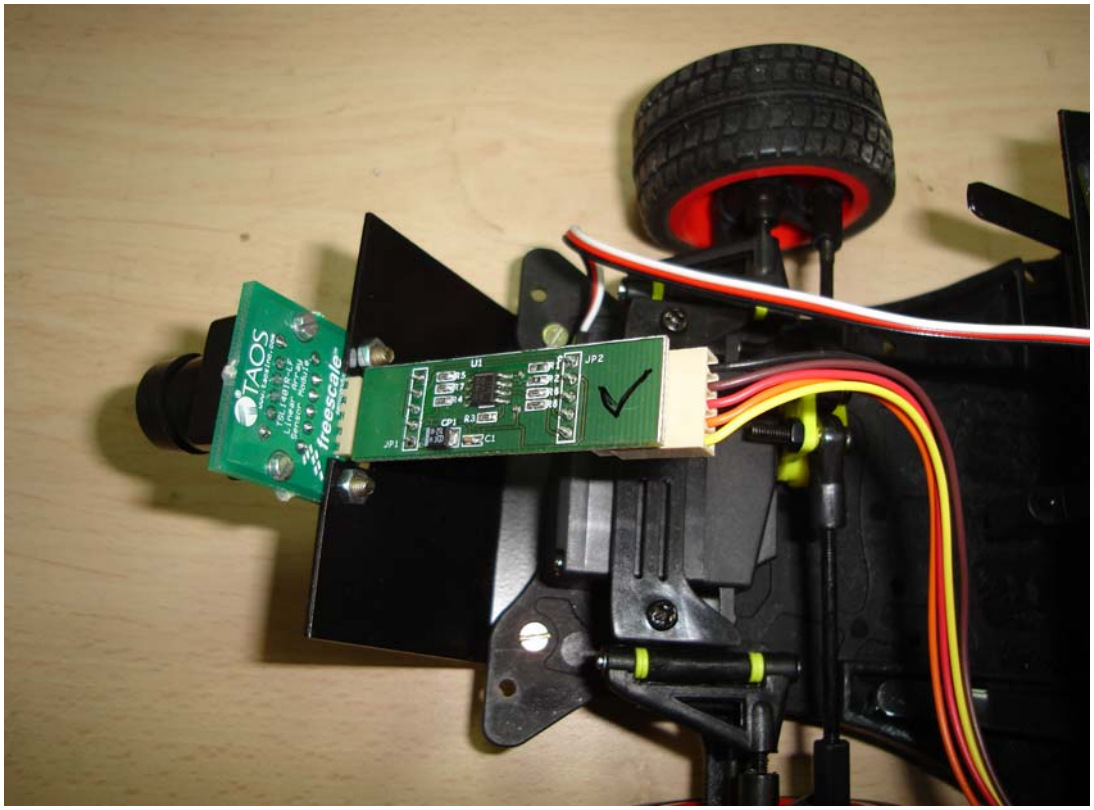
7. Make the cable connections as shown below for dual motor with series drive connection



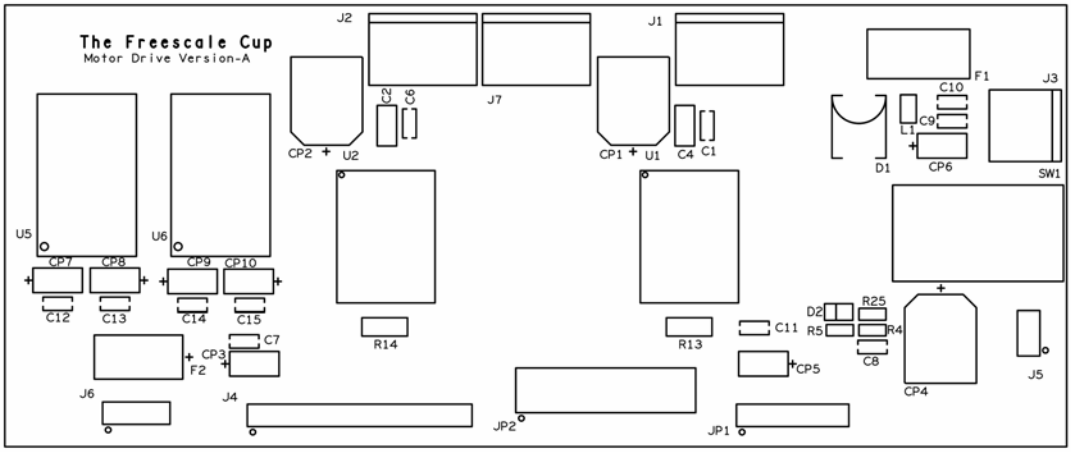
8. Make the cable connections as shown below for Single motor connection



