December 2022

Technical and Sporting Regulations of the VDI Autonomous Driving Challenge

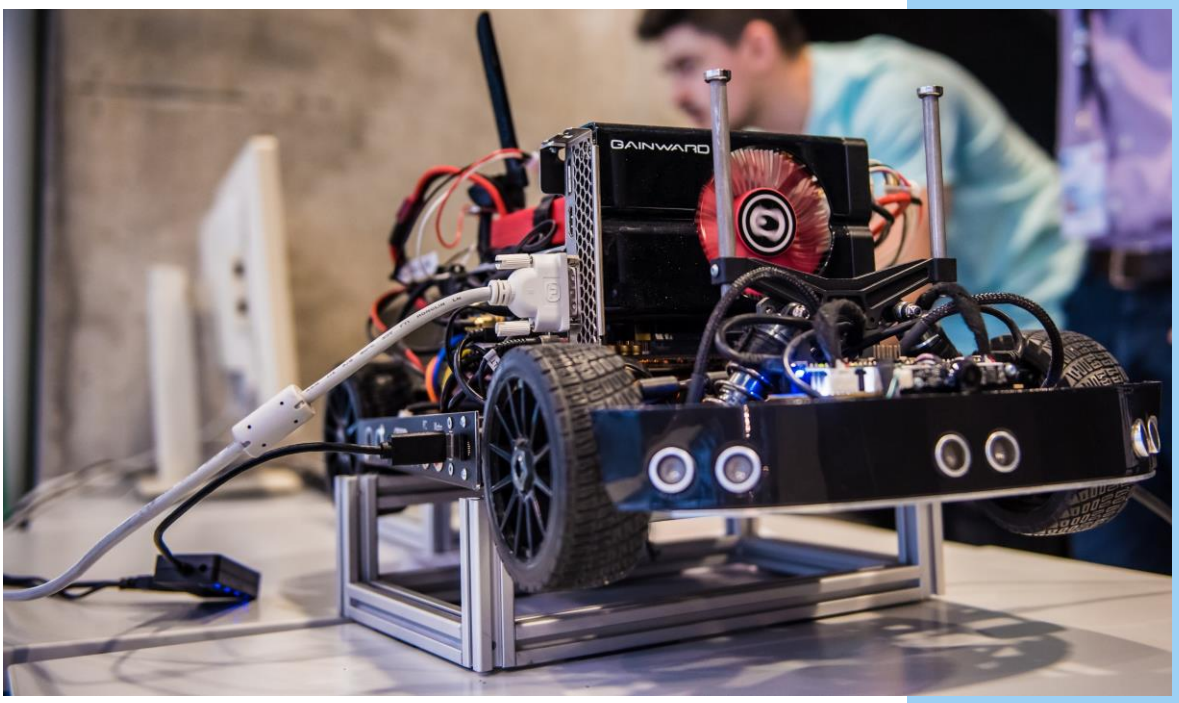

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Table of Contents

1 Changes to previous releases

The following changes are made with respect to version v7 of the VDI-ADC 2022:

- Rework of the award point distribution.
- Revised the definition and consequences of track limit violations.
- Added a mandatory written report for the Static Disciplines.
- The duration of the discipline ‘Time Trial’, ‘Lap Record’ and ‘Pursuit Race’ was shortened.
- Reduced the time duration between clearance of the track for a competition by the Jury and end of a discipline and the time duration between attempts.
- Limited the number of attempts to a maximum of two for all dynamic disciplines.
- Changed details for the Parking Disciplines.
- Added a ‘Connected Drive’ behaviour to the Parking Discipline.
- Added Bluetooth connection as a mandatory part of the competitor’s car.
- Adding details to sensor principle and allowed budget for sensors.
- General clarification and typo fixing.

By the date of publishing this document, previous versions are no longer valid.

Munich, 16 December 2022

Your VDI Autonomous Driving Cup Team

2 General

The aim of the VDI Autonomous Driving Challenge is to give students and young professionals the opportunity to gain experience in the modern field of autonomous driving and to prepare for future challenges together with like-minded participants in this competition.

To combine the ideas, demands and emotions of everyday driving and motorsport a set of disciplines and characteristics has been defined to form the Competition. The combination of disciplines derived from everyday driving on one side and from motorsport genes on the other is providing an interesting and highly self-motivating base for any kind of technical and engineering competition. The VDI Bezirksverein München, Ober- und Niederbayern is the owner of the rights for this regulation.

Any points not expressly permitted in these regulations are prohibited unless the owner of the regulations has certified them.

2.1 Competition

The competition takes place on a circuit that has a lot of similarities to a real-world racetrack. The vehicles on a scale of 1:8 must not differ in their essential aspects (shape, geometry, height, etc.) from their derived originals. To adopt to possible different focus of competitors two classes inside the Competition are defined (see section 2.3).

The Competition itself is divided into so called static and dynamic disciplines. The static disciplines cover the judging of engineering concepts and processes while the dynamic disciplines covering all driving activities. Some of the dynamic disciplines are derived from real-world applications of autonomous driving cars while others have their origin in motorsport. This two folded approach allows to consider a lot of different aspects of autonomous driving cars and also address the spirit and emotions of sport and competition. The area of real-world driving discipline covers, but is not limited to parking and so-called connected drive scenarios. The motorsport disciplines are focused on gaining consistent short lap-times and ideal trajectories.

Both competition areas are continuously developed to give room to new ideas and requirements. These developments will always be communicated via the latest version of these regulations.

2.2 Competitors

Eligible competitors are belonging to one of below described types. A competitor cannot use more than one vehicle. Each competitor can present one spare vehicle (T-car) for its team. In this case both cars have to be technically identical.

In any case the team members of a competitor have to be declared by name at the point of registering for an event. Further rules concerning team clothing etc. may apply based on the organizer demand. If so, they are published together with the registration form.

If the number of interested competitors exceed the provisional maximum number of allowed competitors the organizer reserves the right to adopt this regulation to allow all interested competitors to participate. In this case already registered competitors are informed before adopting the regulations.

Throughout this document the terms ‘competitor’ and ‘team’ are used interchangeably if not otherwise stated.

2.2.1 Regular Competitors

A competitor of this kind is built upon a team of 2-6 persons. All of them are students with the exception of one of them. This team member can be a young professional and has left university no longer than 2 years before the date of the competition event.

Several competitors, coming from the same educational institution, are possible.

