CAuDri-Challenge Regulations 2026

January 21, 2026

DISCLAIMER:
This document may be subject to change up until the day of the competition. All changes will be announced on our Discord Server, in case of major changes we will inform all participants via E-Mail. New features and differences to the previous competition will be highlighted in yellow. Differences to the initial release for each year will be highlighted in green.

Contents

1. Overview

1.1. Objectives

The student competition "Cognitive Autonomous Driving (CAuDri) Challenge" provides a platform for student teams to get involved with the conceptualization and implementation of automated model vehicles. The challenge is to realize the best performing vehicle guidance system for different scenarios, which have been derived from requirements arising from a realistic environment.

In the annual competition, participating students have the opportunity to present their know-how while competing with teams from other universities.

1.2. Tasks

The student team is put in charge of developing, producing and demonstrating a cost- and energy-efficient 1:10 concept for an automated vehicle by a fictional OEM. During the competition several driving tasks have to be executed as fast and precise as possible. In addition, the developed concept must be presented and explained, but will not contribute to the scoring of the competition.

1.3. Organization

The CAuDri-Challenge is organized and presented by CAuDri e.V. More information can be found on our website https://caudri-challenge.de.

Teams can contact the CAuDri-Challenge organization team via the email address:
kontakt@caudri-challenge.de.

Furthermore, we are hosting an official Discord server for all participating teams:
https://discord.gg/ZvPmWd5hAK

2. Regulations

2.1. Commission

Rules and obligations of the CAuDri-Challenge can only be modified by the CAuDri-Challenge Regulations Commission. Members of the commission will be chosen by CAuDri e.V. and announced ahead of the competition.

In cases of uncertainty or discrepancy the commission is responsible for official statements.

The commission can change the schedule or the regulations of the event at any time. All participants are obliged to cooperate with the commission and follow their instructions.

2.2. Validity of Regulations

Only the regulations which have been released on the official CAuDri e.V. GitHub repository are valid for the competition. Old regulations are invalidated, as soon as a new version of the regulations is released. Updates of the regulations will additionally be announced to registered teams.

2.3. Inquiries and Clarification Process

Every participant is obliged to thoroughly read, understand, and accept the regulations. In case of questions, the commission is to be consulted. Questions can either be directly posed to the commission or published on the official CAuDri-Challenge Discord server.

3. Competition Participation

3.1. Dates and Venue

The CAuDri-Challenge 2026 will take place on May 9th at the DHBW Stuttgart Fakultät Technik (Lerchenstraße 1, 70174 Stuttgart). The exact schedule will be published on our website.

3.2. Prerequisites for Attending

Only students and teams fulfilling the following conditions are allowed to participate in the CAuDri-Challenge.

3.2.1. Status of Enrollment

Every participant must either be currently enrolled in a Bachelor's, Master's or a comparable degree program or the respective degree must not have been obtained more than six months before the competition. There is no restriction concerning the subject of study. Research staff and PhD students may not participate actively in conceptualization or development of the vehicle. They may not participate actively in the competition (cf. Section 4.4).

While no proof of enrollment is required for registration, we reserve the right to request a proof of enrollment at any time. Violations of this rule will result in the disqualification of the respective team.

3.2.2. Minimum Age

There is no minimum age for participation. Underage participants must submit a non formal written declaration of consent signed by their legal guardian. A template can be found on our website.

3.2.3. Number of Teams per Institution

The number of teams per institution is not limited. However, the development of the vehicles must be strictly separated. Software and hardware architectures of the respective teams must differ significantly.

3.2.4. Publication Rights

By registering, every team and every participant declares their agreement with the publication of image, video and audio recordings. This also includes the recording of team presentations. This agreement might be revoked until the day of the competition.

4. Vehicle Requirements

The observance of the following regulations will be monitored during the competition. Violating these regulations will lead to a deduction of points or exclusion from the competition. The same vehicle must be used for all events.

4.1. General specifications

4.1.1. Drivetrain

The vehicle must be equipped with at least one electric motor used for propulsion. The number of driven wheels is not limited (torque vectoring is allowed). Other motors (e.g. combustion engines) are not permitted.

4.1.2. Energy Supply

Energy must be supplied in the form of batteries. Changing the batteries between single events is allowed.

4.1.3. Steering / Tires

At least one axle must be steerable. Teams are expected to use cushion or foam rubber tires. Other types of tires need to be confirmed by the commission prior to the training sessions. The use of traction additives or studded tires is not allowed.

4.1.4. Physical Dimensions

The vehicle must be based on a four-wheeled 1:10 scale chassis. Only two axles are permitted. The wheelbase must measure at least 200 mm. The track width (measured from the center of the wheels) must measure at least 160 mm. The vehicle, including possible extensions and bodywork, must not be wider than 300 mm. The height of fixed installations must not exceed a height of 300 mm above the track surface. Flexible antennas are allowed.

Apart from this, the design of the chassis is subject to the team's creativity, as long as it adheres the maximum physical dimensions. For the acceptance test, the car must be able to drive through a fixed gate (inner dimensions: height 300 mm, width 300 mm) in RC-mode.

4.1.5. Bodywork

The teams must be able to quickly disassemble the vehicles' bodywork, so that the inner parts of the vehicle can be inspected at any time. The bodywork must conform to IP 10 (EN 60529).

4.1.6. Sensor Setup

The sensor setup can be arbitrarily chosen by the teams. Laser sensors are allowed only up to class 2 devices.

4.1.7. Lights

The vehicle must be equipped with different lights to signal its driving behavior. All lights must be clearly visible in daylight conditions and be distinguishable from each other.

Headlights

Two clearly visible and distinguishable white headlights must be installed at the front of the vehicle. The headlights must be switched on whenever the vehicle is powered. Their purpose is to indicate the front of the vehicle, full road illumination is not required.

(The headlights are not required for the CAuDri-Challenge 2026, but will be mandatory from 2027 onwards).

Taillights

Two clearly visible and distinguishable red taillights must be installed at the back of the vehicle. The taillights must be switched on whenever the vehicle is powered. The taillights may be identical to the braking lights, provided they operate at a reduced intensity during normal driving. If the same lights are used for both functions, the increase in light intensity during braking must be clearly distinguishable from the taillight state.

(The taillights are not required for the CAuDri-Challenge 2026, but will be mandatory from 2027 onwards).

Braking Lights

Three clearly visible and differentiable red braking lights must be installed at the rear of the vehicle. Active braking must be signaled. The braking lights may be identical to the taillights, provided they operate at a higher intensity during braking. If the same lights are used for both functions, the braking light intensity must be clearly distinguishable from the taillight state.

Direction Indicators

Each corner of the vehicle must be equipped with a yellow / orange light. The respective lights at the correct side must be flashed at a maximum frequency of 2 Hz (50% duty-cycle, initial state "on") when overtaking, turning, or parking.

RC-Mode Indicator

A clearly visible blue light must be installed at the highest point of the vehicle, which flashes to signal the activation of RC-mode (cf. Section 4.3).

4.1.8. Speaker

The vehicle must be equipped with an acoustic device to acoustically signal the transition from autonomous mode to RC-mode.

(The speaker is not required for the CAuDri-Challenge 2026, but will be mandatory from 2027 onwards).

4.1.9. Event selection

The vehicle must provide multiple distinctive buttons (e.g. push-buttons, touchscreen buttons, etc.), which start the different modes for the events. The buttons must be located on the vehicle, uniquely identifiable and easily reachable in order to allow non-team members (e.g. judges, referees) to start the vehicle. A single button or switch may be used if its usage is intuitive and the intended mode of operation clearly indicated.

4.2. Data and Communication

4.2.1. Data Transmission

No data or signals may be transferred from the vehicle to the outside world during the events, except for communication with the remote control (cf. Section 4.3). An active WiFi connection may be used during events. This will lead to a penalty, as specified in the scoring guidelines of the respective event.

4.2.2. WiFi Network

Each participating team may set up a single private wifi network. For internet access, participants can connect to the eduroam network at the venue.

4.2.3. RC Transmission Frequencies

In order to limit interference between vehicles, each team must inform the commission about the transmission frequency of their remote control used when registering. Frequencies are issued on a first-come-first-serve basis. Additionally, specific models are known to interfere with Wi-Fi networks, or other infrastructure. Thus, remote controls using frequencies in the 2.4 GHz band need to be confirmed by the commission individually.

4.3. RC-Mode

In emergency situations, the vehicle must be stoppable and maneuverable using a remote control. This can become necessary due to faults or errors in the data processing or due to other problems that lead to unexpected behavior of the vehicle.

4.3.1. Activating RC-Mode

RC-mode is activated by the remote control. An active RC-mode must be signaled by utilizing a sufficiently bright, flashing, blue light, which is visible from any position on the track. The light must be fixed at the highest point of the vehicle. The light must flash with a frequency of 1 Hz, showing a duty cycle of 50%, beginning with the status "on" when activating RC-mode. Every switch from autonomous mode to RC-mode must aditionally be signaled by an acoustic signal with a maximum length of 0.5 s. (Acoustic signaling is not required for the CAuDri-Challenge 2026, but will be mandatory from 2027 onwards). RC-mode must only be activated after a clear misbehavior of the vehicle. This means e.g. completely leaving the designated course of the track. Activation of the RC-mode inside the start box results in the cancellation of the attempt. It is only allowed to activate the RC-mode once the vehicle has fully left the start box.

4.3.2. Driving in RC-Mode

Switching from autonomous mode to RC-mode must instantly bring the vehicle to a complete halt without further steering maneuvers. The vehicle must remain stationary for at least 1 second before remote control becomes possible and switching back to autonomous mode is allowed. When RC-mode is engaged during the dynamic events, the maximum speed of the vehicle may not exceed 0.3 m/s. There are no restrictions on the RC-mode during test drives. No additional functionality is allowed in RC-mode.

4.3.3. Use in Competition

In case the vehicle is not able to continue following the track on its own, the team may activate RC-mode in order to get the vehicle back into normal behavior. If the vehicle does not return into the right driving lane on its own, RC-mode must be activated immediately. For the events, the penalty applied for activating RC-mode is specified in their respective scoring sections. Clear misuse of the RC-mode can lead to further penalties or the disqualification from the event.

4.4. Development Know-How

The basic concepts of the vehicle must be conceptualized and implemented by the students themselves. They may not accept the direct help of professional engineers or suppliers. The students are encouraged to do research and/or discuss their problems with professional engineers or suppliers.

Ready-made solutions may never be included in the vehicle. This particularly concerns the use of predesigned algorithms which may be part of a hardware platform and serve the purpose of providing a fully functional system for perception, behavior generation or control for automated vehicles or robots. Publicly available or open-source software libraries are generally allowed, as long as they do not provide a complete solution for automated driving. The teams must be able to explain and document all parts of their vehicle and its software.

The final decision on acceptable components is taken by the commission. The teams are encouraged to contact the commission early in case of doubts or questions about a particular component. In case of violating these guidelines or intentional fraud, the commission reserves the right to exclude the respective team from the competition.

4.5. Safety Regulations

During the competition, safety instructions issued by the venue and commission members need to be followed. Ignorance of notes or guidelines can be punished by excluding the respective team from the training sessions or the competition. Each individual is required at all times to take care that no other participants are injured or other vehicles are damaged due to careless behavior.