9. Connect the amplifier PCB for camera sensor as shown below:



10. Motor drive board connector details:



Motor Drive Board Top Assembly Drawing

J3 - Battery Connector
J1 - Left Drive Motor Connector
J2 - Right Drive Motor Connector
J7 - Drive Motor Series Connector
J5 - Power Connector for the TRK-MPC5604B Board
J6 - Steering Servo Motor Connector (Pin-1 to White wire)
JP2 - Expansion Connector to TRK-MPC5604B Board
JP1 - Camera Connector

Not to do to the car Kit and hardware

1. Don't change the position of the steering servomotor by hand. The position of the steering servomotor has to be changed through electrical input only.
2. Don't move the steering servo motor beyond the maximum limit of the movement and this will damage the servo motor.
2. Don't hold or stop the back wheels while they are in rotation, this will burn the motor or drive.
3. Don't disconnect or connect any cable when board is powered ON and it will damage the corresponding circuitry.
4. Don't discharge the battery below 5.5V
5. Don't make the car to collide with any stationary object and this will damage the camera sensor.

II. Sample program Installation and Testing

1. Connect the USB cable to the TRK-MPC5604B board and in the new hardware wizard select automatic driver installation of the Open source BDM and PE Micro USB serial port.

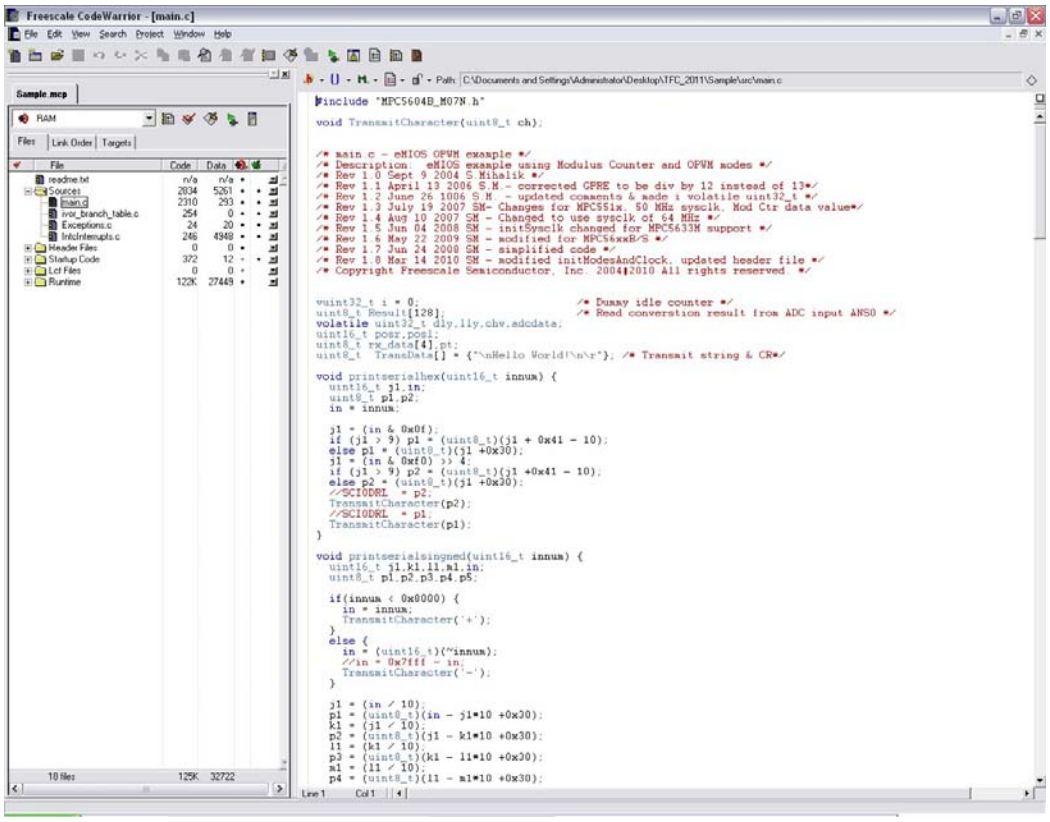
2. Connect the target TRK-MPC5604B board serial cable to the host computer serial port. **Turn on** the power switches of the Drive Board and TRK-MPC5604B board.

