

# The 2016 NXP Cup Rules

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Used for the following regions:

- Americas
- Malaysia
- Taiwan

**The spirit of the game is that students demonstrate excellent hardware integration and superior programming.**

## Section 1: Team Requirements

1. Teams must be registered in the online system to participate.
2. Three person maximum team size, minimum of two.
3. A team may have only one graduate student (master student) on a team. However, if a graduate student is included on a team, the team must have three students where the other two students are undergraduate (bachelor students).
4. It is recommended that every team have a faculty advisor.
5. Cars will be designed and constructed by students ONLY.
6. Participants, advisors and audience are expected to exhibit good sportsmanship. Any inappropriate behavior or cheating may result in disqualification and ejection from the facility.

## Section 2: Equipment Requirements

Each team shall use the same basic kit of parts as described below. The following requirements are in place to keep the playing field level. If any standard component of the car model is damaged, then a replacement part of the same model should be used.

### Mechanical

1. The original and unaltered equipment must be used as the entry.
  - a. Outer tire treads and rim. Tires must have visible tread on them. Bald tires will need to be replaced.
  - b. Two Drive DC motors. (See The NXP Cup Knowledge Center for detailed description -<https://community.NXP.com/docs/DOC-1284>).
  - c. Transmission Ratio of Drive Motors.
  - d. Servo Motor-Futaba S3010 (See The NXP Cup Knowledge Center for detailed description -<https://community.NXP.com/docs/DOC-1284>).
2. Allowed modifications and restrictions:
  - a. You may not change the wheel base (distance between wheels).
  - b. No part of the car shall exceed dimensions of 250mm/9.85in (W) x 400mm/15.75in (L) x 305mm/12in (H).

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- c. You may drill holes and mount auxiliary pieces on the chassis assuming it is contained within the above dimensions.
- d. You may change the orientation of the servo motor and related linkages.
- e. You may add a "skin" to the car but it must be removed during inspection.
- f. You may adjust or remove springs, linkages, and other non-essential pieces.
- g. You may glue the tire to the rim.

### Electrical

1. Battery (provided by participants)
  - a. 7.2V,  $\leq 3000$ mAh, rechargeable NiCd, NiMH or Li-ION.
  - b. Only one (1) battery pack at a time may be used to power the vehicle and any attached hardware.
2. One Microcontroller Development Board (three options available)
  - a. You can use the default Freedom Development Platform FRDM-KL25Z that comes in your kit.
  - b. You can use any other 32-bit NXP Microcontroller development board.
  - c. You may create your own custom board with a 32-bit NXP MCU (see section 3.3 for documents required).
3. The High Voltage Motor Control and Interface (required to use NXP technology)
  - a. You can use the provided TFC-SHIELD. (See The NXP Cup Knowledge Center for detailed description - <https://community.NXP.com/docs/DOC-1284>).
  - b. Or, you can create your own custom board using any NXP **Motor Driver** Integrated Circuits (see section 3.3 for documents required).
4. The electronics can be modified, with some restrictions:
  - a. A NXP 32-bit Microcontroller must be used.
  - b. One processor - No auxiliary processor or other programmable device is allowed.
  - c. NXP Motor Driver Integrated Circuits must be used.
  - d. The car must use an optical sensor to navigate. Different angled lens may be used.
  - e. DC-DC boost may not exceed battery voltage.
  - f. Total capacity of all capacitors should not exceed 2000 uF.
  - g. No wireless connectivity is allowed during the race. Any wireless connectivity modules/technology **must be removed** from the vehicle before the technical inspection.

## 5. Sensor Limits

- h. You may use additional cameras (See The NXP Cup Knowledge Center for detailed description on allowed cameras - <https://community.NXP.com/docs/DOC-1284>).
- i. Maximum of sixteen (16) sensors
  - a. Examples of sensor count:
    - IR Transmitter/Receiver pair is 1 sensor
    - A CCD sensor is 1 sensor
    - The provided Line Scan Camera is 1 sensor
    - A hall-effect sensor on the two rear wheels is 2 sensors
    - An encoder mounted on one wheel is 1 sensor

## Section 3: Vehicle Inspection

Before the race, the judges will perform a technical inspection of all entries. This includes vehicle specifications, dimensions, and equipment requirements listed in section 3.

1. All cars must be placed in the Inspection area on or before the designated time.
2. Once in the Inspection Area, you may not touch car until you are called to race.
3. If the vehicle is using any custom boards, at this time the following documents are required in print for each custom board:
  - a. Description of the purpose of the board.
  - b. Bill of Materials with part number, manufacturer, quantity and function of each part on the board.
  - c. Schematics.
  - d. An enlarged color photo of the board with components labeled (format A5 min – 1/2 of US Letter size) of each side of the board.
4. Any custom board must be completely visible on the car or must be removable as it might require a separate inspection.
5. The judges might request to check the software used on the vehicle and to reprogram the microcontroller at this time.
6. Failure to provide any one of the items above or in the event of any violations, the organizing committee is entitled to disqualify the corresponding team.