As far as the sensor setup is concerned, special requirements and restrictions arise. All components within the vehicles must adhere to established guidelines for safe public usage. Particularly the usage of active sensors can be limited by this rule.

The teams must ensure that no third parties are subject to possible injury due to installation or handling of the sensors or other components. In case of questions concerning particular sensors, the admission must be discussed with the commission prior to the beginning of the training sessions.

Violations of these regulations lead to an immediate exclusion from the competition. Any claim for compensation from the commission is excluded.

4.6. Modification of the Vehicle

During the events, the hardware of the vehicle may not be modified except in case of supervised repair. The software may not be modified during the events. Changing and charging batteries is allowed.

An exception is made for teams being granted a second attempt during a dynamic event (cf. Section 7.1.2).

5. Track Layout

This chapter provides a general definition of the track layout and details all track elements that can appear during the CAuDri Challenge. The specific events descriptions in Chapter 7 describe which of these track elements can be present in the respective event. Not all track elements are part of every event.

5.1. General Track Configuration

The track consists of a closed-loop road with two parallel lanes, one for each direction of travel. It can include other elements such as intersections or pedestrian crossings, which are detailed in the following sections. The track surface is of a dark shade close to black. Unless specified otherwise, all lane markings are white and approximately 18 mm to 20 mm wide. The starting line (a checkered line of approximately 50 mm width) marks the beginning of the track.

Different track elements are spaced at least 1000 mm apart and do not overlap. Neighboring roads of the track are spaced at least 50 mm apart, measured from the outer edges of the markings. The sharpest turn on the track has an inner radius of 1000 mm. The design of the area outside the track boundaries is not defined. Artifacts, such as physical objects or remainders of old lane markings, can be present. The minimum distance between any artifact and valid lane markings is 100 mm.

The track is mostly planar. However, parts of it can show slopes of up to 10% (a 0.1 m height difference over a 1 m length). Uphill and downhill grades are announced by traffic signs placed at least 1000 mm prior to the change in slope. Track elements will not be located on uphill or downhill grades.

5.1.1. Designated Route

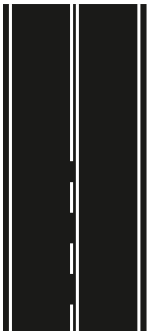
The designated route refers to the intended path along the track, starting at the starting line and following all mandatory turn directions at intersections (cf. Section 5.3). A vehicle that leaves the start box (cf. Section 6.2.3) and follows the designated route will complete one lap of the track and return to the starting line.

A valid track will always have a designated route that is implicitly defined by the track layout and included track elements.

5.1.2. Lane markings

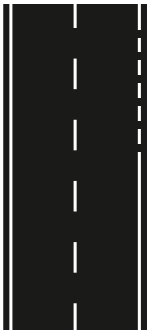
Each driving lane has a width of 350 mm to 450 mm, measured from the inside edges of the markings. The left and right boundary markings are geometrically continuous, except where lane markings are missing. They do not show any abrupt lateral displacements or misalignment. While the lane width can vary within the specified range, the transition of the outer markings remains

smooth. The centerline can display lateral displacements or misalignment under specific circumstances, such as when the marking type transitions from a single dashed line to a double solid line as defined in the following.



The two lanes are separated by a center line. There are three possible configurations for it:

- **Dashed:** Consists of 200 mm strokes separated by 200 mm gaps. This pattern continues until it reaches an intersection or the starting line, where the line might end with a gap.
- **Double Solid:** Consists of two solid lines spaced approximately 20 mm apart, resulting in a total marking width of approximately 56 mm to 60 mm.
- **Mixed:** A combination of one solid line and one dashed line.



Marking types persist for a distance of at least 1000 mm. Transitions between marking types are immediate and can show lateral misalignment.
The left and right boundaries of the track are marked by solid white lines. On straight sections, the outer boundary can indicate a side road junction. In these areas, the boundary consists of 100 mm long dashes separated by 50 mm gaps. Despite the dashed appearance, these markings must be treated as solid lines and must not be crossed, as the vehicle on the main track is assumed to have the right of way. These side road junctions are at most 960 mm long and are identified only by the change in marking type. There are no additional markings.
Any lane marking can be missing at arbitrary locations for a maximum length of 1000 mm. Except for intersections, no more than two markings will be missing simultaneously.
An example of a full track layout is depicted in Section A.12.

5.1.3. Traffic Signs

Traffic signs occur in combination with the track elements described in the following sections. They are located 75 mm to 125 mm from the right-hand side of the lane unless specified otherwise. The exact dimensions and positioning of signs are defined in Section A.2. Longitudinal distances are measured along the right-hand lane marking. Some traffic signs are complemented by road surface markings. Those markings do not have to be at the same distance from the track element as the sign itself (cf. Sections 5.3, 5.9).

In addition to the signs from the track elements, guide signs are used to indicate sharp turns. They mark a curved section of the track with radii below 1200 mm, if it is located after a straight section of at least 3 m length. A first guide sign is placed approximately 1500 mm before the transition to the turn. The second sign marks the beginning of the turn. Smaller signs will be repeated approximately every 400 mm until reaching the apex of the turn.

5.2. Obstacles

Obstacles are used to simulate other vehicles on the track. They are represented by white cardboard boxes measuring 100 mm to 400 mm in width, 100 mm to 240 mm in height, and at least 100 mm in length (cf. Section A.3.1). Obstacles can be positioned in either lane or outside the track boundaries and do not occur in track elements unless stated otherwise. Along the track, there is a minimum spacing of 1000 mm between any two obstacles. An obstruction of both lanes will not occur, except for no-passing zones and barred areas (cf. Sections 5.5 and 5.6).

5.2.1. Static Obstacles

Static obstacles are stationary and can be fixed to the ground. While their placement within a lane can vary, they will never block both lanes simultaneously. Unlike other objects found outside the track, static obstacles placed outside the track are not considered artifacts. Therefore, the minimum distance requirements applicable to artifacts do not apply to static obstacles.

5.2.2. Dynamic Obstacles

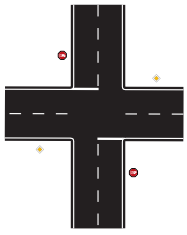
Dynamic obstacles can move along the track, simulating other traffic participants. They move at a speed of up to 0.6 m/s, keeping to the right lane. They do not execute lane changes or passing maneuvers and can stop temporarily, potentially blocking the lane.

5.3. Intersection

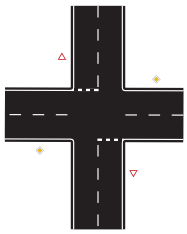
Sections of the track can intersect with other track sections at angles between 70° and 90°. An intersection consists of three or four entries and exits. The lane boundaries at the corners can be connected via rounded transitions with a radius of approximately 100 mm. No more than one dynamic obstacle can be present at an intersection at any given time. The dynamic obstacle will approach the intersection from a different direction than the vehicle. It may proceed straight, turn left, or turn right, and shall comply with the intersections priority regulations, such as priority-to-the-right, give-way, or stop signs. Scenarios resulting in ambiguous right-of-way regulations will not be encountered.

Intersections exist in three variations:

- **Stop:** Intersections with stop lines (cf. Section A.4.1) feature a solid white line (36 mm to 40 mm wide) that crosses the entire lane. Stop lines can occur at up to two intersection entries and are always complemented with a stop sign. Entries without a stop line are not marked separately. For these, the right of way is indicated only by the corresponding traffic sign.

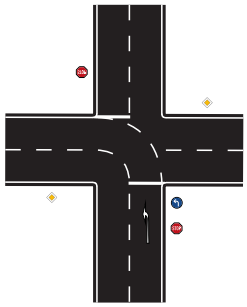


- **Give-Way:** Intersections with give-way lines (cf. Section A.4.2) are similar in layout to stop intersections but utilize give-way markings and signs. A give-way line consists of 80 mm long dashes (36 mm to 40 mm wide) separated by 60 mm long gaps.



- **Priority to the Right:** If an intersection does not have markings or signs indicating priority (cf. Section A.4.3), the "priority to the right" rule applies. These intersections are not announced by traffic signs. Instead, all entries to the intersection are marked with a give-way line on the road surface. A give-way line consists of 80 mm long dashes (36 mm to 40 mm wide) separated by 60 mm long gaps.

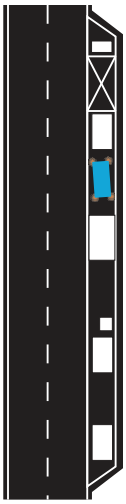
Additionally, intersections of all 3 types can impose a mandatory driving direction for specific entries (cf. Section A.4.4). This requirement is indicated by a traffic sign and complementary road surface markings. Within the intersection, the mandatory path is defined by dashed turn lines that extend the center line and the relevant lane boundary. Unlike other markings, turn lines are never missing.



5.4. Parking

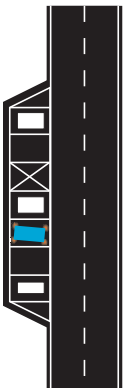
Parking zones contain multiple spots for parallel and perpendicular parking. The beginning of a parking zone is announced by a corresponding traffic sign placed 300 to 500 mm before the start of the first parking area. A parking zone is a planar, straight section of the track with a dashed center line and no missing lane markings (cf. Section A.5.3). Additional track elements (intersections, crosswalks and others) are not present. Static obstacles are used to represent other parked vehicles and can be fixed to the ground, however they cannot occur in either driving lane.

5.4.1. Parallel Parking



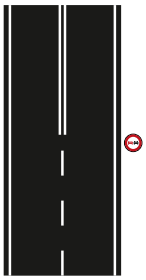
The parking zone includes at least one parallel parking area located next to the right lane when following the designated route of the track (cf. Section 5.1.1). Obstacles representing parked vehicles are positioned with a lateral gap of 20 mm to 200 mm next to the right lane marking. Individual spots within the parking area can be marked as "no parking" zones. These areas must not be used for parking but may be used for maneuvering.
The parallel parking area contains multiple parking spots of varying sizes. Approaching from the parking sign, the spots increase in length. The final and largest spot will be at least 700 mm long. The front and rear limits are defined either by obstacles or by "no parking" zones (cf. Section A.5.1). The lateral limits of the parking spots are defined by the right lane marking and an additional solid white line (18 mm to 20 mm wide). Gaps smaller than 400 mm can exist between obstacles anywhere in the parallel parking area. These spaces are not valid parking spots.

5.4.2. Perpendicular Parking



The parking zone includes at least one parking area with parking spots oriented perpendicular to the track and is located on the left-hand side of the road. All parking spots have uniform dimensions (cf. Section A.5.2).
The spots are separated from one another and limited at the front and rear by white markings (18 mm to 20 mm wide). Parking spots can be blocked by obstacles or designated "no parking" zones. A spot is considered blocked if the vehicle cannot be positioned fully inside the boundaries of the spot. Obstacles blocking these spots can be placed at a distance of 20 mm to 100 mm from the solid left lane marking.