3. Download the Program file Sample.zip from www.cedt.iisc.ernet.in/tfcindia2011/ and unzip the file into your home directory.

4. From the Start Menu run the CodeWarrior IDE by using **Freescale CodeWarrior>CW for MPC55xx, MPC56xx 2.7 > CodeWarrior IDE** and select the option Start Using CodeWarrior.

5. Open the CodeWarrior project file sample.mcp which is available in the unzipped sample program directory.

6. In sample.mcp project manager window expand the source folder under the Files menu and open the main.c by clicking on it, and you will get the following screen display.



7. In sample.mcp project manager window target selection window is set to the default **RAM**. This means the code runs in the RAM. This target option can be changed using the dropdown menu to **internal_FLASH**. This means the code runs in the flash and this code can run without debugger when the board is powered up. You can select either **RAM** target or **internal_FLASH** target for the following test procedure. If you select **internal_FLASH** target you can test the standalone operation of the board.

7. From the Start menu Run the hyper terminal by using **All programs> Accessories> Communications> HyperTerminal** and make **COMx** properties port settings as Baud rate 115200, Data bits 8, Parity None, Stop bits 1 and Flow control None.

8. In the **project** menu select **make** (or F7) you will get few warning messages ignore it. Next select **Debug** option (or F5) from **projec**t menu.

9. The debug window opens with few sub windows such as **Code**, **Status** and **CPU** etc. To run the program, select the **Source GO** menu button.

10. Debugger will produce the output in HyperTerminal, you can see the following options for testing the functionality of the car by pressing any one number (**1,2,…8**) at a time. **Hold the car in hand while selecting the options 5, 6, 7 and 8**.

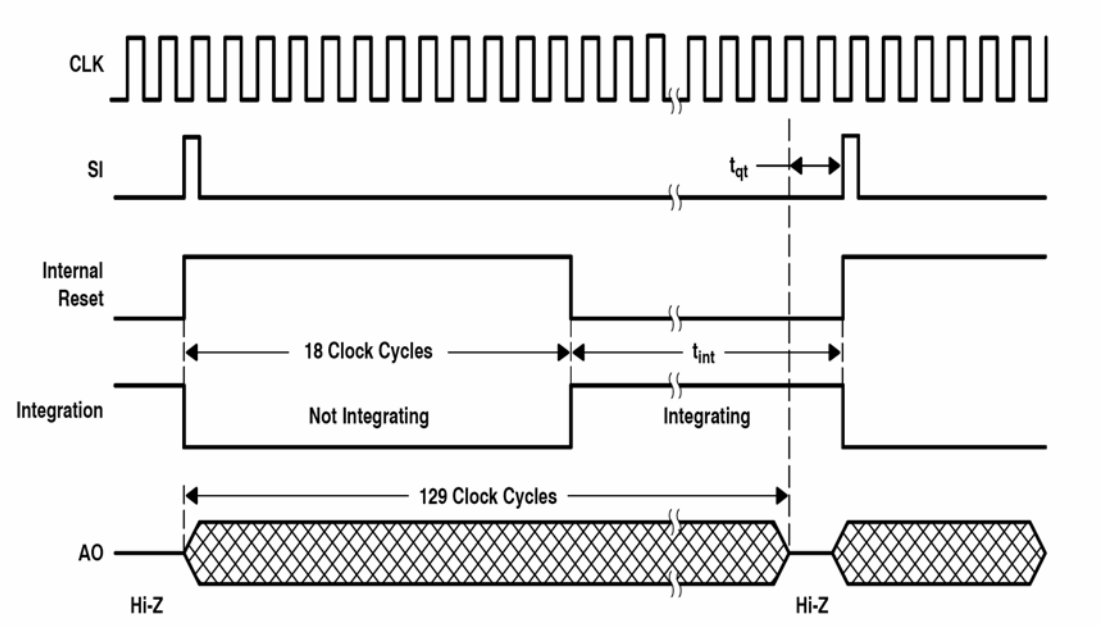
1. Led
2. Switch
3. Servo
4. Motor Left
5. Motor Right
6. Camera
7. Left Motor Current
8. Right Motor Current