2.2.2 Special Group Competitors

A competitor of this kind is built upon a team of up to 6 persons. There is no restriction on the kind of profession and education for the team members. This open definition should be an invitation to anybody who is interested in and enthusiastic about this competition. To preserve the main spirit of the VDI Autonomous Driving Challenge the competitors of this group have the right to take part at each discipline and to collect points. However, for the overall ranking the competitors of these group are excluded.

2.3 Competition Classes

The competition is divided into two classes. Both classes include identical competition disciplines and are built on electric powered 1:8 scale model cars. However, they distinguish in the degree of freedom allowed concerning their hardware specifications. The classes are named VDI Cup and VDI Super Cup.

When registering for a competition, the appropriate class must be chosen by the competitors.

2.3.1 VDI Cup

The VDI Cup car specification is simplified to allow a low threshold entry into the competition. Ready to run kits are available from MdynamiX that include a basic application and access to tutorials and how-to’s to allow a rapid development.

2.3.2 VDI Super Cup

The VDI Super Cup gives more degrees of freedom concerning the hardware specification of the car. Generally spoken almost all kinds of components are allowed to be used. However, to prevent undesired high expenses the Super Cup cars need to be certified or homologated by the owner of the VDI Autonomous Driving Challenge regulation.

Therefore, it is strongly recommended to get in touch with the VDI long beforedeveloping a car for this class.

Just as for the VDI Cup, MdynamiX offers a high-performance kit for the VDI Super Cup. This kit offers a high potential for any kind of control strategy and is already homologated.

2.4 Events

Competition events are organized several times a year. The corresponding calendar, including deadlines for registration is published on the website http://www.vdi-adc.de.
Before a Competition, there may be a pre-meeting online or onsite. The aim of this pre-meeting is to present the track at the venue that is similar or equal to the competition track and has its equitant to a shake-down session in real world motorsport. The actual format of the pre-meeting is decided by the organizer and has to be published with the announcement of an event.
The actual event is scheduled for one day.

2.5 Participation Fee and Deposit

For the registration, a deposit of 100€ with the team's name must be transferred to a bank account defined by the organizer. The deposit will be refunded upon participation in the competition.

3 Disciplines

3.1 General

Each team has to declare by name one of its members to be the team representative. This team member will be the contact person for the Jury for all disciplines. The person who is acting as team representative may change only from the Static to the Dynamic Disciplines.

The time table and order of the disciplines is announced in the team briefing on the day of the Competition. There may be a preannouncement in the event invitation. If a team cannot compete in one of the disciplines, it will not receive any points for it. If a team fails to perform well in a discipline, the Jury has the possibility to reduce the score of the achieved points to a minimum of one point. To attend the Static Disciplines it is mandatory to follow the Competition.
Each Discipline is rated separately. The distribution of points is given in the description of the different disciplines.
The Jury has the exclusive right to set the number of awarded points. On request by a team representative the Jury will explain its decisions. However, the decisions of the Jury cannot be questioned.

3.2 Ranking

The final ranking is based on the number of points that have been assigned to the competitors during an event. In case of equal points, the ranking is finalized upon the following rules that are applied in the given order:

1. The number of points in the dynamic disciplines get a higher rating
2. The fastest accepted lap time in any of the dynamic disciplines gets a higher rating
3. The fastest time for the acceleration discipline gets a higher rating
4. The number of points in the Software Concept in the static discipline gets a higher rating

If these rules do not identify a final ranking the same rank for different competitors is assigned.

3.3 Prize money

The organizer is obliged to offer attractive prices for the competitors. The prizes should reflect the spirit of the competition and ideally support the teams in their developing effort. The actual prizes are published right after the end of the registration deadline.

3.4 Static disciplines

3.4.1 Procedure

The teams present to the Jury their vehicle concepts. The model car that is meant to be used in the competition has to be brought along. The Jury evaluates the concept with regard to sections below. The duration of the team's presentation should take approximately 10 minutes. All team members have to be present. The presentation is followed by questions asked by the Jury. The Jury is allowed to ask the team to dismantle the car. The type of media, used for the presentation, is free to the teams. It's recommended to clarify required media installation with the organizer beforehand.

The content of section 3.4.2 to 3.4.4 has to be documented by a written report. This written report has to be handed over as a digital copy to the Jury at the start of the event (time set by the time table published by the event organizer). The only accepted file format is pdf. The written report is limited to 30 pages in DIN A4 or letter format.

3.4.2 Software Concept

All relevant codes and algorithms should be presented in a comprehensible way. The idea as well as the implementation and application will be evaluated. If applicable, differences between the dynamic disciplines need to be pointed out. The Jury can award a maximum of 50 points for each competitor.

3.4.3 Hardware Concept

The selection and interaction of the different components must be shown and explained in relation to the use in the dynamic disciplines. The Jury can award a maximum of 50

points for each competitor in the VDI Super Cup class and 30 points in the VDI Cup Class.

3.4.4 Design

The installation of the components and the external appearance is evaluated regarding installation and quality of functionality as well as optical appearance. The Jury can award a maximum of 50 points for each competitor.

3.5 Dynamic Disciplines

3.5.1 Preconditions

Aspects that are violating the spirit or content of the technical regulations must be removed immediately after being identified. In this case the Jury will inform the team representative accordingly. If parts of the Competition already has been completed the Jury reserves the right to raise a penalty, by reducing the number of awarded points, because of it. The Jury reserves the right to exclude model cars and teams from the ongoing Competition if the identified items are violating the regulations in an unacceptable way.

If not otherwise noted the performing car setup and software has to be unchanged during different attempts of each Dynamic Discipline. The use of the T-car has to be granted by the Jury.

The actual discipline may be pre-set in the vehicles control unit.

The movement of the model car is initiated in each discipline either manually or by a remote signal. In both cases it is initiated by the team representative upon the Jury's request. This request defines the start of the discipline.

For the disciplines where timing results are relevant an automatic stop-watch system is used.

The Jury keeps the right to declare the discipline for the currently performing car to be finished at any time.

The pit-lane, parking spot locations, pit-stop area, acceleration race strip, circuit and connecting lanes scenario is described in chapter 4.

All disciplines have to be performed by the model car autonomously. Nevertheless, the wireless emergency stop mechanism has to be active all the time and operated by the team that is running the corresponding car. A team representative is in power to command an emergency stop. The Jury reserves the right to ask the corresponding team representative to activate the emergency stop at any time during a Dynamic Discipline. A functional check of the emergency stop mechanism is performed at the beginning of the Dynamic Disciplines and upon request by the Jury at any time during the event.

