The NXP Cup Official Rules

Season 2019/2020

Version 1.3 updated version 27 September 2019

1. Change log

The change log gives you an executive summary of what have changed compared to the NXP CUP 2018/19. Read carefully all the rules throughout:

- Participants are allowed to purchase their own car kit and fit it with NXP-approved electronics. Specific requirements are spelled out in this document.
- Brushless motors are now allowed and so are LiPo batteries but check out the rules before selecting your car kit
- Participants are allowed to create their own car kit (3D-printed, wood laser cut…) and fit it with NXP-approved electronics. Specific requirements are spelled out in this document
- Specifications for the car requirements have been validated and reformatted to align with the new and expanded rules on supply of the kit.
- To make things easier, all limitation on car kit size have been removed. Participants need to make sure their car can handle the race track size (especially turning radius)
- The car or vehicle must have maximum 4 wheels. Tricycles and self-balancing 2-wheel vehicles are allowed into the challenge
- A new optional challenge called the emergency braking has been creating to help students prepare their cars for avoiding the penalty during the timed race for not stopping past the finish line
- Added information concerning the DFRobot vehicles and use of commercial ESC (Electronic Speed Control) on the kits
- Changed the 8-figure challenge from 90 seconds time to 60 seconds time to help accommodate more teams during the events
- Limited LiPo battery specs to 2S 7.4v 5500mhA battery types to help create a plain level challenge between battery types allowed into the competition
- Limited NiCd, NiMH or Li-ION battery specs to 5300mAh maximum rating

The NXP Cup Rules 2019/2020 EMEA Rules

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2. Introduction

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

The NXP Cup EMEA 2019/20 is a brand-new season focused on opening up the rules to allow students to source their car kits where they think best fits their need. Legacy Model-C and Alamak cars are allowed as well as any other car kit as long as the electronic are within the rules. Participants can use the broad range of NXP's technology solutions including MCUs, MPUs and Sensors.

Also, regardless of the board(s) and electronic configuration of the car, car size, motor type, all teams will compete in the same group – there will only be one 2019/20 NXP Cup EMEA Champion team.

3. Conditions of Enrollment

Teams must register online to participate. The registration opens in October and closes on 30 November 2019. Link to registration can be found → here

- Team member count must be 2 (two) or 3 (three)
- Each team member must be a student from a registered school. Enrolled team member can be member of a robotic club or a STEM Association. Students enrolled into the challenge can be in any field of study.
  Students of all grades can team up as they wish as long as the number of students per team is within the rules. Team members can be a mix from middle-school, high school, undergraduate or graduate program or all the same group.
- All registered teams will compete in the same race regardless of the education grades of the students composing the team
- Team members might be from different schools, universities, association or club.
- Validation of the eligibility of the students (middle-school, high school, under-graduate or graduate) will be done through the registration process. Students may be asked to provide proof of student status to access the qualification events.
- It is recommended that each team have a faculty coordinator. If a team chooses not to have one, they must designate a team member as team coordinator for receiving racing notifications.
- It is forbidden for non-student support team to build and program the racing car.

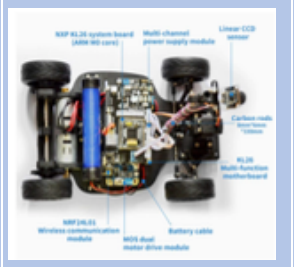
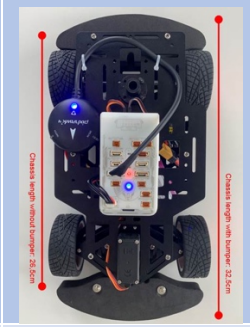
- Enrolled teams agree to share their log book (as described in these rules) on communities.
- Participants, advisers, and audience are expected to exhibit good sportsmanship. Any inappropriate behavior or cheating may result in disqualification.
- Teams are allowed to register more than one race car into the race. If such, each car must have a different team name at the time of registration. Cars must be running on different MCU or MPU board to qualify.