11. Select the **stop menu** button in the debugger window to stop the debugger mode.

III. Camera Testing and Amplifier usage

1. Integration time

The camera has 128 linear sensors and these sensor output levels depend on the time of integration and ambient light intensity. The following diagram shows the integration of sensor, the clock and the start pulse. Each clock gives out one sensor output.



The minimum integration time is calculated by the following formula.

$$T_{int(min)} = \left(\frac{1}{maximum\ clock\ frequency}\right) \times (n - 18)\ pixels + 20\mu s$$

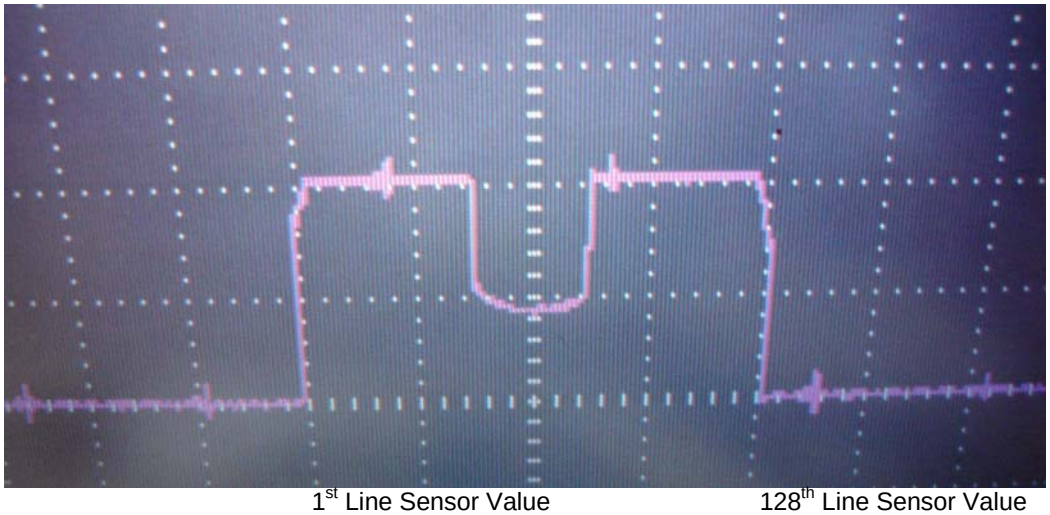
Where n is the number of pixels (Refer the sensor datasheet for more information).

At lower ambient light levels, the integration time needs to be increased to get reasonable output from the sensor. Increasing the integration time will lead to slower sampling frequency and lower bandwidth.

An amplifier board is provided to amplify the sensor voltage by 1.47 or 2.1609 times. The default gain value is 2.1609. Using the amplifier slower integration time can be achieved for reasonable sensor output and consequently faster sampling frequency. The gain values can be changed to suit your requirement. Refer to the amplifier circuit to change the gain values. The integration time of the sensor need to be adjusted to suit the ambient light in which the car is running (This is a trick which will make the car to run in any ambient light, the integration time need to be adjustable to suit the ambient light).