3.5.2 Assigning Points

If not otherwise stated the points assignment is defined as follows: the first place in a discipline is awarded the max. number of points defined. For the other competitors eligible for scoring points the following rule applies.

$$P_R = P_{max} \cdot \left[1 - \left(\frac{R-1}{N+1}\right)\right]$$

P_R: $Points\ for\ the\ Rank$

P_{max}: $maximum\ reachable\ points$

R: $Rank$

N: $number\ of\ qualified\ teams$

This formula basically assigns points equally distributed and weighted depending on the classification. Please note that for some dynamic disciplines the points are assigned differently.

3.5.3 Parking Competitions

The parking competitions are divided in parallel and cross parking. Each of it is subdivided in inbound and outbound manoeuvre.

These two manoeuvres are executed right after each other. In case the inbound manoeuvres fail the team can request the Jury to place the car manually in the appropriate position for the outbound manoeuvre. At the end of each outbound manoeuvre the car has to be stopped either by itself or by the emergency stop mechanism. If the emergency stop is not working the assigned points for the outbound manoeuvre are divided by two.

The distinguishing between parallel and cross parking is made by the corresponding sign. It's placed in the pit entry zone right after the dashed lane markers that identify the area where the entry driving line is allowed. From the pit lane view point and its driving direction this sign is placed on the opposite site with respect to the circuit.

3.5.3.1 Pit lane entrance and parallel parking inbound

The goal of this discipline for the competition car is to autonomously enter the pit-lane, coming from the circuit, and position itself in one of the available parallel parking spots.

- The Jury places the performing vehicle on the circuit at least 2 m meters ahead of the sign 'PIT IN' (see section 4.5.1) and requests the team to start.
- A maximum duration of 40 sec, beginning from the Jury's start request, for this discipline is allowed.
- As soon as the vehicle has reached its final position, the manoeuvre is declared to be finished. The position is understood to be final if the car in the pit-lane has not moved for 10sec, a team representative is declaring it or the maximum time for this discipline is exceeded.

- Each team has up to two runs. The circuit and pit-lane setup is not changed inbetween.
- The Jury awards up to 20 points for each competitor based on the trajectory, required time and final position of the car. The jury evaluates on the basis of the realism of the vehicle movement.

3.5.3.2 Parallel parking outbound and pit lane exit

The goal of this discipline is to leave a parallel parking spot, followed by leaving the pit-lane autonomously. Possible surrounding traffic has to be considered to strictly avoid accidents.

- A maximum duration of 40sec, beginning from the Jury's start request, for this discipline is allowed.
- After leaving the park position, the vehicle must enter the circuit via the pit lane exit.
- While the pit-lane exit is covered by a traffic light system that has to be respected the pit-lane itself is not. The traffic light shows green and red depending on whether the circuit entry is permitted or not. During the competition the traffic light system of MdynamiX will be used.
- The traffic light will be set to red until the vehicle approaches. A Bluetooth command will be issued by the traffic light 5 sec before the traffic light switches to yellow and green. The vehicle is allowed to start moving upon that Bluetooth command or upon the traffic light switch to green.
- After driving onto the circuit, the vehicle must be stopped? either by itself or by the team representative upon request of the Jury. The stop command has to be issued by the emergency stop by one of the team members.
- If necessary, the performing vehicle can come to standstill during the manoeuvres.
- As soon as the vehicle has entered the circuit the discipline is closed.
  Alternatively, the discipline is closed if the team representative is declaring its finish or the maximum time for this discipline is exceeded.
- Each team has up to two attempts. The circuit and pit-lane setup are not changed inbetween.
- The Jury awards up to 20 points for each competitor based on the trajectory, required time and stop request for the car. The jury evaluates on the basis of the realism of the vehicle movement.
  Additional 10 points are granted if the vehicle reacts on the Bluetooth command of the traffic light within 2 sec.

3.5.3.3 *Pit lane entrance and cross parking inbound*

The goal of this discipline is to autonomously enter the pit-lane, coming from the circuit, and position itself in one of the available cross parking spots.

The procedure is similar to the parallel inbound parking (see 3.5.3.1) besides(or apart from) the parking spot being aligned orthogonal to the pit-lane driving directions.

The Jury awards up to 20 points for each competitor based on the trajectory, required time and final position of the car. The jury evaluates on the basis of the realism of the vehicle movement.

3.5.3.4 *Cross parking outbound and pit lane exit*

The goal of this discipline for the competition car is to leave a cross parking spot followed by leaving the pit-lane autonomously.

The procedure is similar to the parallel outbound parking (see 3.5.3.2) besides (or Apart from) the parking spot being aligned orthogonal to the pit-lane driving directions.

The Jury awards up to 20 points for each competitor based on the trajectory, required time and final position of the car. The jury evaluates on the basis of the realism of the vehicle movement.

Additional 10 points are granted if the vehicle reacts on the Bluetooth command of the traffic light within 2 sec.

3.5.4 Acceleration Race

The goal of this discipline is to drive on a straight line from a standstill position as fast as possible. The acceleration race is carried out on the longest straight of the course. The organizer of the event defines an appropriate length of minimum seven meters. Each competition vehicle has to stay inside the track limits. For the run-off area, the lane markings may be crossed.

- The Jury places the performing vehicle at the start position of the acceleration race discipline and requests the start.
- Each team has up to two attempts. Between the Jury's start request and the first attempt a maximum of 10 sec delay is allowed. Between the attempts a maximum of 60 sec is allowed. Within this time the starting point of the acceleration strip must be passed for the second attempt.. While the beginning of the 60 seconds can be one of the following:
  - passing the end of the acceleration strip of the first attempt
  - leaving the track limits during the first attempt
  - team representative declares the end of the first attempt.
- Either the vehicle is able to stop or the wireless emergency stop mechanism has to be activated after crossing the finish line.

- The fastest drive through is awarded with 20 points. Further point assignments are given as described in 3.5.2.

3.5.5 Time Trial

The goal of this discipline is to gather as many laps on the main circuit as possible within three minutes. During this discipline only repair work on the model car is allowed that has to be permitted by the Jury.