4. Equipment Requirements

Each team shall use a car kit and boards as described below. Some changes are allowed. 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.

Participants can use:

- An existing NXP Cup car kit (DFRobot, Model-C or Alamak)
- Acquire a commercial kit (recommended scale 1/16)
- Build their own kit (example: 3D-Print, wood laser cutting, Lego…)

Item	Alamak Kit	Model C kit	DFRobot Brush	DFRobot Brushless
Photo				
Body Structure	Unibody	Segmented Body	Unibody	Unibody
Size	28,5 x 16 x 7 cm	28,5 x 16 x 8 cm	32.5c m length	32.5 cm length
Motors	7.2v 380 brush (2 units)	7.2v 260 brush (2 units)	Brush (2 units) ESC 160A	Brushless (2 units) 1000 Rpm/V
Stearing gear	15 kg cm	6.5 kg cm		
Tire diameter	65mm	50mm	64mm	64mm
Wheel base	16 cm	16 cm	17.3 cm	17.3cm

For all car kits, the following requirements must be respected:

- The car can be propelled by up to 2 motors, brushed or brushless. When 2 motors are used, they can be on the same axle (one motor for the right wheel, one motor for the left wheel) or each on a separate axle (one motor for the front axle, one motor for the rear axle).
- The car must have maximum 4 wheels. Tricycles or 2-wheels balancing vehicles are allowed into the challenge
- Participants are allowed to use any NXP MCUs or MPUs (such as i.MX) or even the combination of the two. All boards must be NXP brand boards or powered with an NXP brand MCU / MPU. Students may create custom boards in addition to the boards provided in the default kit (for Model-C and Alamak)
- Any board modification (from a purchased board) or creation must follow the same rules as stated below and provide a detailed technical report including Bill of

Material (BOM) into the Log Book. The restrictions for modifications or creation of new electronics are:

- The default camera (for Model-C or Alamak) can be changed. Any camera used must either be equipped with a NXP MCU / MPU or no embedded MCU / MPU at all (direct connection to the MCU/MPU board via SPI). Recommended camera NXP powered camera is Pixy2 camera (https://pixycam.com/pixy2/)
- The MCU(s) and/or MPU(s) on the board must be of NXP brand. More than one processing unit can be used on the car
- The car must use an optical sensor (camera) for primary navigation. Additional sensors can be used to improve the management of the surroundings of the vehicle
- The car must be autonomous and cannot be remote controlled. During the race and the challenges, the car cannot be fitted with any wireless connectivity. Connectivity is allowed only during training sessions to help monitor the vehicle and run diagnostics during the development but must be removed from the vehicle during the official challenges and races
- Participants can add up as many sensors as they want on the car. NXP sensors must be used when such sensors are available into the NXP product line card. Please consult the Mouser NXP Cup microsite and Mouser.com or consult with the NXP Cup Management team in case of questions or doubts. Here are some examples of sensors that can be used:
    - IR Transmitter/Receiver
    - CCD sensor
    - Hall Effect sensor (one per wheel)
    - Encoders
    - 3-axis sensors
    - Optical sensors
    - Ultrasonic sensors
    - Gyroscope sensor
    - Lidar sensor

- If required, participants can add a commercial Electronic Speed Control (ESC) module to help manage motor performance. When an ESC is selected, information and specifications must be added to the Log Book.
- Battery requirements
    - Only 1 (one) battery can be used to power the vehicle and any attached hardware
    - rechargeable NiCd, NiMH or Li-ION with a maximum rating of 5300mAh
    - LiPo (Lithium Polymer) batteries can be used but are limited to 2s models (2 series of cells) 7.4 maximum rating of 5500mAh
    - LiPo batteries are allowed but participants must ensure they travel with LiPo special and authorized packaging. A separate area for battery charging will be created during the NXP Cup events. LiPo batteries can be charged only in the specific and designated areas. Batteries must be moved to the garage and race floor only in the approved safety packaging. Careful: special regulations are in effect for traveling with LiPo batteries. Consider verifying those conditions to be able to attend the racing events before acquiring your kit and batteries (see FAA rules)

There is no size limitation on the car kit however, it is highly recommended to ensure that the chosen car kit can handle the turning radius of the track to respond to the requirements of the challenge. Recommended vehicle scale is 1/16.