5.5. No-Passing Zone

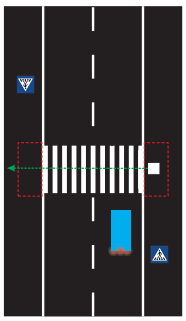


Sections of the track can be defined as no-passing zones, indicated by the corresponding traffic sign and lane markings (cf. Section 5.1.2). A no-passing rule applies in sections where the center line facing the current driving lane is solid (either a double solid line or a mixed line where the line on the driver's side is solid). If a passing maneuver is initiated prior to entering a no-passing zone, the vehicle is allowed to complete the maneuver and return to the right lane in any case.
Static obstacles are not placed in a no-passing zone. However, up to one dynamic obstacle can still be present, driving on the right lane. After the no-passing zone no other element can occure for 2000 mm.

5.6. Barred Area

Barred areas are located on straight sections of the track and block one lane for a maximum length of 2000 mm, measured along the outer lane marking. They are marked with a trapezoidal outline (18 mm to 20 mm wide), filled with diagonal white markings (36 mm to 40 mm wide) separated by 150 mm wide gaps and are always connected with the left or right lane boundaries. For shape and dimensions, refer to Section A.6.
Oncoming traffic in the unobstructed lane has the right of way, as indicated by a corresponding traffic sign (cf. Section A.2). No more than one dynamic obstacle can be present at a barred area at any given time.

5.7. Crosswalk



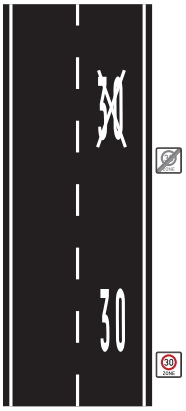
Crosswalks are marked by a "zebra" pattern consisting of multiple white stripes parallel to the direction of travel. The stripes are 36 mm to 40 mm wide, 400 mm long, and spaced 40 mm apart (cf. Section A.7). Crosswalks are indicated by a corresponding traffic sign.
Two designated waiting areas are defined on the roadside at each crosswalk. Up to 1 pedestrian is located in these areas and represented by a small white cardboard box, similar in structure to static obstacles. Additionally, the pedestrian box is marked with a specific pictograph (cf. Section A.3.2). The pedestrian can be present on both the right- and left-hand sides of the crosswalk and will always be clearly distinguishable from the view of an approaching vehicle.

5.8. Two-lane Expressway

An expressway is a mostly straight, planar section of the track with one driving lane in each direction and a minimum length of 5 m. It does not contain any sharp turns. Any distinctive curves within this track element will be marked by guide signs as described in Section 5.1.3. The start and end of the expressway are indicated by specific traffic signs. Vehicles on the expressway have the right of way, no stop lines will be encountered. No obstacles will be present throughout this track element.

5.9. Speed Limit

The track can include sections where a specific speed limit is enforced. The speed limit is indicated by numeric signs in steps of 10 km/h (e.g., 20 km/h) and must be scaled by a factor of 1:10 for the actual vehicle speed. Speed limits begin and end at the corresponding signs and road surface markings (cf. Section A.8). A speed limit can start and end at any location on the track. However, the surface markings for speed limits do not interfere with or overlap the markings of other track elements. In cases where other traffic signs are present at the same location, they are either placed next to each other in no particular order or spaced at least 500 mm apart.



5.10. Landmarks

Landmarks are additional signs that serve as navigation points for the vehicle. They can appear at any location where their position is not obstructed by other road elements or obstacles. A maximum of 10 landmarks are placed across the track.

The landmark sign shares the same shape and size as a speed limit sign but features a QR code with a unique identifier (cf. Section A.10). The identifiers are assigned in ascending order, starting with 0. Each landmark consists of two landmark signs with the same identifier, one on each side of the track, facing the vehicle on the right-hand side. This allows the vehicle to detect the landmark from either direction.

6. Competition Structure

This chapter describes the general schedule of the competition.

6.1. Training

In order to guarantee safe and fair training conditions, the training sessions are divided into time slots. The number of teams allowed on the track at the same time and the length of the slots will be announced prior to the competition. The commission might change the slots and the number of teams on the track without further notice. In case of clear violations of training slots, the commission may issue penalties which will be subtracted from the final score of the respective teams. In case of repetitive violations of slots or if team members endanger other teams or their equipment, the commission may expel single team members or whole teams from the competition.

6.2. Competition

6.2.1. Parc Fermé

The "parc fermé" is a designated area where all vehicles will be kept during the competition while not actively in use.

At least 15 minutes ahead of the competition, all teams must hand in their vehicles at the “parc fermé”. No modifications of the vehicles can be made after this point. Batteries must be separated or disconnected from the system and the vehicle switched off. All external tools must be removed from the vehicle, any wireless communication on board of the vehicles (Wi-Fi, Bluetooth, etc.) must be switched off or removed, except for the remote control communication. The remote control must be placed next to the vehicle in switched off state.

When handing in the vehicle, the teams must make a definite statement to the commission in which events they would like to participate.

6.2.2. Start Scheduling System

A traffic-light-like start scheduling system will signal the teams when to pick up their vehicle at the “parc fermé” and begin to prepare for their attempt. The traffic light will show the following stages:

- **1. Red - Standby:**
  No preparation is necessary. The vehicle must be parked at the “parc fermé”.

- **2. Yellow - Preparation:**
  The team must pick up their vehicle at the "parc fermé" and prepare for the next event. The team may switch the vehicles batteries and change the mode of operation as described in Section 4.1.9. No further modification of the vehicle is allowed at this point. The team will receive a penalty if an active wifi connection or other external tool is required to start the vehicle.

  The vehicle must be placed in the start box, located at the beginning of the track (cf. Section 6.2.3). When ready, the team may signal the commission to start the event.

  A total time limit of 5 minutes is given for preparation. If the time limit is reached, the the event will proceed to the next stage automatically and the attempt may be canceled (cf. Section 7.1.2).

- **3. Green - Start:**
  The gate of the start box will open and the commission will start the timing of the event. The vehicle may leave the start box while the gate is open. No further preparation is allowed.

- **4. Red - Stop:**
  The event has ended or has been aborted. The vehicle needs to come to an immediate and complete stop. It needs to remain stationary until the commission signals that the vehicle can be moved.

  After each event, the vehicle must be returned to the "parc fermé" immediately. Batteries must again be separated from the system and switched off. The remote control must be placed next to the vehicle in a switched off state.

In addition to the traffic light, a countdown timer will be displayed to inform the teams about the remaining time in each stage.

6.2.3. Start Box

The start box is separated from the track by physical barriers. Up to two team members are allowed to prepare the start of the vehicle in the start box. To the front of the start box is an openable gate, marked with a traffic sign and a matrix barcode (cf. Section A.11). An attempt starts with the opening of the gate. The start box exit can be separated from the track by a solid white line. This line may be crossed to enter the track. The gate of the start box remains open for 30 seconds.

7. Dynamic Events

During the dynamic events, the performance of the automated model vehicles will be challenged in multiple events:

- Free Drive Course
- Obstacle Course
- Navigation Course

Each event focuses on different aspects of autonomous driving and will be scored individually. Teams can freely choose in which events they want to participate.

7.1. Event Execution

The following sections describe the general execution and rules of the dynamic events. Event-specific rules and regulations are described in the respective chapters (cf. Chapters 7.3, 7.4, and 7.5). In case of discrepancies, the event-specific regulations take precedence over the general regulations.

7.1.1. Starting Order

The starting order of the teams will be announced ahead of the competition. It will remain unchanged throughout all events, unless stated otherwise. The commission may change the starting order if this is required to comply with the schedule. Affected teams will be informed at least 10 minutes prior to their attempt.

7.1.2. Attempts

Each team is allowed one attempt per event. The first attempt may be canceled under the conditions described below and repeated once.

The Start Scheduling System (cf. Section 6.2.2) will inform the teams about preparation and start times. The attempt starts with the opening of the start box gate (cf. Section 6.2.3). It will stay open for 30 seconds.

Penalties will only apply once the vehicle has left the start box and passed the starting line.

An attempt may be canceled by the team while the gate of the start box is open, even after the vehicle left the start box.

An attempt is canceled automatically if:

- The vehicle has not been placed in the start box when the gate opens.
- The gate is damaged or forced open by a vehicle.

- The vehicle fails to leave the box while the gate is open.
- RC-mode is actively used inside the start box.

The affected team is granted a second attempt after all other teams have completed their first attempt. To comply with the schedule, the commission may arbitrarily choose the time of the second attempt. At least 10 minutes of preparation time will be given to the affected team after the first attempt has been canceled. The vehicle does not have to be placed back at the "parc fermé" and may be modified by the team while preparing for the second attempt. No additional attempt is granted if the second attempt is canceled.

Canceling an attempt will be penalized. Any progress made during a canceled attempt will not be counted towards the final score.

7.1.3. RC-Mode

If the vehicle is not able to continue following the track on its own, the team may activate RC-mode in order to get the vehicle back into normal behavior. If the vehicle does not return into the right driving lane on its own, RC-mode must be activated immediately. Before switching back to autonomous mode, the vehicle must be repositioned on the track within 1 m of the point at which it left the track. Each activation of RC-mode is penalized. RC-mode is subject to the regulations in Section 4.3.

7.2. Referees

Referees around the track are evaluating each vehicle's performance and will be responsible for registering violations.

7.2.1. Official Referees

Official referees are appointed by the commission to oversee the dynamic events. They are responsible for monitoring the track, registering violations, and ensuring compliance with the regulations. If required, the commission has the authority to overrule decisions made by any referee.

7.2.2. Team Referees

In addition to the official referees, at least one team referee is nominated by each team to support the scoring during the dynamic events. Teams consisting of less than five members can choose to refrain from providing a referee. Team referees are expected to approve the compliance of the track prior to the start of the individual discipline. During the dynamic events, they will be asked to join an official referee in observing a specific section of the track. Team referees are expected to remain impartial and objective in their observations.

7.3. Free Drive Course

The "Free Drive Course" focuses on the speed and maneuverability of the vehicle.

Within a given time limit, the vehicle has to cover the farthest possible distance on an unobstructed road. Points are awarded based on the covered distance, penalties, and achieved multipliers (cf. Section 7.3.3).

7.3.1. Scenario

The track shall imitate a rural road environment, consisting of long straight sections, tight turns and intersections. Every track element introduced in Section 5 can occure on the track, except for obstacles, barred areas, crosswalks and landmarks. All center lane markings (cf. Section 5.1.2) can be treated as regular dashed markings. Instructions announced by traffic signs can be ignored.

The vehicle is expected to stay in the right driving lane at all times. Crossing the lane markings with two or more wheels will result in a penalty.

7.3.2. Elements of the Free Drive Course

The following sections describe the vehicle's expected behavior when encountering specific elements on the track.

Intersections

Intersections must be crossed driving straight. Possible give-way, stop lines, mandatory turning directions and regulations concerning the right of way can be ignored.

No-Passing Zones

The no passing zone can be treated as a regular section of the track., the double solid line can be treated as if it was a regular dashed marking. No dynamic obstacles will occure in the no passing zone.

Parking

The parking zone can be treated as regular section of the track. No parking maneuver has to be performed and the parking slots can be ignored. No obstacles will occure in the parking zone.

7.3.3. Scoring

The covered distance under consideration of penalties will be multiplied by the received multiplier.

The longest resulting distance will be awarded the maximum number of points. The subsequent teams will be scored in relation to the best team.

Timing

Each team will be given a **2 minute time limit** to complete this event. The start of an attempt is signaled by the Start Scheduling System (cf. Section 6.2.2).