- The Jury places the performing vehicle right behind the start-finish line in driving directions or in the longitudinal middle of the pit-lane depending on the teams decision and requests the team representative to start.
- The team can decide between the two start positions. For a start out of the pit lane the team will achieve 5 additional points regardless of their actual Rank in this discipline.
- The three minutes duration is started either when the model car is crossing the start/finish line, the vehicle starts to move inside the pit-lane or 20sec after the Jury requested the start. The start is determined by what happens first.
- The discipline lasts for the three minutes plus the time to complete the lap that was started before the end of the three minutes.
- In case two or more competitors complete the same number of laps the one, which completes its laps in shorter total time, is placed first.
- A lap is considered to be correctly driven if the model car is following the track and not leaving the track with more than two wheels of one side of the vehicle at the same time.
- If the model car is leaving the track with more than two wheels the Jury will set a penalty time for the lap during which the failure occurred. The penalty time will be added to the actual achieved lap-time.
- If the model car leaves the track it has to be placed back on the track by the team members or staff working for and authorized by the event organizer at about the position it has left the circuit. In case of doubt, the Jury owns the right to define the position. The Jury also reserves the right to add a penalty time if this rule is violated. The time is not stopped during such an event.
  If the number and kind of track limit violations increase above a reasonable threshold the Jury reserves the right to declare the current attempt invalid. Such a declaration will lead to setting back the number of gained points as far as to 0.
- Each team has two attempts. The one with the highest number of valid laps is the attempt that is considered for the point allocation. In case of two attempts leading to the same number of laps the one with the shorter total time is chosen.
- The team members and staff that is authorized to reposition a model car have to stay in marked areas. The organizer defines the areas by judging potential critical parts of the track and guaranteeing that the marked areas are safe for the people working inside.

- Several categories are awarded within this discipline:
  - Highest number of completed laps:
    - The ranking to award points in this discipline spans from the most successful car to the ones that complete at least 30% of the highest number of laps completed.
      For the calculation of the minimum number of laps needed the fractional part is ignored.
    - The competitor with the most completed laps gains 30 points. Further points are given as described in 3.5.2.
  - Fastest lap-time:
    - 10 points are awarded to the competitor, regardless of his overall result in this discipline, that scores the fastest lap-time.
  - Consistent lap-times:
    - The competitor that with the smallest deviation between his lap-times gets 10 points.

3.5.6 Lap Record

The goal of this discipline is to complete a full lap, within a five minutes period, as fast as possible.

- During the discipline changes to software and hardware may be made. For this setup changes the car needs to stop autonomously or brought by team members to an area that has been specified by the organizer.
- The five minutes duration is started either when the model car is crossing the start/finish line or 60sec after the Jury requested the start. The start is determined by what happens first.
- The definitions for a correctly driven lap and possible manual repositioning are identical to those of the discipline 'Time Trail' described in 3.5.5.
- A restart is allowed any time during the five minutes duration from the position that has been chosen by the team for the initial start.
- Every lap that started within the time limit of five minutes is considered.
- The team whose model car has driven the fastest lap time receives 30 points. Further point assignments are given as described in 3.5.2.

3.5.7 Pursuit Race

The goal of this discipline is to conduct a pursuit race with overtaking manoeuvres and distance driving. The discipline lasts seven minutes plus finishing the current driven lap of each vehicle.

- Two model cars from two different teams compete against each other. The selection of the two competing cars is done by a lottery and executed by the Jury.

- In case of an odd number of competing cars in the event the remaining car is competing in the last round. It will compete against the one that has gained the most points in this discipline so far. Only the remaining car can gain points in this run.
- The Jury positions one car right after the start finish line, while the other is placed as precisely as possible at the middle of the circuit. The discipline starts after the Jury requests the start.
- Right after the start request of the Jury, the model cars try to catch up to one another.
- If one car can catches the other it may initiate an overtaking manoeuvre. Overtaking is only allowed on straights between the signs 'overtaking zone start' and 'overtaking zone end'. The signs are described in section 4.5.
- It is permitted that during the overtaking manoeuvre the overtaking car can leave the track limits with all four wheels in the overtaking zone.
- The definitions for a correctly driven lap and possible manual repositioning are identical to those of the discipline 'Time Trail' described in 3.5.5. If a car needs to be repositioned manually and its opponent is passing that track position it is released right after. Such a position change is not considered as overtake manoeuvre but as 'Position Change'.
- Several categories are awarded within this discipline:
    - Highest number of completed laps:
        - The car that completes more laps compared to his opponent is awarded 10 points
    - Close distance driving:
        - If the trailing model car manages to pass the start-finish line within 1 sec after the leading one at the final start-finish line crossing the trailing one is awarded 30 points.
    - Overtaking Manoeuvre:
        - For each successful overtaking manoeuvre, the performing model car is awarded 60 points.
    - Position Change:
        - For each position change, the 'overtaking' model car is awarded 10 points.

4 Track specifications

4.1 Driving lane

The track consists of one lane, which is kept in dark colour (if possible black). Since the organizer must be able to set up and dismantle the track system, he can use suitable floor mats as basic elements. For the VDI Autonomous Driving Challenge MdynamiX provides certified track elements and lane markings. MdynamiX ensures that these items can also be purchased at any time through MdynamiX.

The track dimensions and the example of a circuit is given in section 4.3.

The smallest inner radius is 500 mm, the largest outer radius is 4000 mm. The values refer to the lane markings.

For a detailed geometric definition of the track see sections 4.2, 4.3 and 4.4.

4.2 Lane Markings

The track limit marking and all other types of lane marking is defined as a white stripe of 50 mm width. The start-finish line is marked with two white stripes of 50 mm width that are placed orthogonal to the track limit markings. The pit entry and pit exit sections have dashed lane markings as shown in Figure 2. Dashed lines are defined by a 100 mm line-gap-line pattern and a line width of 50 mm.

4.3 Track Layout

The racetrack is composed of two main segments. The pit lane area and the circuit. While the pit lane area is more precisely defined (see section 4.4), the layout of the main circuit is designed by the organizer within the given limits described in the sections 4.1 and 4.2. The main circuit has a drive line between 50 m to 100 m distance. The track width remains at 750 mm (inner to inner distance of the lane markings) constantly throughout the circuit and is composed by one lane only.