The rules apply to all vehicles entered into the challenge regardless of their make or size. No exception will be granted.

The car kit and electronics used to manage the race car are interchangeable. Participants can decide to use a purchased, 3D-printed, Model-C or an Alamak kit with any NXP-approved electronics. For Model-C and Alamak, the original electronic boards supplied with those kits might no longer be available, participants can opt for new NXP-approved boards or use the MikroE/HE-ARC Ingenierie KL-25Z-based board as communicated in the NXP Cup newsletters and listed on the NXP Cup community.

5. Team Log book

Each team is to provide a log book about the specifications of their car. All car kits are to be documented unless they are of the original Model-C or Alamak kits:

- Car make, overall size, motor and battery information
- Board and electronics information (board model with full reference part number)
- Schematics of boards used unless they are NXP's original boards
- Bill of Material
- Specific performance parameters for the choice of the car kit and electronics

The log book must be delivered before the technical inspection time at the event (both a the qualification and final event if applicable) as a PDF File sent via email at email address (matthias.wilkens@nxp.com). A printed copy is acceptable in addition to the email. Students might be called during the technical inspection to show their Log Book and answer questions from the NXP Cup organizing team.

6. Vehicle Inspection

Optional Extra Disciplines

Before the challenges the judges will validate that the cars are in compliance with the rules. This includes vehicle specifications and equipment requirements listed in this document.

Note: different sets of electronics and sensors can be installed on the car for each Extra Discipline. For example, a LIDAR sensor can be installed for the obstacle avoidance and removed for the speed race. However, team members must comply with the time constraints during the event to avoid creating delays on the racing and challenge schedule.

Log book must be readily available (see Paragraph Team Log Book) before the technical inspection.

Timed Race

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

All cars must be placed in the Inspection area on or before the designated time prior of the timed race.

Log books must be provided (see Paragraph Team Log Book) before the technical inspections.

Once in the Inspection Area, you may not touch car until you are called to race. The car can only be removed from the Inspection Area upon approval from the race management. No repairs or modifications can be made on the Inspection Area.

The judges might request to check the software used on the vehicle and to reprogram the MCU or MPU at this time.

In the event of any violations, the organizing committee is entitled to disqualify the corresponding team.

7. Event procedure

There is one main race (timed race) and 4 additional Optional Extra Disciplines to earn extra points. During the qualification and finals events, participating teams collect points.

Scoring system

Figure 8: 90 seconds total completed laps	Figure 8 points	Emergency Braking	Emergency Braking Points	Obstacle Avoidance	Obstacle Avoidance Points	Speed Control	Speed Control Points	Timed Race Best Lap Time	Timed Race Points
1st	200	Success	150	Success	150	Success	150	1st	650
2nd	150							2nd	550
3rd	125							3rd	450
4th	100							4th	400
5th	75							5th	350
6th	50							6th	300
7th	40							7th	250
8th	30							8th	200
9th	20							9th	150
10th	10	No Success	0	No Success	0	No Success	0	10th	100
11th and above	0							11th and above	0

During the Qualification and Final events, teams can collect points within different disciplines. The main discipline, the “Timed race” will bring the most points and is mandatory. “Figure 8”, “Emergency Braking”, “Obstacle avoidance” and “Speed limit zone” are optional races and give the possible to earn additional points. Here, students have the chance to get to a higher ranking in the overall results.