Penalties

Violation	Maximum Count	Penalty
Leaving the right lane	∞	5m
Activation of RC-mode	∞	5m
Faulty activation of the brake light	3	2.5m
Driving in the wrong direction at an intersection	∞	5m

Multipliers

Each team starts this event with a multiplier of **1.0**.

Triggering Event	Maximum Count	Multiplier Modification
Canceled attempt / second attempt	1	-0.3
WiFi enabled during competition	1	-0.5

7.4. Obstacle Evasion Course

The "Obstacle Evasion Course" tests the vehicle's advanced driving capabilities and decision-making in complex traffic scenarios.

7.4.1. Scenario

The track of the Obstacle Evasion Course can contain any of the elements described in Section 5 except for landmarks.

Static and dynamic obstacles are present on the track, intersections may specify turning directions and right of way regulations. All traffic signs defined in Section 5.1.3 can be present and must be respected.

The vehicle is expected to stay in the right driving lane at all times, exceptions can be made for overtaking obstacles or other track element specific regulations. Crossing the lane markings with two or more wheels will result in a penalty.

The vehicle will be evaluated for each element it passes according to the scoring guidelines in Section 7.4.5. Additionally, parking maneuvers can be performed once per lap.

7.4.2. Elements of the Obstacle Evasion Course

The following sections describe the vehicle's expected behavior when encountering specific elements on the track.

Static and Dynamic Obstacles

Obstacles may force the vehicle to change lanes. Lane changes must be indicated using the turn indicators. Passing maneuvers must be executed without touching an obstacle. After the obstacle has been passed, the vehicle must return to the right driving lane within 2 meters. Collisions with obstacles will be penalized. A successful passing maneuver will be evaluated positively (cf. Section 7.4.5).

Apart from static obstacles, at least one dynamic obstacle will be present on the track. It may be passed anywhere on the track, except for intersections, no-passing zones, barred areas and crosswalks.

Intersections

Intersections without a mandatory turning direction must be crossed driving straight. A mandatory turning direction is indicated by the lane markings and a corresponding traffic sign (cf. Sections 5.3 and 5.1.3).

If a stop line is located in the driving lane, the vehicle must stop for at least 3 seconds. The front of the vehicle may not cross the stop line, but must be positioned no further than 150 mm away from it.

At a give-way line, the vehicle must stop for at least 1 second. The same regulations as for stop lines apply.

The right of way of a dynamic obstacle must be respected at an intersection, if the dynamic obstacle is located within the defined area (cf. Section A.4.6). If the vehicle does not possess the right of way, it must wait until the dynamic obstacle has completely crossed the intersection.

No-Passing Zones

If a dynamic obstacle occures in a no-passing zone, it must be followed with a distance of at least 300 mm until the end of the zone.

Barred Area

A barred area may not be entered by the vehicle. If it is located in the driving lane, it must be passed by changing to the left lane. Lane changes must be indicated using the turn indicators. After passing the barred area, the vehicle must return to the right driving lane within 2 meters.

In case a dynamic obstacle is approaching from the opposite direction, the vehicle must yield the right of way and wait for the obstacle to pass. It will be be evaluated as an "Oncoming Obstacle" (cf. Section 7.4.5). No more than one dynamic obstacle will be present at a barred area.

If the vehicle has aready started a passing maneuver when an oncoming obstacle approaches, the vehicle may continue. The obstacle will stop and wait for the vehicle to pass. It will keep a distance of at least 500 mm from the barred area.

Failure to yield might result in both vehicle and obstacle encountering each other in the unobstructed lane. In this situation, the obstacle will perform an evasive maneuver, avoiding a collision or deadlock scenario.

Barred areas located in the left lane can be passed without changing lanes, no oncoming traffic will be present.

Crosswalk

One or more crosswalks may be present on the track with up to one pedestrian per crosswalk. If a pedestrian is present in the defined zones, the vehicle must stop in front of the crosswalk. Stopping must be performed with the same regulations as at intersections. The pedestrian starts crossing only after the vehicle has stopped. If the pedestrian has crossed in front of the vehicle, the vehicle may continue. Driving on before the pedestrian starts to cross and has cleared the crosswalk will be penalized. If no pedestrian is present, the vehicle may slow down, but is not allowed to come to a complete stop.

Parking

Parking can be performed once per lap during the Obstacle Course.

The vehicle can perform a parking attempt by finding a parking spot within the parking areas and maneuvering into it, without touching surrounding obstacles. Attempting more than one parking attempt per lap will be penalized. Parking spots are indicated by the corresponding traffic sign.

The start of a parking maneuver must be signaled using the turn indicators. The turn indicators must point in the direction of the parking spot (i.e. blink left if the parking spot is to the left of the vehicle).

A complete parking maneuver requires the vehicle to come to a full stop being located in a valid spot with all of its wheels and flash all turn indicators at least one time. While maneuvering out of the parking spot, the vehicle may cross the left lane, but has to continue driving in the right lane after the parking maneuver.

The correct position of the vehicle will be checked from both sides of the track with the first flashing of the indicators. Penalties may apply until the vehicle is driving with a positive speed along the route while touching the right lane with at least 3 wheels.

Leaving the outer boundaries of the parking area is penalized the same as leaving the right lane while driving. The speed in the parking lot is limited to the speed on the adjacent road. Collisions with obstacles during the parking maneuver will invalidate the parking attempt.

Vehicles may move forward or backward into the parking space. The left lane of the track may only be crossed during the actual parking maneuver. When searching for a parking spot, the vehicle must continue to use the right lane.

7.4.3. RC-Mode

For the Obstacle Evasion Course, additional regulations regarding the use of RC-mode apply.

Elements of the Obstacle Evasion Course may not be retried using RC-mode. If the vehicle shows incorrect behavior in regard to an element before the activation of RC-mode, the element will be evaluated based on that behavior. Once RC-mode has been activated, the element will only be further evaluated if the activation was not caused by incorrect behavior related to that element.

Each activation of RC-mode is penalized (cf. Section 7.4.5).

7.4.4. Scoring

Each team will start the event with a fixed number of base points. The base points are predetermined by the commission and will depend on the length of the track and the number of occuring elements. Additional base points can be awarded for each successful lap. A lap is considered successful after the vehicle has passed the starting line without skipping any elements or sections of the track (i.e. by leaving the right lane). The total distance covered by the vehicle will have no influence on the scoring.

Additional points can be gained or lost by the evaluation of the individual track elements as described below.

Timing

Each team will be given a **5 minute time limit** to complete **three laps** around the track. After the vehicle has completed all three laps, the attempt is over and no further points will be awarded. The start of an attempt is signaled by the Start Scheduling System (cf. Section 6.2.2).

Evaluation of Track Elements

Whenever the vehicle passes one of the elements described in section 5 and 7.4.2, it will receive either a positive, neutral or negative evaluation.

Any time the vehicle complies with all the requirements of a certain element, it will receive a positive evaluation and gain points. If the vehicle fails to comply with any of the requirements, it will generally receive a neutral evaluation and no points will be awarded. In some cases, the vehicle may receive a negative evaluation and points will be deducted.

The following section 7.4.5 provides an overview of the scoring guidelines for each element. The bottom row of each table shows the amount of points that will be awarded or deducted for each evaluation.

If the vehicle skips an element of the Obstacle Evasion Course by leaving the designated route, it will receive a neutral evaluation for the respective element. Each element will only be evaluated once per lap.

Only after a vehicle has completed at least one full lap will the attempt be valid and any points awarded. In case the vehicle has left the track or skipped certain parts of it, the commission will decide whether the attempt was valid.

The final score of each team will be the sum of the base points and the points gained or lost during the event.

7.4.5. Scoring Guidelines

Static Obstacles

Positive	Neutral	Negative
Successfully passed the obstacle	Merging distance $>$ 2m	Collision with an obstacle
+10	**0**	**-10**

Dynamic Obstacles

Positive	Neutral	Negative
Successfully passed the obstacle	Merging distance $>$ 2m	Collision with an obstacle
	Passed the obstacle in an intersection	
	Did not pass the obstacle	
+15	**0**	**-10**

Obstacles at Intersections

Positive	Neutral	Negative
Respected the right-of-way [1]	Did not respect right-of-way [1]	Collision with an obstacle
	Obstacle has not fully cleared the intersection	
+10	**0**	**-10**

Oncoming Obstacles

Positive	Neutral	Negative
Respected the right-of-way [1]	Did not respect right-of-way [1]	Collision with an obstacle
+5	**0**	**-10**

Drive Straight Stop/Give-Way Intersection

Positive	Neutral	Negative
Stopped at the stop or give-way line [2]	Distance from stop or give-way line $>$ 15cm [2]	Did not stop at the stop line [3]
Went straight through the intersection	Turned at the intersection	
	Stopped for $<$ 3s at stop line [2]	
	Stopped for $<$ 1s at give-way line [2]	
+5	**0**	**-5**

Drive Straight Priority-to-Right Intersection

Positive	Neutral	Negative
Stopped at the give-way line [2]	Distance from give-way line $>$ 15cm [2]	
Went straight through the intersection	Turned at the intersection	
	Stopped for $<$ 1s at give-way line [2]	
+10	**0**	*No negative points possible*

Mandatory Turn Stop/Give-Way Intersection

Positive	Neutral	Negative
Stopped at the stop or give-way line [2]	Distance from stop or give-way line $>$ 15cm [2]	Did not stop at the stop line [3]
Took the correct turn	Made a wrong turn [4]	
	Stopped for $<$ 3s at stop line [2]	
	Stopped for $<$ 1s at give-way line [2]	
+15	**0**	**-5**

[1] If the obstacle has the right-of-way, e.g. at a barred area, priority-to-right, ...

Mandatory Turn Priority-to-Right Intersection

Positive	Neutral	Negative
Stopped at give-way line [2]	Distance from give-way line > 15cm [2]	
Took the correct turn	Made a wrong turn [4]	
	Stopped for < 1s at give-way line [2]	
+15	**0**	*No negative points possible*

Parking

Positive	Neutral	Negative
Parked correctly in the parking lot	Not parked correctly	Collision with an obstacle
All wheels are within the boundaries of the parking spot	No or more than one parking maneuver performed	
+20	**0**	**-10**

No-Passing Zones

Positive	Neutral	Negative
Did not cross the solid center line	Distance to obstacle < 30cm	Crossed the solid center line with more than 1 wheel
Distance to obstacle > 30cm		
+5	**0**	**-10**

Barred Area

Positive	Neutral	Negative
Did not enter the barred area	Entered the barred area	
+10	**0**	*No negative points possible*

[2]Only applies if a stop or give-way line is present
[3]Only applies if a stop line is present and does not apply for give-way lines
[4]Includes driving straight incorrectly

Crosswalk with Pedestrian(s)

Positive	Neutral	Negative
Stopped at the crosswalk	Stopped for $<$ 3s at the crosswalk	Collision with a pedestrian
Pedestrians have cleared the crosswalk	Distance from the crosswalk $>$ 15cm	
	Pedestrians have not fully cleared the crosswalk	
+15	**0**	**-10**

Crosswalk without Pedestrians

Positive	Neutral	Negative
Did not stop at the crosswalk	Stopped at the crosswalk	
+5	**0**	*No negative points possible*

Additional Penalties

Violation	Maximum Count	Penalty
Second Attempt	1	-0.5 x base points
Active WiFi Connection	1	-0.5 x base points
Exceeding Speed-Limit	∞	-5
Activation of RC-Mode	∞	-5
Leaving the right lane	10	-2
Collision with road sign	∞	-5
Falsely using turn indicators	10	-2

7.5. Navigation Course

The "Navigation Course" is designed to test the ability of the vehicle to map an unknown environment and navigate between predefined landmarks.