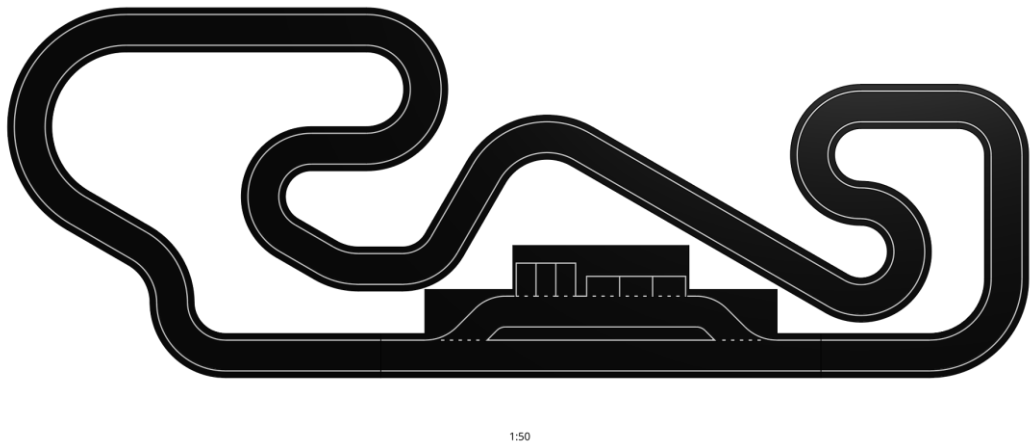

Figure 1: Example racetrack containing all relevant elements (not to scale)

4.4 Pit Stop Area

The entrance to the pit stop area is positioned at the right- or left-hand in relation to the driving direction of the track. The pit lane entrance is preceded by a minimum of a straight of 2 metres. The same principle is applied for the pit stop exit. A detailed geometric definition of the pit stop entrance is given in Figure 2. All lane markings in the pit stop area have a width of 50 mm. The driving line for leaving the circuit and entering the pit lane is limited by the dashed line marking. The pit lane exit is a mirrored copy of the entrance. The 650 mm width for the inbound and outbound chicane refers to the inner-to-inner distance between the lane markings. In the pit lane the standard track width of 750 mm is used.

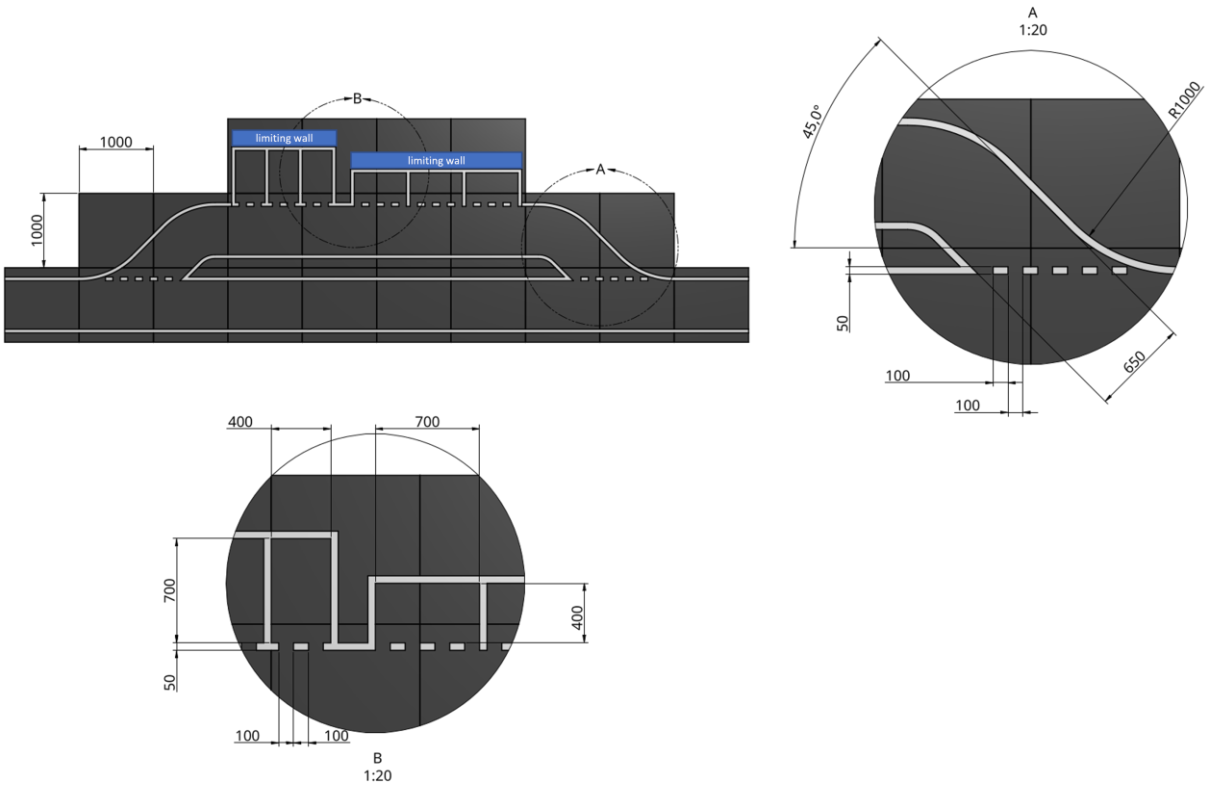

Figure 2: pit lane entrance

Several parking spots are positioned alongside the pit lane. The parallel parking spots are placed first. There are three or more parking spots for both parallel and cross parking. In both cases obstacles like other model cars or plain boxes will be positioned on different parking spots to represent occupied parking spots. At least one parking spot remains free for each type of parking. The parking area is limited by a dashed line that can be crossed. At the rear or side end of the parking spots there is a dark (if possible black) obstacle positioned with a height of at least 300 mm (referred as limiting wall). Other measures are given in Figure 2.

4.5 Signs

The following section contains signs mentioned in section 3.5. All images of signs are not to scale. The content, coloring and graphical elements can be used for reference. A set of certified signs can be ordered from MdynamiX. The dimensions of the signs are 300 mm by 200 mm. They are mounted on a base at a height of 10 - 50 mm. The lower part at about 40% of the height is separated by a line. During a VDI Autonomous Driving Challenge this lower area might be used to place sponsor information.

4.5.1 Pit In sign

The sign *PIT IN* (Figure 3) can be placed manually by the team, when the team desires that the car enters the pit lane for one of the Dynamic Disciplines. The sign has to be positioned no later than 100 mm before the actual pit lane entry.

Figure 3: Enter Pit Lane sign (image not to scale)

4.5.2 Pit Out

The sign PIT OUT (Figure 4) is placed by the Jury in the pit lane and gives the direction a model car has to exit the pit lane.