Example: Team A has the fastest lap time in the “Timed race”, ranks 7th on “Figure 8” and decides not to participate in the remaining disciplines. In total Team A will have **690 points**.

Team B ranks 3rd in the “Timed race”, 1st in “Figure 8” and successfully completed “Obstacle avoidance” and “Speed limit zone”. In total Team B will have **950 points**. They

also perform at the “Emergency Braking” challenge adding an additional 150 points, totaling 1100 points. Team B will be the overall event winner.

If teams score the same total points, the ranking is performed based on the ranking of the “Timed Race” lap time.

Example: if teams A, D and F all have a total scoring of 850 points and the lap times for the final race are:

Team A: 34,5 seconds, Team D: 32,4 seconds and Team F: 40,2 seconds then the ranking is:

- Higher rank: Team D
- Second rank: Team A
- Third rank: Team F

This ranking system applies to any level in the final ranking of teams.

At the qualification events, a select number of teams will advance and qualify for the finals. The count of teams allowed to be selected will be communicated at the beginning of the qualification event. The ranking of the teams follows the scoring rules described above.

At the Finals event, the ranking of the teams follows the scoring rules described above. Only one team will be crowned the NXP Cup 2020 EMEA Champion.

Timed Race Procedure

The timed race is mandatory. The Race start order will be determined by a random drawing. The random order will be published a few minutes before the race. The random drawing might not be a formal part of the agenda.

There will only be one race for all car models regardless of their make. The teams will race on the same race track layout regardless of car model and team members’ composition education grades.

When the team is called, one (1) team member may remove the racecar from inspection area and has two (2) minutes to prepare the car. These following actions are allowed during the preparation time:

- Configure parameters via on-board interfaces. (Switches, Knobs, etc.)
- Alter the angle of the camera

- Change the battery
- Clean the wheels

It is not allowed to connect the racecar to any computer devices to upload, reconfigure or change any part of the programming on the racecar.

Only one (1) team member is allowed on the racetrack area during the race procedure.

After the referee confirms “Ready”, the vehicle should leave the starting area within 30 seconds.

The team has three (3) attempts to complete one (1) lap. The first (not the best) completed time will be recorded. For 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 forfeited because FIRST close loop tine has been recorded (in attempt 2)

After each attempt, the same team member has two (2) minutes to make approved adjustments to vehicle.

Once all the attempts have been done and the team has recorded a time, the team member must return the vehicle to inspection area.

Optional Extra Disciplines

The 4 additional challenges will be rewarded with additional points (see scoring system). All challenges take place on the same track elements as the NXP Cup “Timed race”, meaning, same line thickness and same width of track. These disciplines are not mandatory, however there are better chances to win the overall NXP Cup participating in all challenges (see scoring system).

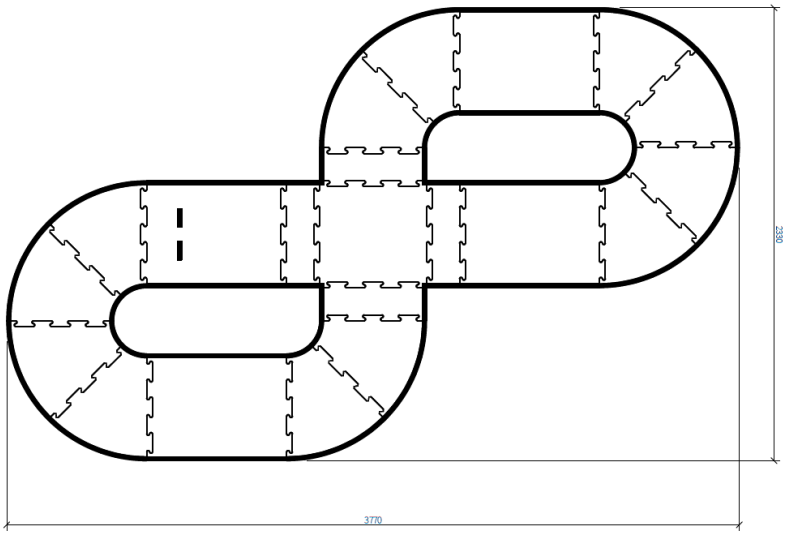
IMPORTANT: The track layouts shown below are examples. Track layouts for the Extra Disciplines may vary depending on space and organizational requirements.