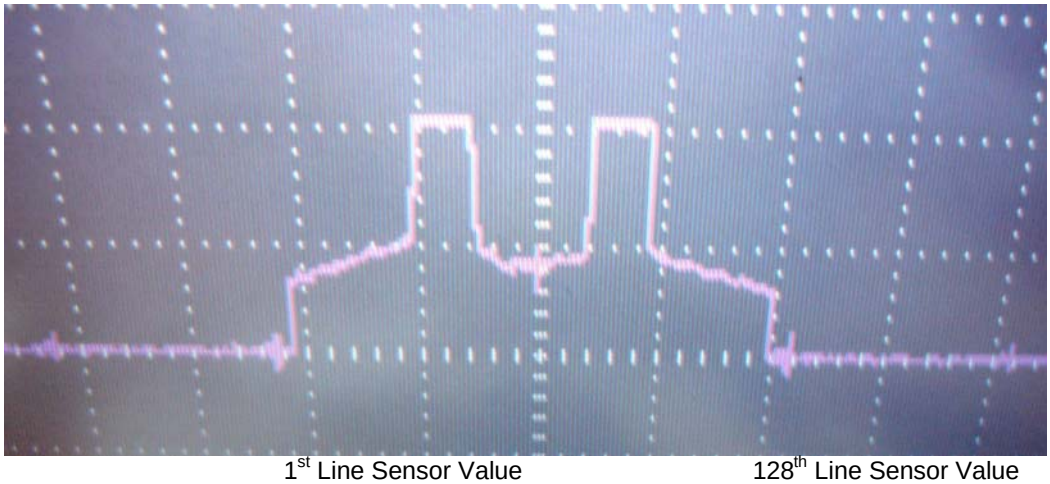
2. The sensor output voltage

The sensor output voltage with the amplifier when the sensor center is aligned to the middle of the (25mm) black line which is used to track is shown below:



1st Line Sensor Value 128th Line Sensor Value

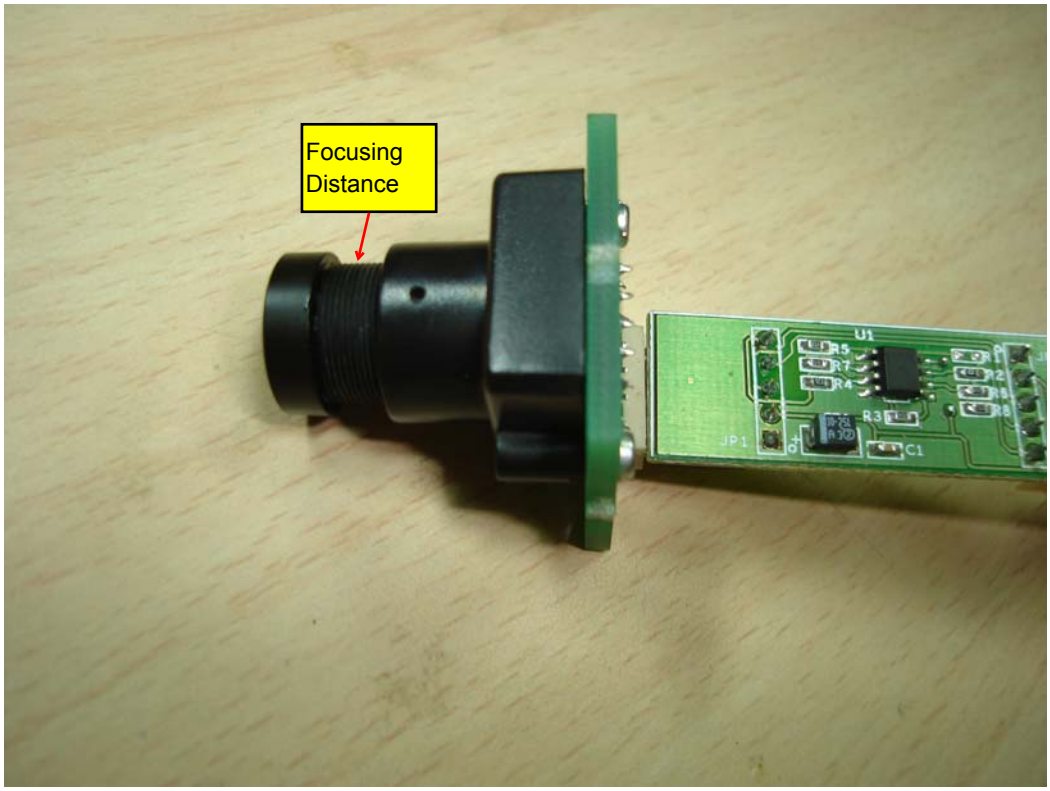
The sensor output voltage with the amplifier when the sensor center is aligned to middle of the stop line of the racing track is shown below:



1st Line Sensor Value 128th Line Sensor Value

3. Camera lens focusing

The camera lens has to be focused to get better sensor output value; the following figure shows the camera lens position for above sensor output voltages.



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