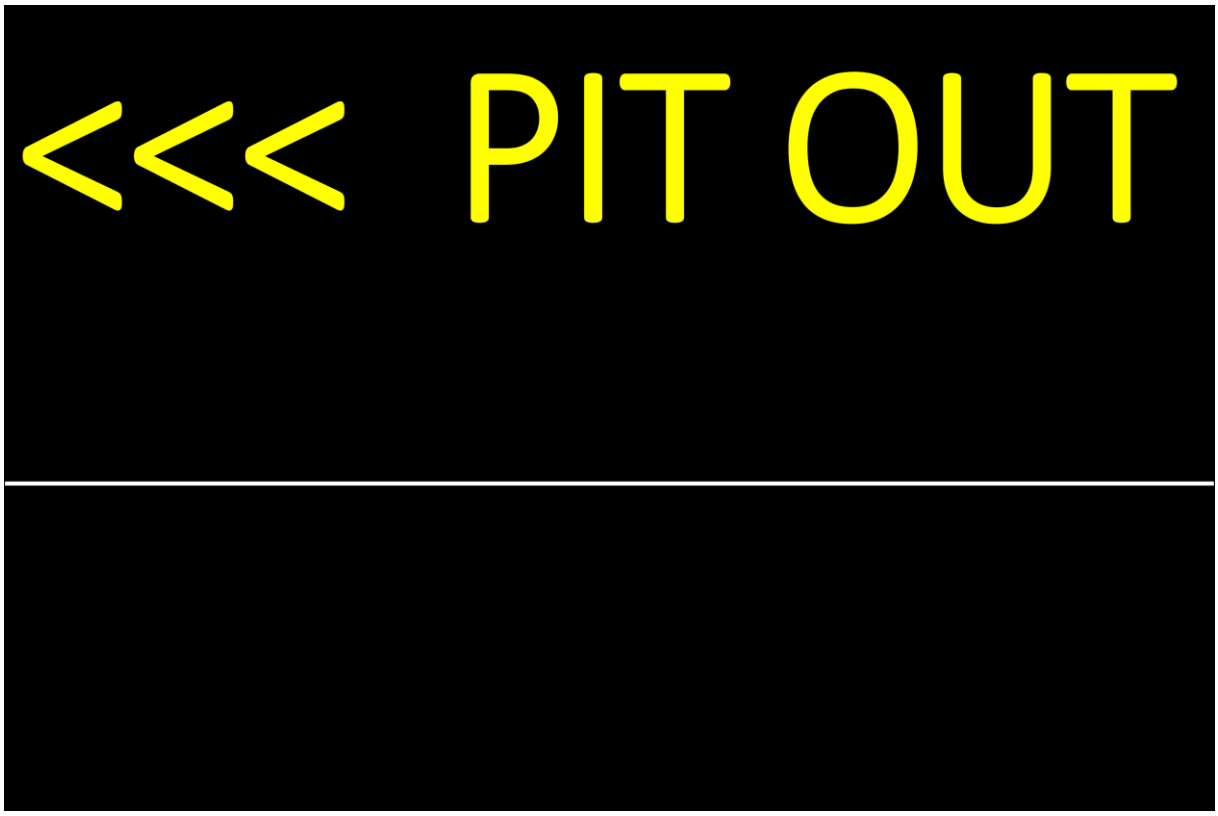

Figure 4: Enter Pit Lane sign (image not to scale)

4.5.3 Cross Parking Only

The sign Cross Parking Only (Figure 5) is placed by the Jury in the pit lane and gives the information to the model car that currently the dynamic discipline cross parking (section) is requested.

Figure 5: Cross Parking Only sign (image not to scale)

4.5.4 Parallel Parking Only

The sign Parallel Parking Only (Figure 6) is placed by the Jury in the pit lane and gives the information to the model car that currently the dynamic discipline cross parking (section 3.5.3) is requested.

Figure 6: Parallel Parking Only sign (image not to scale)

4.5.5 Overtaking Prohibited

The sign Overtaking Prohibited (Figure 7) is placed by the Jury on the track and gives the information to the model car that till further notice overtaking is prohibited (section 3.5.7).

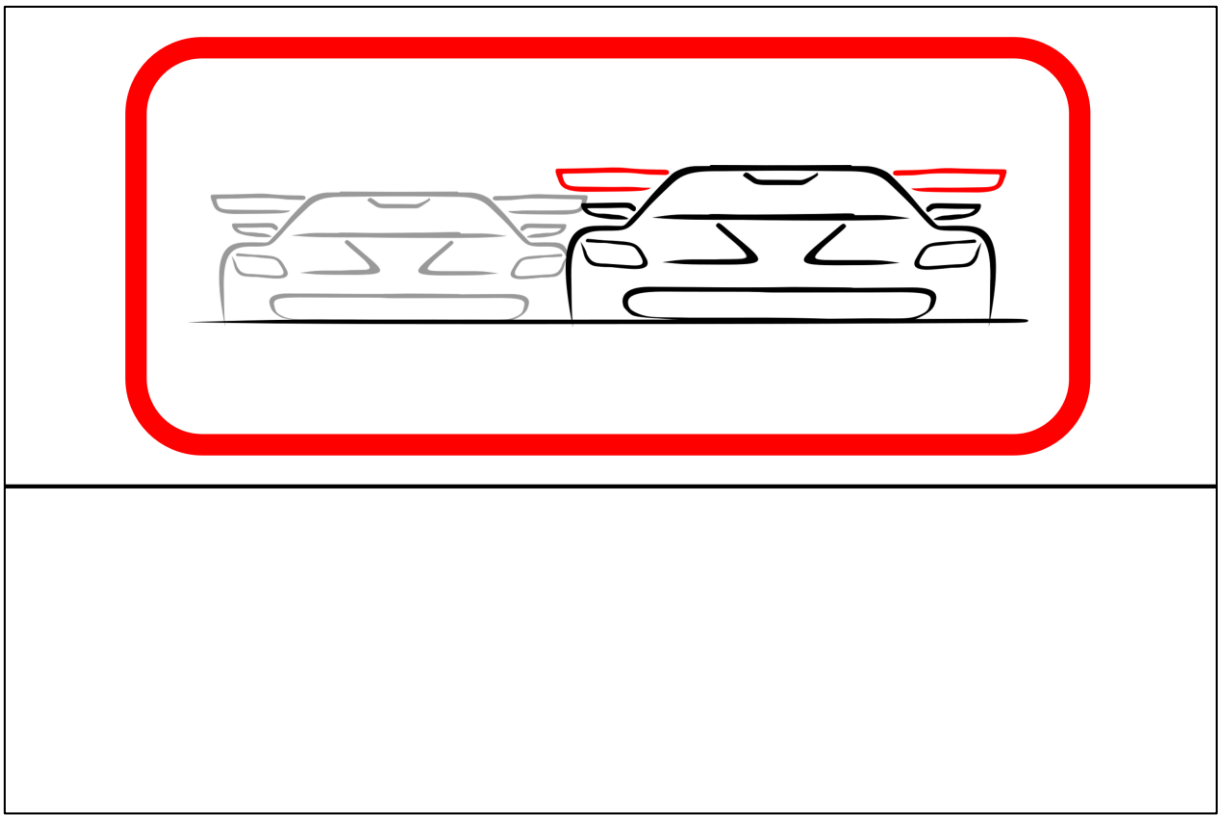

Figure 7: Overtaking Prohibited sign (image not to scale)