Figure 8

The Figure 8 track will be in a similar shape as an “8”. It will contain curves, straights and an intersection. Participants will have 90 seconds to complete as many laps as possible. Only fully completed rounds will be counted. The Figure 8 is a precision and reliability task. No wheel or part of the wheel is allowed to get out of the track.

Participants have 3 attempts to complete the maximum number of laps in 60 seconds. If a participant fails (car exits the track or part of a wheel exits the track) during the 60 seconds, he can retry up to 3 times. If the attempt is successful (60 seconds without exiting the track or part of a wheel out of the track), the count of laps is the one recorded for the challenge and other attempts are voided.

The team with the most completed laps will earn the most points. Participants have 30 seconds of time to tune the car between each attempt.



Obstacle avoidance

Teams will participate on a small size track (track example: oval with 2 straight track segments in a row and a 180-degree curve).

The car is positioned to start on a straight segment.

First round will be an ordinary round on a regular track.

After completing the first round, the jury will place the obstacle on one of the straight track segment (in any position on the straight segment).

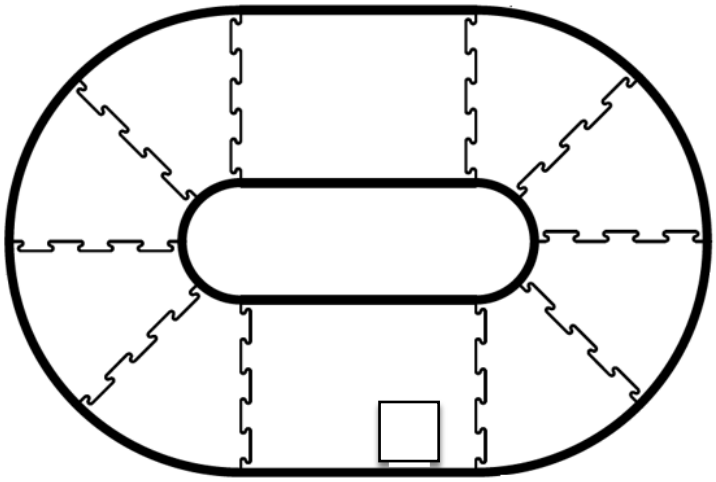
The race car must avoid this obstacle. Neither the tires nor the chassis are allowed to touch the obstacle.

Pace (speed) does not count into the scoring.

No wheel or part of the wheel is allowed to get out of the track.

The maximum time allowed to close the track is 90 seconds. The obstacle will a white cube (made out of Styrofoam or similar) with dimensions of 20x20x20cm. Only 1 attempt is allowed.

The position of the cube might not be as described as on the image below.



Speed limit zone

Teams will participate on a small size track (track example: an oval with 2 straight track segments in a row and a 180-degree curve).