7.5.1. Scenario

The track layout of the Navigation Course will not be announced before the event.

All track elements of the Obstacle Course (cf. Section 7.4.2) can appear. In addition, landmarks (cf. Section 5.10) will be placed on the track. Neither pedestrians nor static or dynamic obstacles will be present. The track might include areas where a speed limit is enforced (cf. Section 5.9).

In this event, regulations announced by regular traffic signs and mandatory turning directions at intersections can be ignored. A designated route (cf. Section 5.1.1) is not guaranteed to exist on the track.

Landmarks

During the event the vehicle has to navigate to the landmarks in the given order (cf Section 5.10). The exact number of landmarks will not be announced before the event.

7.5.2. Event Excecution

The event can be divided into two parts, a mapping phase and a navigation phase.

Mapping Phase

The start and end of the mapping phase is signaled by the Start Scheduling System (cf. Section 6.2.2). The vehicle will be given a **3 minute time limit** to freely drive around the track and map the environment. Landmarks are placed at random locations on the track. Information gathered during the mapping phase can later be used in the navigation phase.

After the mapping phase has ended, the vehicle must be placed back into the start box. A button on the vehicle may be used to signal the end of the mapping phase. It follows the same regulations as the buttons for the dynamic events (cf. Section 4.1.9). No further modifications or adjustments to the vehicle are allowed.

Navigation Phase

The Start Scheduling System (cf. Section 6.2.2) will once again signal the start of the navigation phase. The goal is to navigate between the landmarks in the correct order, covering the shortest distance possible.

The order is given by the unique identifier encoded in the QR code of each landmark (cf. Section 5.10). Landmarks do not have to be visited strictly in this order (e.g. 0-1-2), but can be passed multiple times or in between (e.g. 2-0-2-1-2). However, a pass is only counted if the previously required landmarks have already been visited.

A landmark is considered visited the moment the vehicle has fully passed both landmark signs. The vehicle is not required to stop at the landmark or to signal its arrival. The vehicle may pass the landmark from either direction.

The navigation phase ends after the vehicle has visited all landmarks in the correct order. Each team will be given a **time limit of 3 minutes** to complete the navigation phase.

Second Attempt

An attempt may be canceled at the beginning of either the mapping or the navigation phase, as described in Section 7.1.2. The second attempt will always start with a new mapping phase.

Any information gathered about the track and landmarks during the first attempt may not be used in the second attempt and needs to be discarded.

7.5.3. RC-Mode

Passing a landmark in RC-mode will not be counted as a successful visit. RC-mode may not be used to influence the vehicle's navigation behavior in any way. Using RC-mode to correct the vehicle's path will result in a penalty (cf. Section 7.5.4). Each activation of RC-mode will be penalized. RC-mode is subject to the regulations in Section 4.3.

7.5.4. Scoring

The total distance covered by the vehicle during the navigation phase will be measured. A shorter distance is considered better. In case of vehicle misbehavior, penalties will be added to the total distance. If an active Wifi connection is used or an attempt is canceled, an additional multiplier will be modified to affect the overall score.

A minimum distance will be defined by the commission based on the track layout and the positions of the landmarks. In conjunction with a predetermined number of base points, the final score will be calculated as follows:

$$Total\ Score\ =\ Base\ Points\ \cdot\ Multiplier \cdot \frac{Min.\ Distance}{Distance\ +\ \sum Penalties}$$

Penalties

Violation	Maximum Count	Penalty
Leaving the right lane	∞	1m
Activation of RC-mode	∞	1m

Multipliers

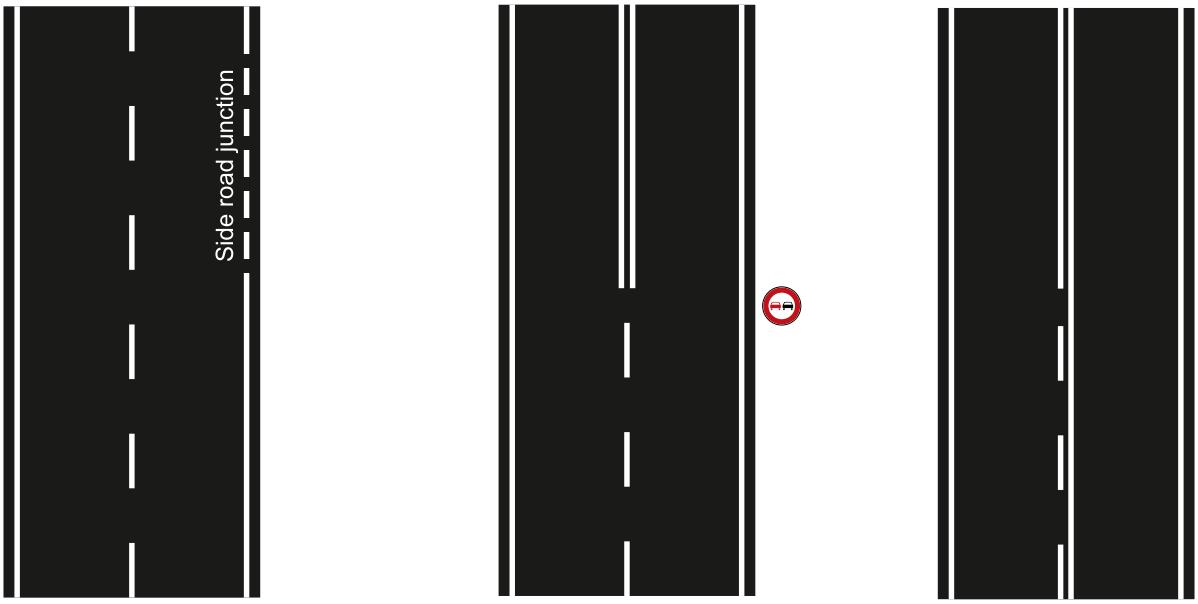
Each team starts this event with a multiplier of **1.0**.

Triggering Event	Maximum Count	Multiplier Modification
Canceled attempt / second attempt	1	-0.3
WiFi enabled during competition	1	-0.5

A. Appendix

If not indicated differently, dimensions and angles specified in the figures have a tolerance of ±5%. Unless otherwise noted, all dimensions are in millimeters (mm). Dimensions and angles defined in the previous chapters may not be repeated in the figures.

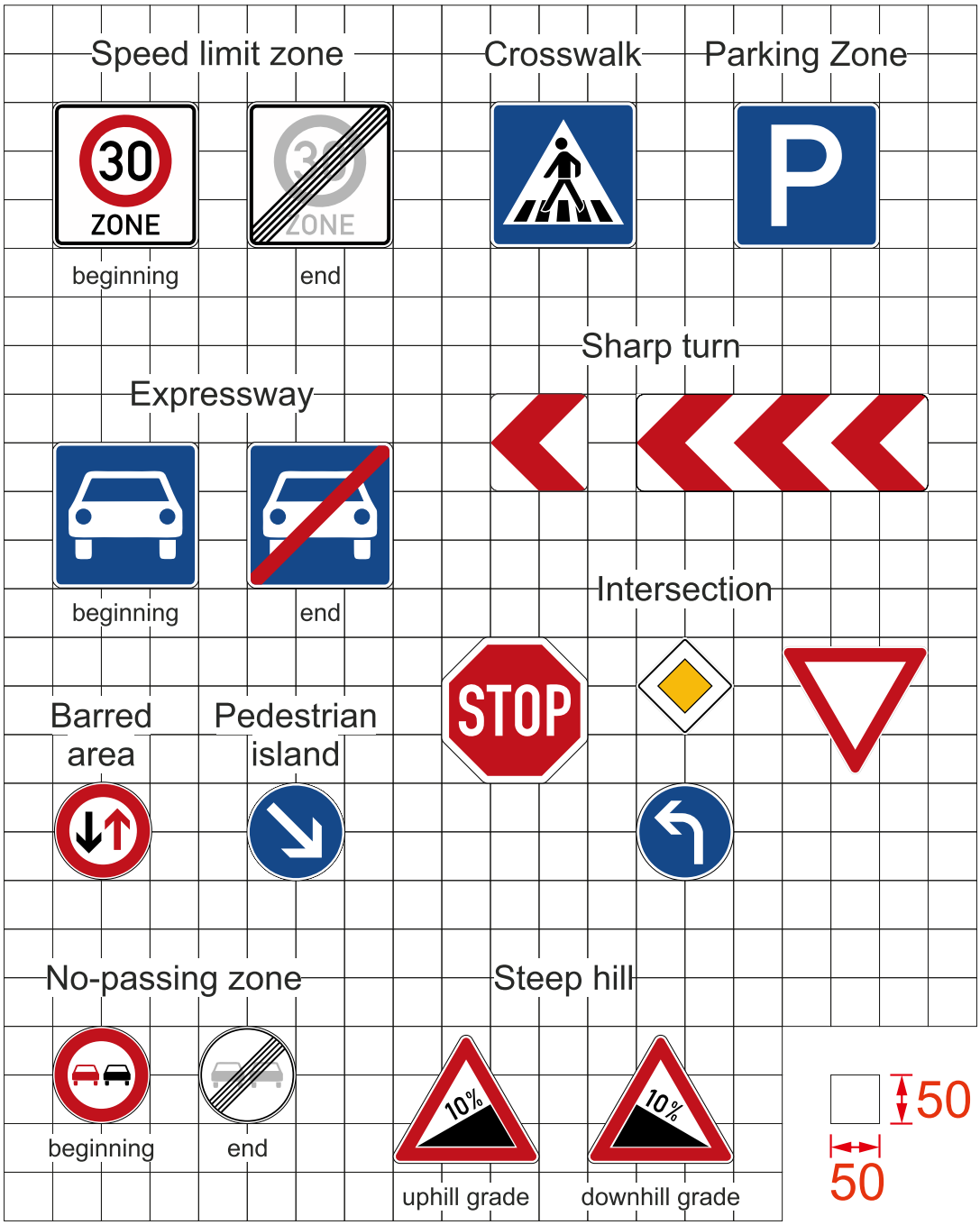
A.1. Road Layout and Lane Markings

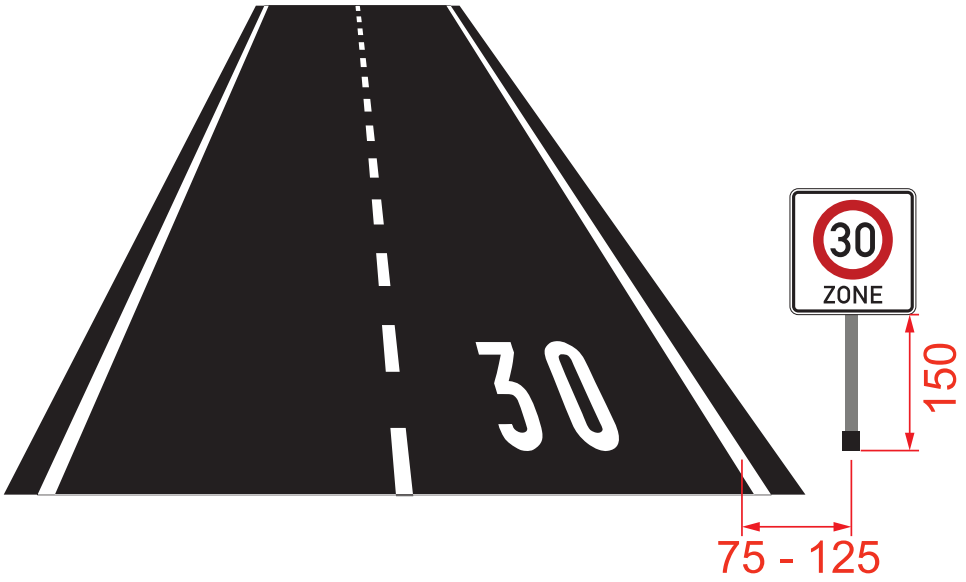


A.2. Traffic Signs

The traffic signs are defined according to StVO (Legal definition of traffic rules) and are applied as described there, except otherwise defined in this document. Additional information about the dimensions can be scaled based on this source.