4.5.6 Overtaking Permitted

The sign Overtaking Prohibited (Figure 8Figure 7) is placed by the Jury on the track and gives the information to the model car that till further notice overtaking is permitted (section 3.5.7).

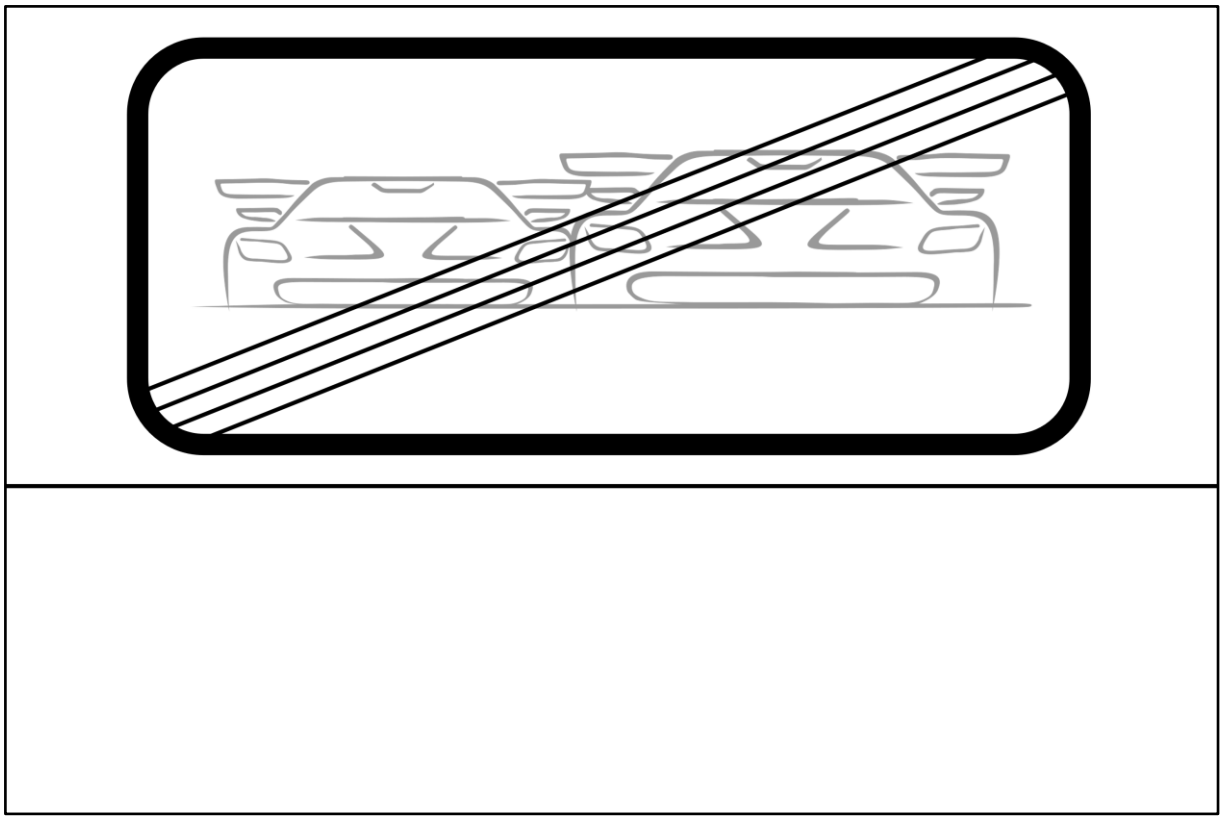

Figure 8: Overtaking Permitted sign (image not to scale)

4.6 Traffic Lights

The dimensions of the traffic lights can be seen in Figure 9. The traffic lights are used to permit the pit lane exit (see dynamic discipline described in section 3.5.3.2 and 3.5.3.4). The model car will face the 3-element traffic light as shown in Figure 9. However only the red and green light is used. As stated earlier during the competition the traffic light system of MdynamiX will be used. This traffic light system is also available for purchase from MdynamiX.

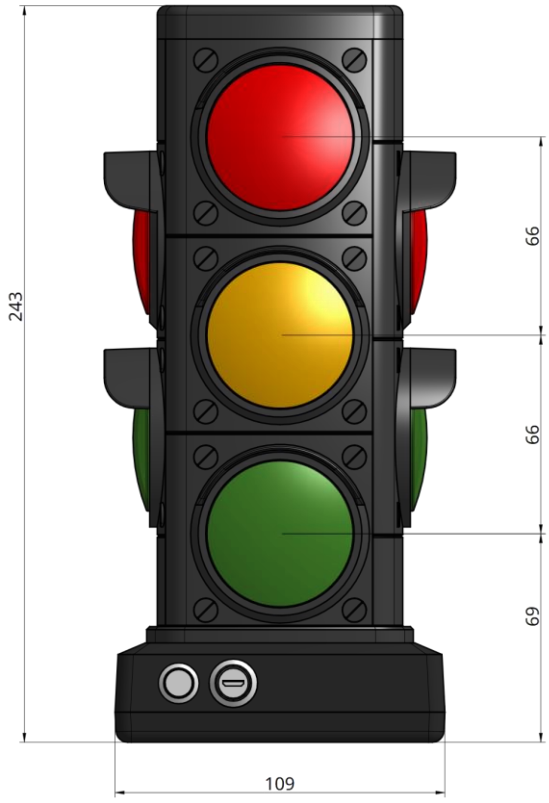

Figure 9: Traffic Lights

5 Technical Specifications

The choice of components is free, if not explicitly mentioned otherwise.