The car is positioned to start right passed the 3-stripes pattern

The car must promptly accelerate

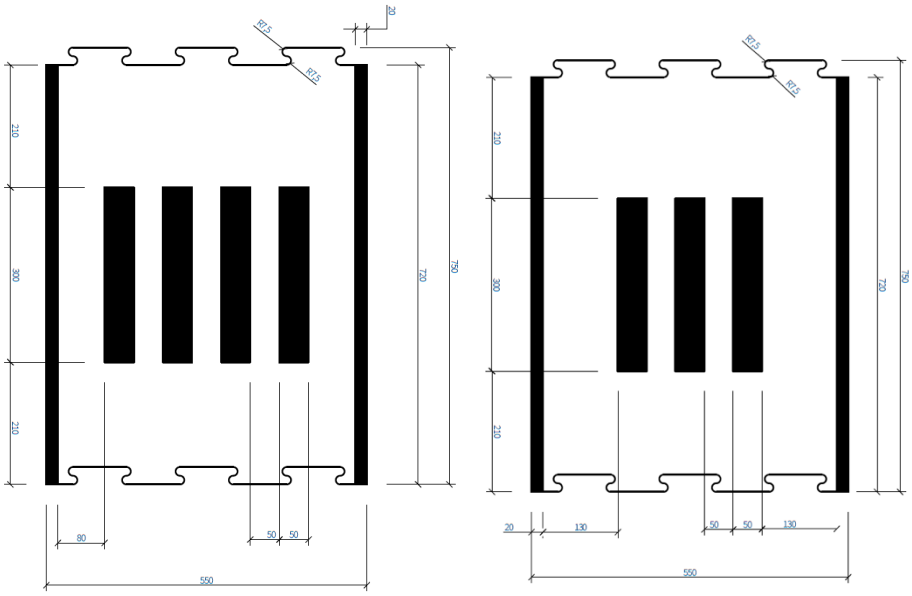
When the car sees the 4 stripes pattern designating the beginning of the speed zone, the car must reduce its speed significantly (about ½ of the initial speed).

When the car sees the 3 stripes pattern designating the end of the speed zone, it must resume its original speed.

Once those steps are done, the task has been completed successfully.

No wheel or part of the wheel is allowed to get out of the track.

Pace (sped) does not count into the scoring. The maximum time spend on the track is 90 seconds. Only 1 attempt is allowed.



Emergency Braking

The emergency braking challenge requires for the car to stop without touching an obstacle when placed across the track.

The car is positioned on a designated part of the track and must gain significant speed

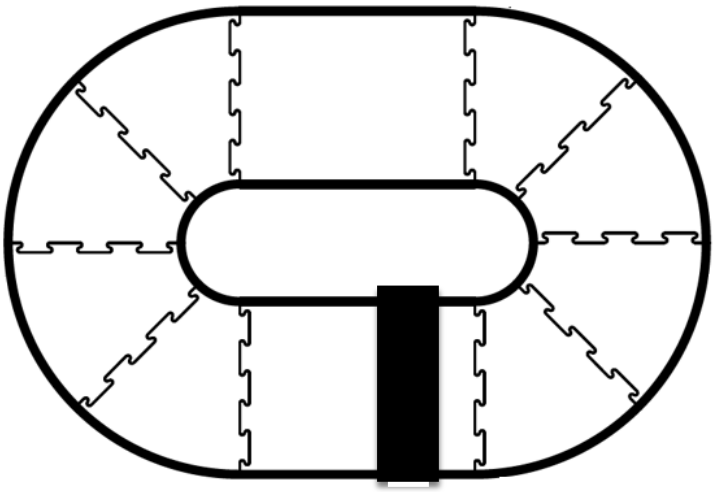
The vehicle must run 2 laps on the track (generally an oval track). The track does not have any markings such as speed zone or start/stop line

As the car continues to run on the track, a staff member places a black obstacle across the track. Obstacle's dimensions are 20 x 20 x 60cm, made out Styrofoam or similar. The obstacle will obstruct (block) the total width of the track

The car must stop before the obstacle without touching it to score the points

If the car touches the obstacle or exits the track, no points are scored

Only 1 (one) attempt for this challenge is given to each team



8. Race Day Schedule

The event usually runs during 1 day for qualification races and 2 days for the EMEA finals.