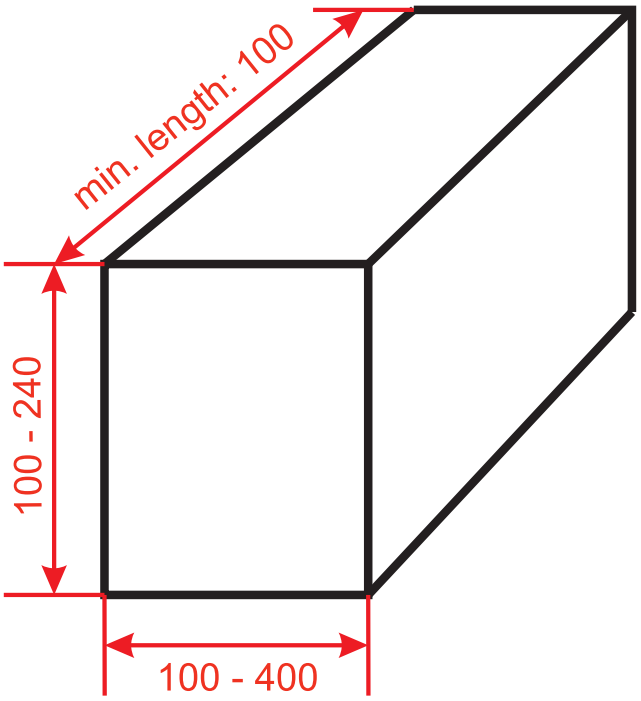
Traffic signs might appear in their mirrored version as well, e.g. turning symbols can indicate right or left turns.


Speed limit zone
30
ZONE
beginning
ZONE
end
Crosswalk
Parking Zone
P
Sharp turn
Expressway
beginning
end
Intersection
STOP
Barred area
Pedestrian island
No-passing zone
beginning
end
Steep hill
10%
uphill grade
10%
downhill grade
50
50