5.1 Vehicle chassis

Model vehicle approx. scale 1:8, road car silhouette. The use of the specification INFERNO GT2 VE RACE SPEC from Kyosho (e.g., at the time of this document's publication, EAN: 4548565393756) is strongly recommended. Other vehicle chassis can be approved upon a competitor's request. In principle, the values for the electric drive of the above-mentioned model may not be exceeded or changed.
The bodywork can be modified for the installation of sensors. However, a strong deviation from the original design due to add-on parts can lead to a deduction of points or even disqualification if the installation is not in accordance with the rules. The leading principle is to stay as close as possible with the original shape of a road car.
If you have any questions, please contact adc@vdi-sued.de.

5.2 Vehicle dimensions

The maximum permitted vehicle dimensions for both classes shall be complied with as follows:
width: 320 mm; height 250 mm; length 650 mm.
All components shall be accommodated within these dimensions.

5.3 Tyres

5.3.1 VDI Cup

In the VDI Cup the KYOSHO EUROPE K.IGT00 tyres are mandatory for all participating vehicles (regardless of class).

5.3.2 VDI Supercup

In the VDI Supercup the specification of the tyres is not regulated.

5.4 Single board computer

5.4.1 VDI Cup

Any board hosting one Nvidia Jetson Nano

5.4.2 VDI Super Cup:

Not regulated but within the specification of one Nvidia Jetson Xavier NX module.

5.5 Sensor- and actor hubs

Not regulated if they have the functionality to collect sensor data or distribute actor commands. It is prohibited to run vehicle control algorithms on it.

5.6 Sensors

- Four cameras maximum. One stereo camera is accounted as two cameras. The total budget for the cameras is limited to 600€ typical end customer price by the time the event takes place.
- Maximum 10 near field sensors either based on ultrasonic or ToF measuring principle. The maximum measuring distance is limited to 2 m. The total budget for the near field sensors is limited to 200€ typical end customer price by the time the event takes place.
- Maximum 2 6DOF motion sensors (only MEMS technology is allowed).
- Wheel speed sensor (own designs are possible).
- LIDAR (the LIDAR system may cost a maximum of 500 € typical end customer price by the time the event takes place).
- Other types of sensor technologies are not permitted.

5.6.1 Sensor Positions

The overall silhouette of a road car has to be persevered. Exceptions to this rule can be granted for the sensor's positions. They can be moved outside the silhouette of the model car up to a position where their field-of-view is comparable to real world road cars for the same type or purpose of the sensor.

Special attention is on the position of the front camera(s). They are allowed to be moved outside so that the nearest position in sight on the track is in scale to real world dimensions. This position is defined as greater or equal 44 cm in front of the front axle and the longitudinal axis of the model car. Figure 10 is illustrating this definition. Any competitor is asked to clarify his demands with the VDI in case of doubt or questions.

During the event the jury reserves the right to ask a competitor that its sensor positions comply with this reglement. Therefore, the teams need to be prepared to allow a non-time-consuming validation procedure.

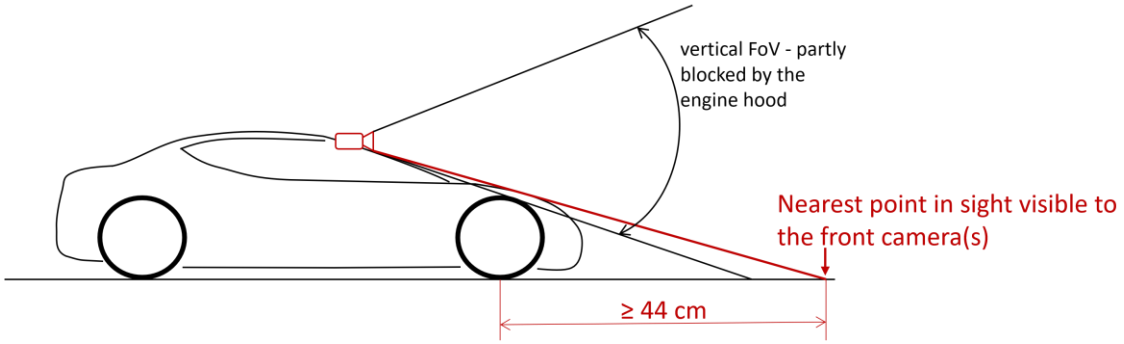

Figure 10: Front camera positioning

5.7 Connected Drive

The vehicle must be equipped with a Bluetooth LE interface for the cooperative competition disciplines. Detailed definition of the transmission interfaces will be made at a later date. The cooperative disciplines are embedded in the Parking Disciplines in 2023.
Further cooperative disciplines are planned but will be not executed in 2023. However it is recommend to be prepared to add a WiFi interface also.

5.8 Power Supply

Up to two electric power supplies are permitted. One battery to store energy for the drivetrain and one to supply other electronics. Exchanging or recharging the batteries is permitted between the individual disciplines.

5.9 Manual Control

The vehicles must be able to be controlled by remote control. A remotely activated emergency stop of the autonomous driving mode is mandatory.

5.10 Pre-setting for Disciplines

It is permitted to set the vehicles in different modes for the respective discipline by software measures.

5.11 Transponders

Transponders are used for timekeeping and must be attached to the vehicle. For this purpose, a power supply between 5 - 16V @ 40 mA must be available. A CAD - model of the transponder is provided for this purpose. The plug connection must be of USB Type A. The timing transponder will be let on the day of the competition. The proper installation and functioning of the transponder is in the response of the team. The organizer is providing support for installation and checks. None functional transponders may lead to exclude the model car from the point assignment of a Dynamic Discipline.

6 Legal notice

When registering for the VDI Autonomous Driving Challenge, all rights to photos and video recordings are transferred. Declaration of consent to photo and/or film recordings:

By registering, participants agree that within the VDI-ADC, photos and/or videos will be taken of the attending participants which can be used for publication

- on the homepage of the organizer
- in (print) publications of the organizer
- on the social media pages of the organizer

and may also be stored for this purpose. Furthermore, photo and/or film recordings are made available to sponsors of the respective VDI Autonomous Driving Challenge. They are granted the same rights to use and retain the material as the organizer.

7 Registration

Registration for the competition is possible until the track presentation is held.

It is recommended to have the technical configuration and especially the sensor equipment confirmed by the organizer.

If you have any questions, please contact the Autonomous Driving Challenge team: adc@vdi-sued.de.