## Section 4: Technical Report

1. Teams are required to submit a technical report which include items like:
  - a. Mechanical design
  - b. Control circuit design
  - c. Electronic design
  - d. Control software design
  - e. Vehicle characteristics/components (e.g. # of sensors)
  - f. Schematics
2. Reports must be written in English
3. Reports must be presented at time of technical inspection
4. Delivery of Technical Report **must be** on a USB drive
5. Failure to submit a Technical Report will result in a 1 second penalty. (+1 second) will be added on to your qualified race time

## Section 5: Timed Race Procedure

1. Race order will be determined by a random drawing.
2. When your team is called you may remove your car from inspection area. You will have two (2) minutes to prepare the car.
  - a. Approved Adjustments - You may:
    - Configure parameters via on-board interfaces. (Switches, Knobs, etc.)
    - Alter the angle of your camera.
    - Change batteries.
  - b. Disallowed Adjustments -You may not:
    - Reprogram your processor.
    - Configure parameters via wired or wireless communications.
3. There shall be only one team member on the track at any given time. (excludes testing times)
4. Before the 2 minute expires you must signal "Ready" to the referee before starting car.
5. After the referee confirms "Ready", the vehicle should leave the starting area within 30 seconds.
6. Teams have THREE attempts to complete ONE lap. The FIRST (not the best) completed time will be recorded.
  - a. Example:
    - Attempt 1 – Vehicle goes to fast around a curve and goes off track. Time is not recorded.
    - Attempt 2– Vehicle makes it around track successfully. Time is recorded.
    - Attempt 3 – Is forfeit because FIRST time (Attempt 2) has

been recorded.

7. After each attempt you have two minutes to make approved (see above) adjustments to vehicle.
8. After the attempts, the team shall return the vehicle to inspection area.
9. Event displays will post the times after each team races.

## Section 6: Race Day Schedule

1. Practice Time - Prior to final race, a test track will be available. Final calibration may be made at this time. This will be organized with team slots and/or "free-time".
2. Reconfigure practice track to final track.
3. Vehicle Inspection (see section 4).
4. Timed Race.
5. Awards Ceremony.

## Section 7: Event Personnel

**Organizing committee**-A committee of senior judges and NXP event organizers. Will coordinate event day activities and mediate and resolve any disputes.

**Referees**-Responsible for on-track activities. This includes race track management such as starting and stopping vehicles, as well as timing and scorekeeping. Comprise up of faculty, student, and/or NXP and industry employees.

**Judge**-Interpret and enforce rule compliance. This will be comprised of NXP employees and members of contributing industry sponsors.

***Event Personnel shall not aid any one specific team. Communication shall be open to all teams and shall not disclose any information that might compromise the fairness of the competition.***

## Section 8: Fouls, Failure and Disqualifications

The rules will be interpreted by NXP and the organizing committee of the event.

**Foul**-minor infraction which results in time penalties.

**Failure**-current attempt time is not recorded. Subsequent attempts are allowed.

**Disqualification**-major infraction which results in all times not being recorded.

1. Referee will determine whether the racing car ran out of the race track and assign time penalties.
2. Any of the following conditions will be considered a **foul** and will result in time penalty added:
  - a. The race car fails to leave the starting area within 30 seconds after beginning of the race [+1 second].
  - b. The race car fails to stop 2 meters/6 feet or leaves the track after

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- crossing the finish line [+1 second].
3. Any of the following conditions will be considered a **failure** and no time will be given:
    - a. Three or more wheels leave the race surface.
    - b. The racing team fails to get prepared for the attempt within the two (2) minutes allotment.
    - c. The player touches the race car after the technical inspection without consent of the referee.
    - d. The race car fails to finish within 120 seconds after leaving the starting area.
    - e. Touching the car at any time between start and finish.
      - "Start" - Once the vehicle crosses the starting line.
      - "Finish" - Once the vehicle crosses the finish line.
  4. Any of the following conditions will be considered a **disqualification**:
    - a. Any off track equipment or behavior that may influence or impede cars.
    - b. Doing a Disallowed Modification anytime after Inspection.
    - c. More than one team member in the playing field.
    - d. Any cheating during the competition.
    - e. Failure to pass the technical inspection.

Equality and fairness will be ensured as much as possible on the condition of actual feasibility. Disputes will be resolved by a vote of NXP, members of the organizing committee, and judges.

### Section 9: Timing/Scoring

1. Time will be captured using an electronic gate and/or handheld timer.
2. Time starts and ends when the first part of the racing car breaks the start/finish line.
3. Fouls will result in the time addition to the car's lap time.
4. Disqualifications and Failures will result in no score.

### Section 10: Parameters of the Racing Track

1. A test track made from the same material as the final track will be made available on the day prior to or before the final race for calibration and design modifications.
2. The actual layout of the final racing track will be unknown to competitors until competition day.
3. Width of the racing track shall not be less than 600mm/23.65in.
4. Material and dimensional specifications can be found on the community.
5. Surface of the racing track is matte white, with a continuous black line (25mm/1in wide) on each edge of the track.
6. The racing track can intersect with a crossing angle of 90°.
7. The racing track can have inclines, declines and tunnels.

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***The rules and conditions are subject to change by NXP if necessary. NXP reserves the right in their sole discretion to cancel, suspend and/or modify The NXP Cup race at any time. These official rules are drawn up in the English language. If these official rules are provided in any other language and there is a conflict in the text, the English language text shall prevail.***

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