The typical schedule is:

- Practice Time: prior to the 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”.
- Optional Extra Discipline tracks will be available at designated times during the practice time for teams to score their optional challenge points.
- Teams will not be called to the Optional Extra Disciplines. It is their choice to attend and record extra points.
- The timed race is the last event of the day. At the designated time, all cars must be set for final inspection on the inspection tables. Training time is ended.
    - Reconfigure practice track to final track (layout not disclosed to the participants)
- Vehicle Inspection (see section 4)
- Timed Race
- Communication of the results and qualified teams
- For the EMEA Finals only: Awards Ceremony
- Conclusion of the event

9. Event Personnel

A committee of NXP people (organizers, engineers, HR) will coordinate event day activities and mediate and resolve any disputes.

The NXP organizing team will name some referees. They are 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.

The NXP organizing team will also name some judges to Interpret and enforce rule compliance. This will be comprised of NXP employees and members of contributing industry sponsors.

The Event Personnel shall not aid or give favors to 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.

10. Fouls, Failure and Disqualifications

NXP and the organizing committee of the event will interpret the rules as needed in case of conflict.

Foul is a minor infraction, which results in time penalties.

Failure results in the current attempt lap time not recorded.

Disqualification is a major infraction that no result times will be recorded

During the Timed Race

During the race, referees will determine whether the racing car ran out of the race track and assign time penalties.

Any of the following conditions qualifies as a foul and result in time penalty added:

- The racecar fails to leave the starting area within 30 seconds after beginning of the race [+1 second].
- The race car fails to stop within 2 meters/6 feet of the finish line or leaves the track after crossing the finish line [+1 second]
- The racecar exits the racetrack after crossing the finish line [+1 second]

Any of the following conditions qualifies as a failure and no race time is given:

- Three or more wheels leave the race surface
- The racing team fails to get prepared for the attempt within the two (2) minutes allotment
- The team member handles/touches the racecar after the technical inspection without consent of the referee.
- The race car fails to reach the finish line within 120 seconds after leaving the starting area.
- The team member touches the car at any time between start and finish as "Start" is once part of the racecar crosses or partially crosses the starting line and "Finish" once the vehicle crosses the finish line.

During the Optional Extra Disciplines

During the optional Extra Disciplines, referees will determine whether the racing car ran out of the race track.

Any of the following conditions qualifies as a foul and will count as a void attempt:

- The racecar fails to start within 30 seconds after beginning of the attempt.
- The racecar exits the racetrack
- Any part of any wheel leaves the race surface
- The racing team fails to get prepared for the attempt within the one (1) minute after being cleared to start the challenge
- The racing team exceeds one (1) minute time between two (2) attempts (where applicable)

Any of the following conditions qualifies as a disqualification and all registered scores will be nullified:

- Any of track equipment or behavior that may influence or impede cars
- Failure to allow the sharing of the Team Log Book
- Making modification to the racecar any time after the technical inspection
- More than one team member in the race field (for the timed race)

- Any cheating during the competition
- Failure to pass the technical inspection

Equality and fairness are 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.

11. Timing/Scoring

During the timed race

The timed race lap time is captured using an electronic gate and/or hand-held timer. Time starts and ends when the first part of the racecar passes the start/finish line.
Fouls will result in the addition of the penalty time in addition to the car's lap time.

During the Optional Extra Disciplines

The time is captured using a hand-held timer.

12. The Race Track

Test tracks are laid from track elements that will be used during the final race as test track for calibrations and tests. The actual layout of the tracks for the Optional Extra Disciplines and Timed Race are unknown to the competitors the time of each challenge. The race track specifications are as follow:

- The width of the race track is 55cm.
- Material and dimensional specifications are listed here
- Surface of the race track is matte white with a continuous black line (2cm) on each edge of the track.
- The race track can intersect with a crossing angle of 45° and 90°.

The additional challenges will have separates patterns. Follow this link to learn more about the configuration.

13. Contact Information

The organizing team is composed of the following persons:

Matthias Wilkens: matthias.wilkens@nxp.com

Flavio Stiffan: flavio@stiffan.eu

14. Legal Clause

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.