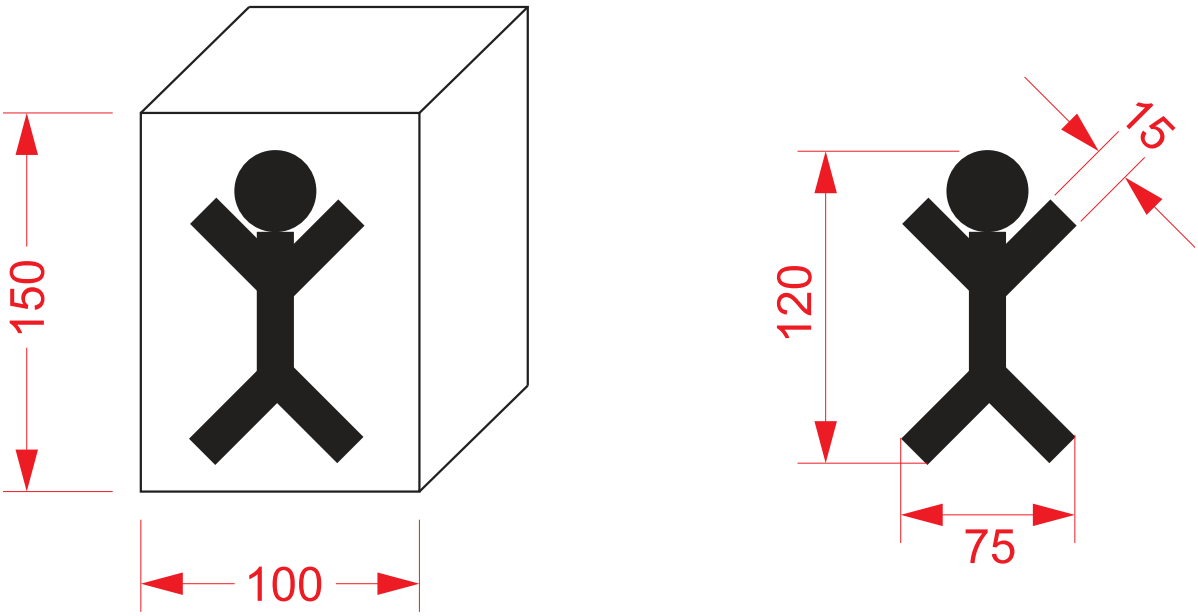


A.3. Dimensions of Obstacles

A.3.1. Static and Dynamic Obstacles

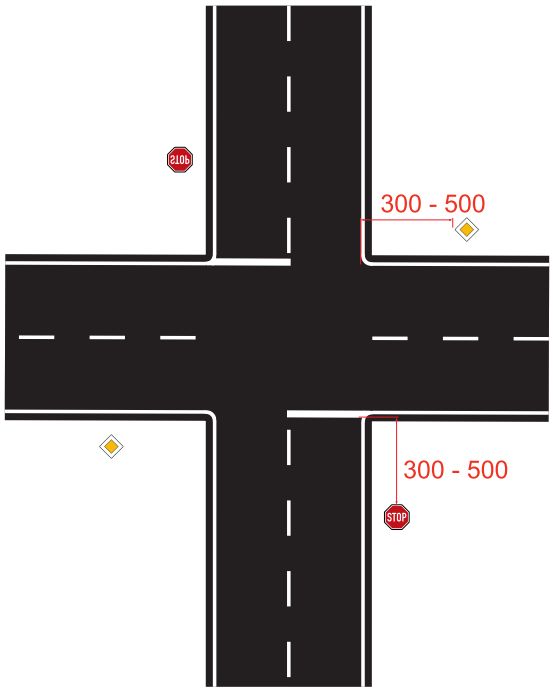


A.3.2. Pedestrians

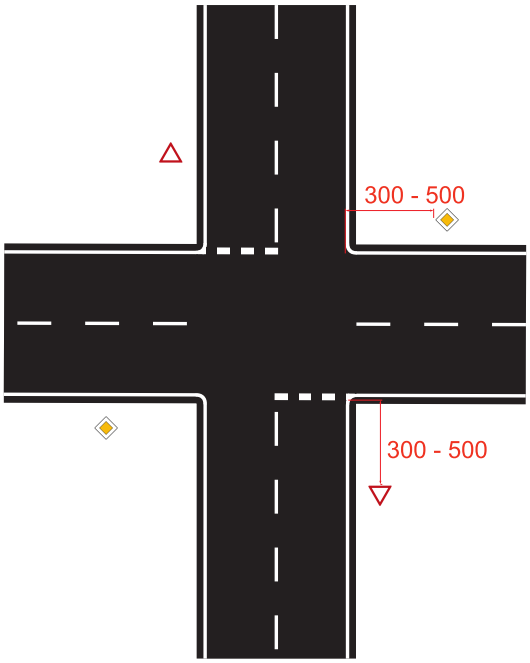


A.4. Intersections

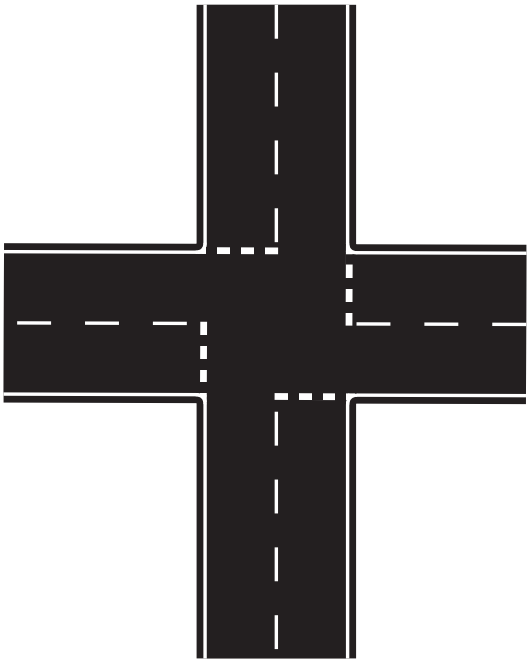
A.4.1. Intersection with Stop Lines



A.4.2. Intersection with Give-Way Lines

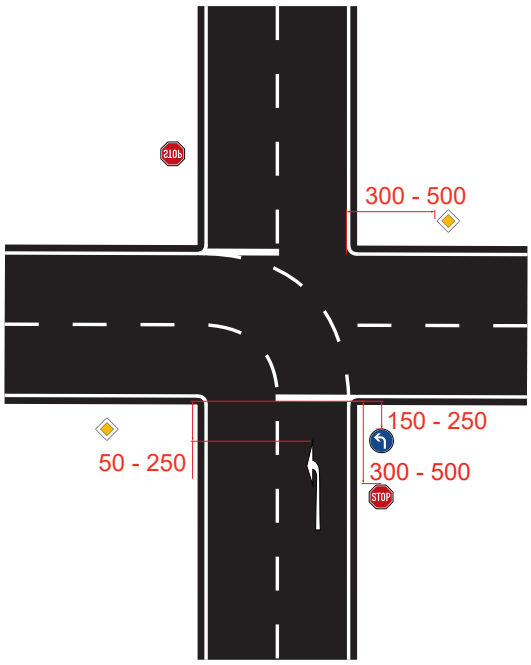


A.4.3. Intersection with Priority to Right

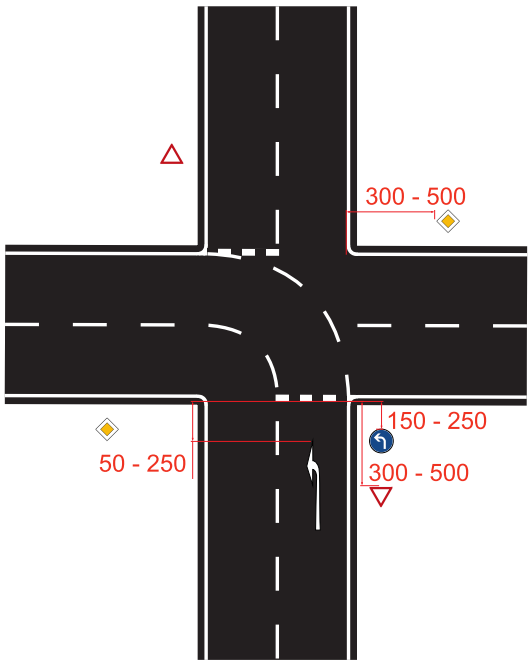


A.4.4. Intersection with Mandatory Turn

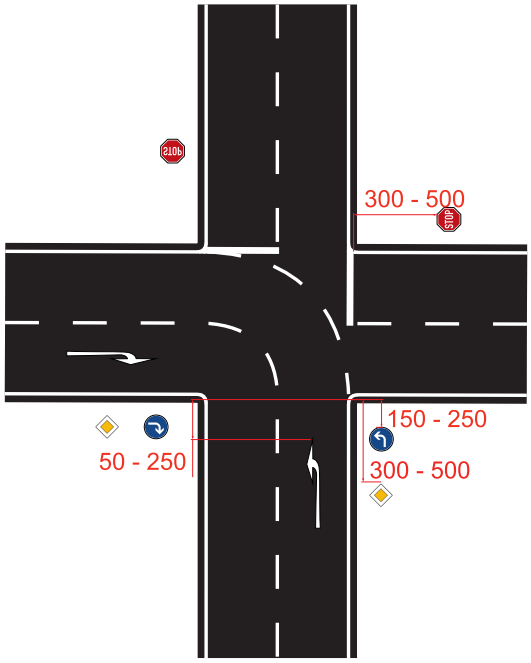
with Stop Lines



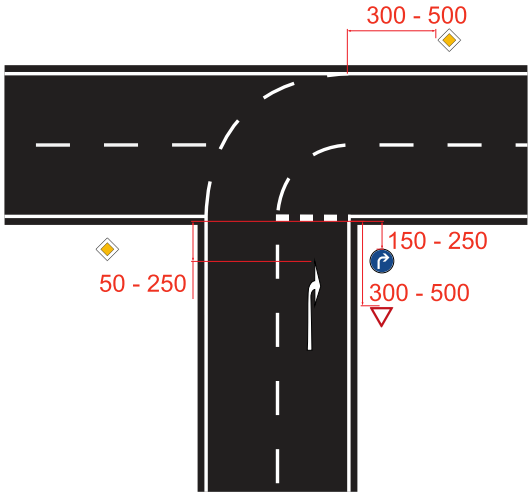
with Give-Way Lines



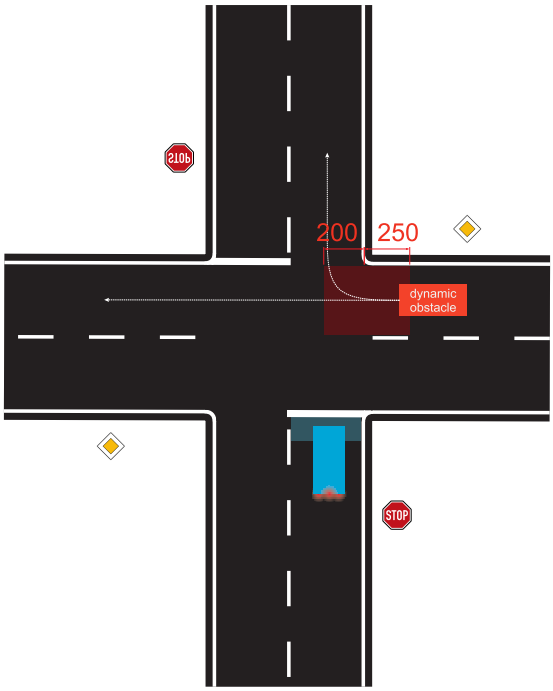
with Right of Way



A.4.5. Intersection with three Entries and Exits, Mandatory Turn and Give-Way Line

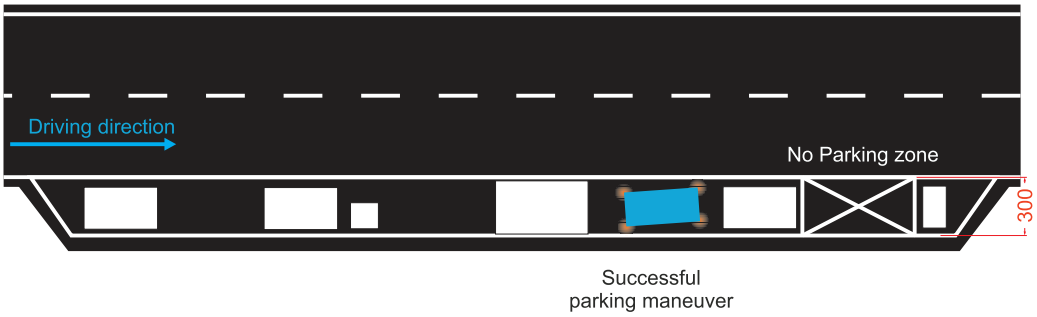


A.4.6. Dynamic Obstacles at Intersections

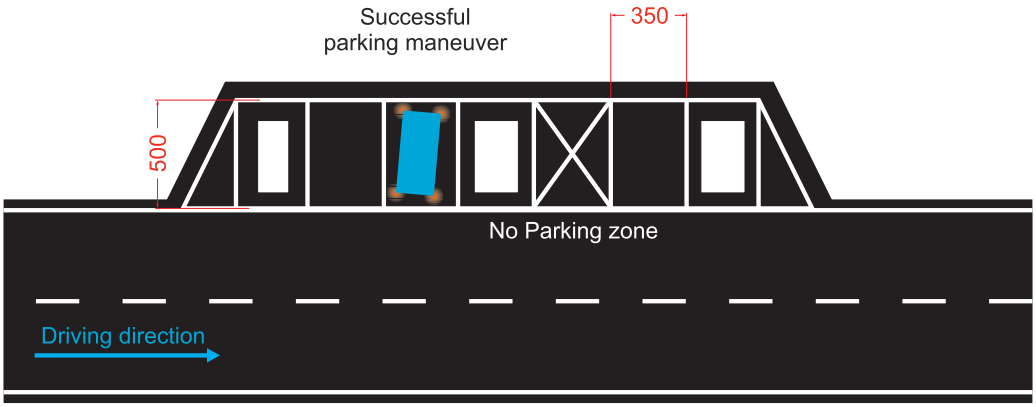


A.5. Parking

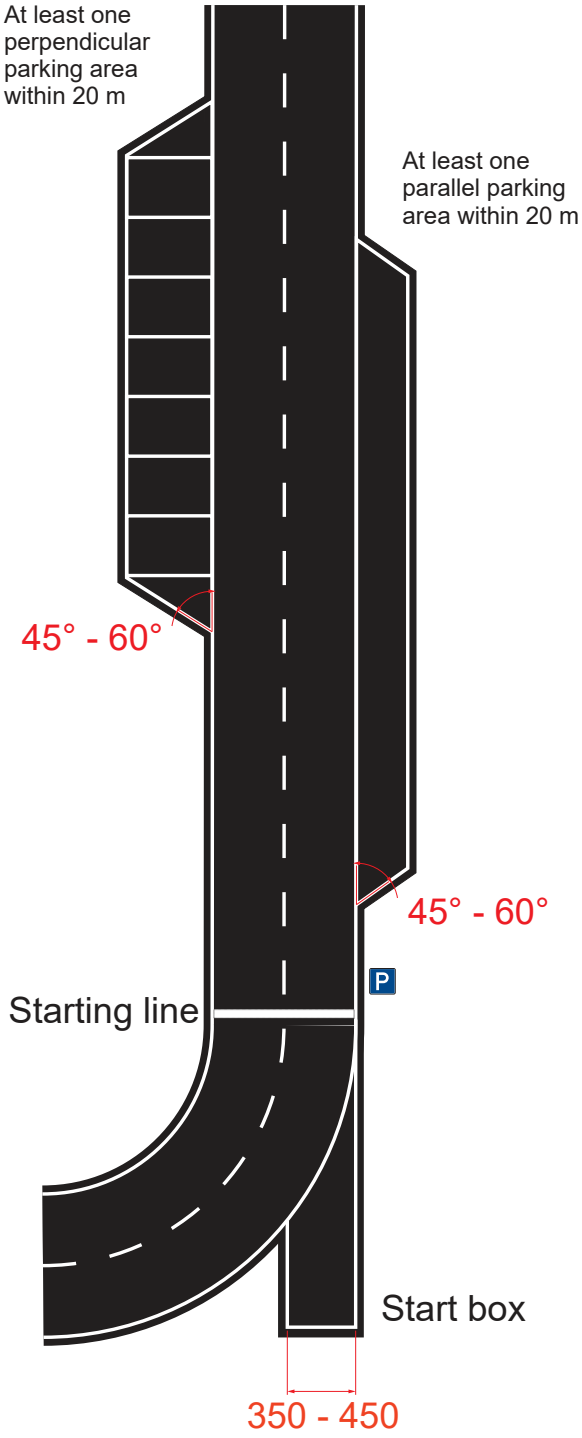
A.5.1. Parallel Parking



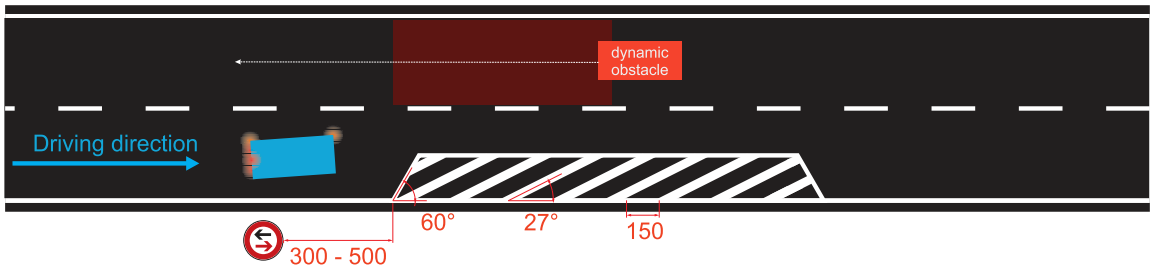
A.5.2. Perpendicular Parking



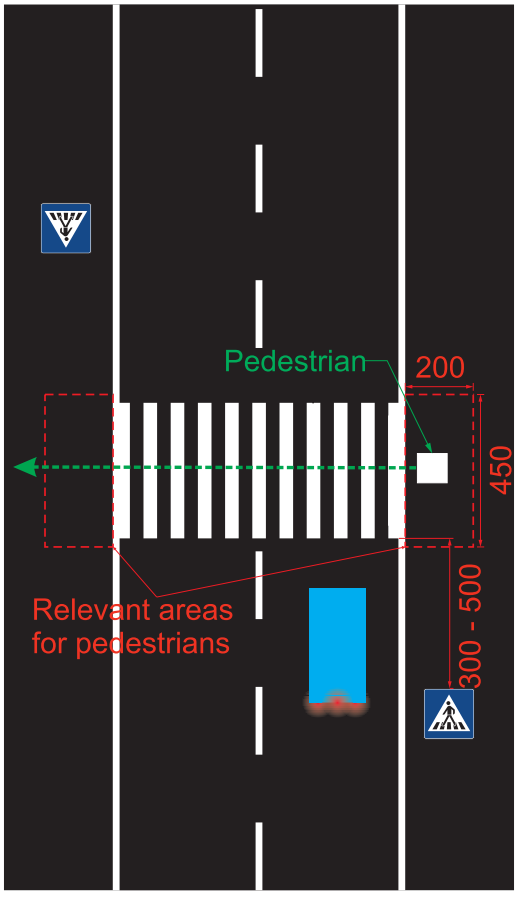
A.5.3. Parking Lot



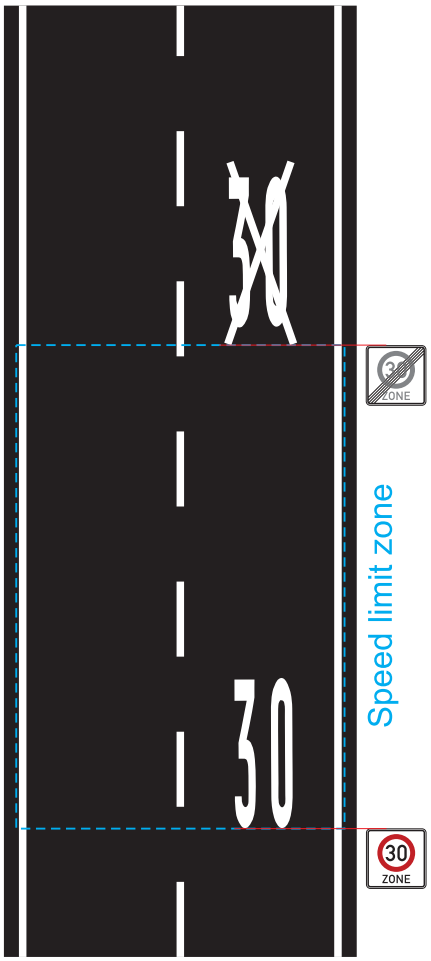
A.6. Barred Area



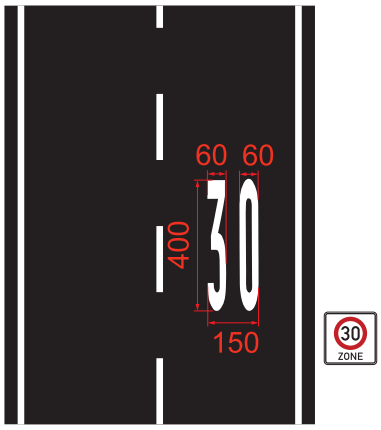
A.7. Crosswalk



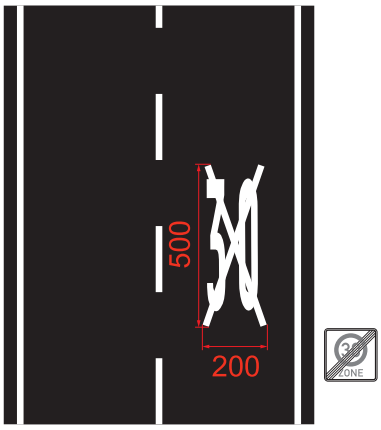
A.8. Speed Limit Zone



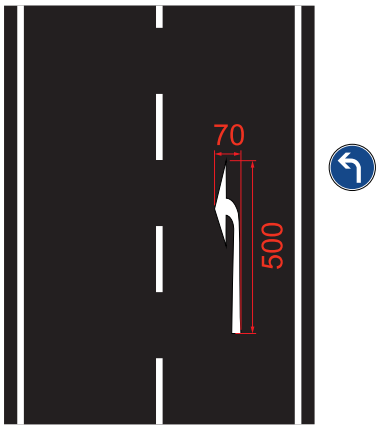
A.9. Road Markings



Speed limit zone



Speed limit zone end

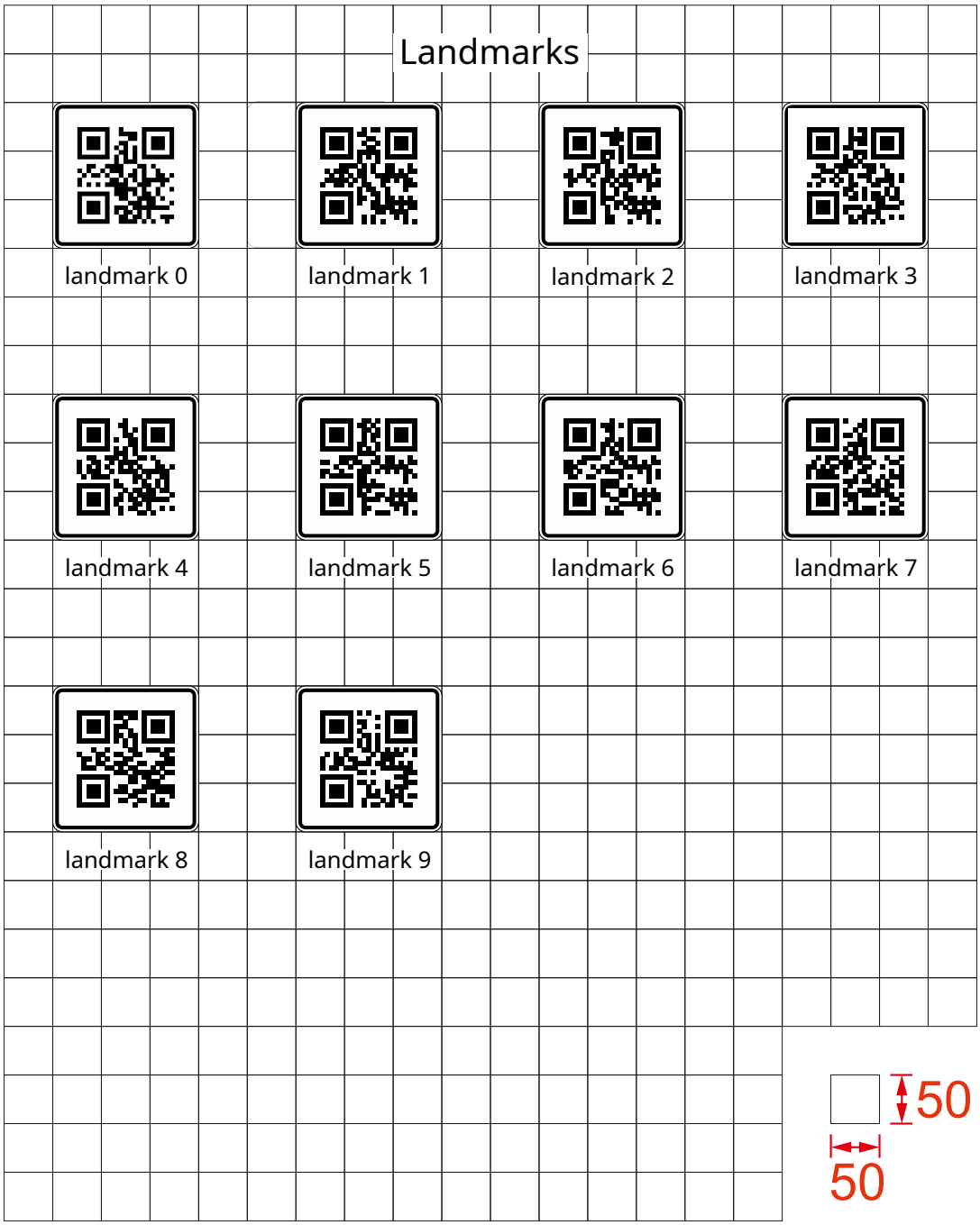


Turn left ahead

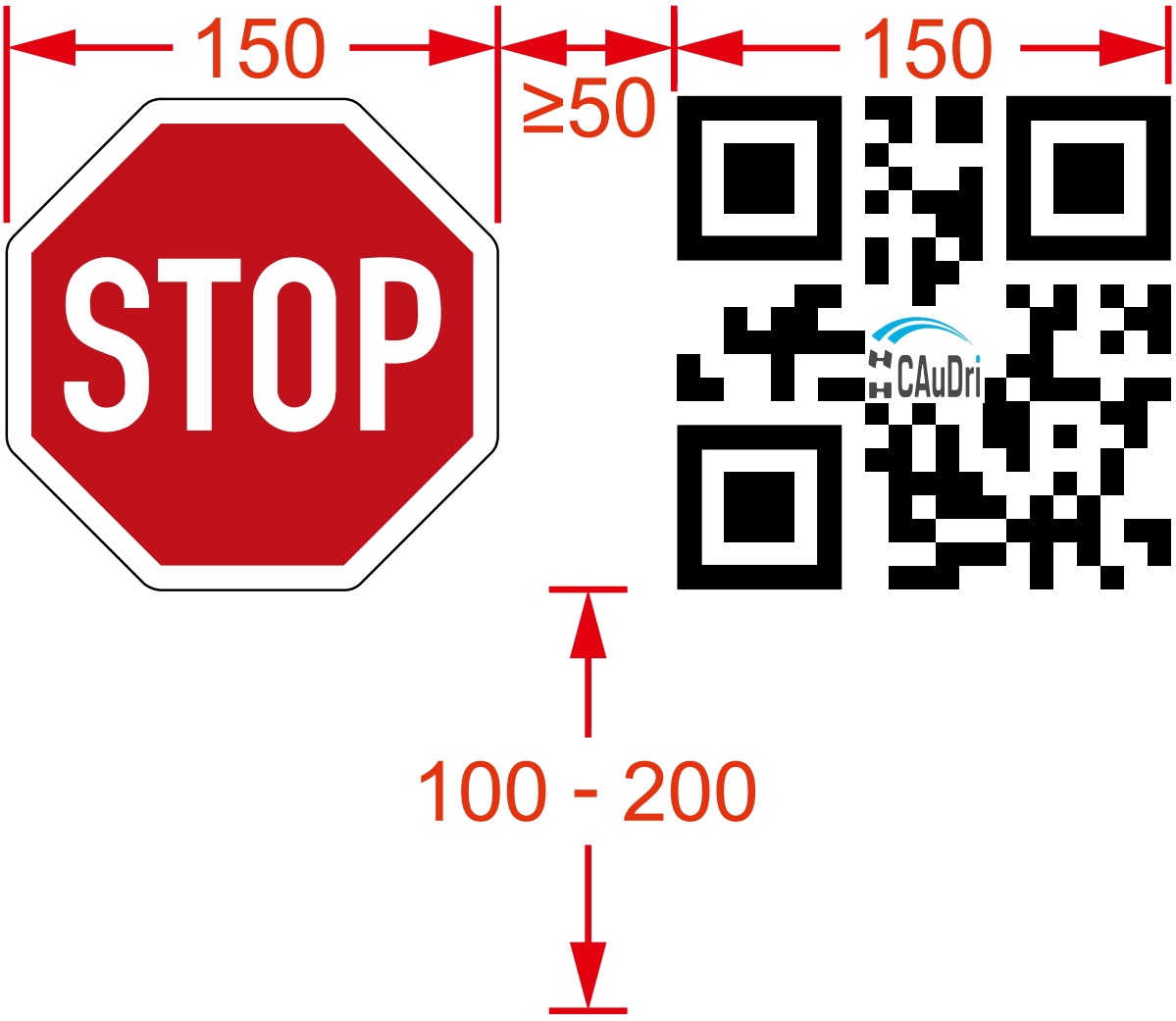
All digits possibly present

A.10. Landmarks

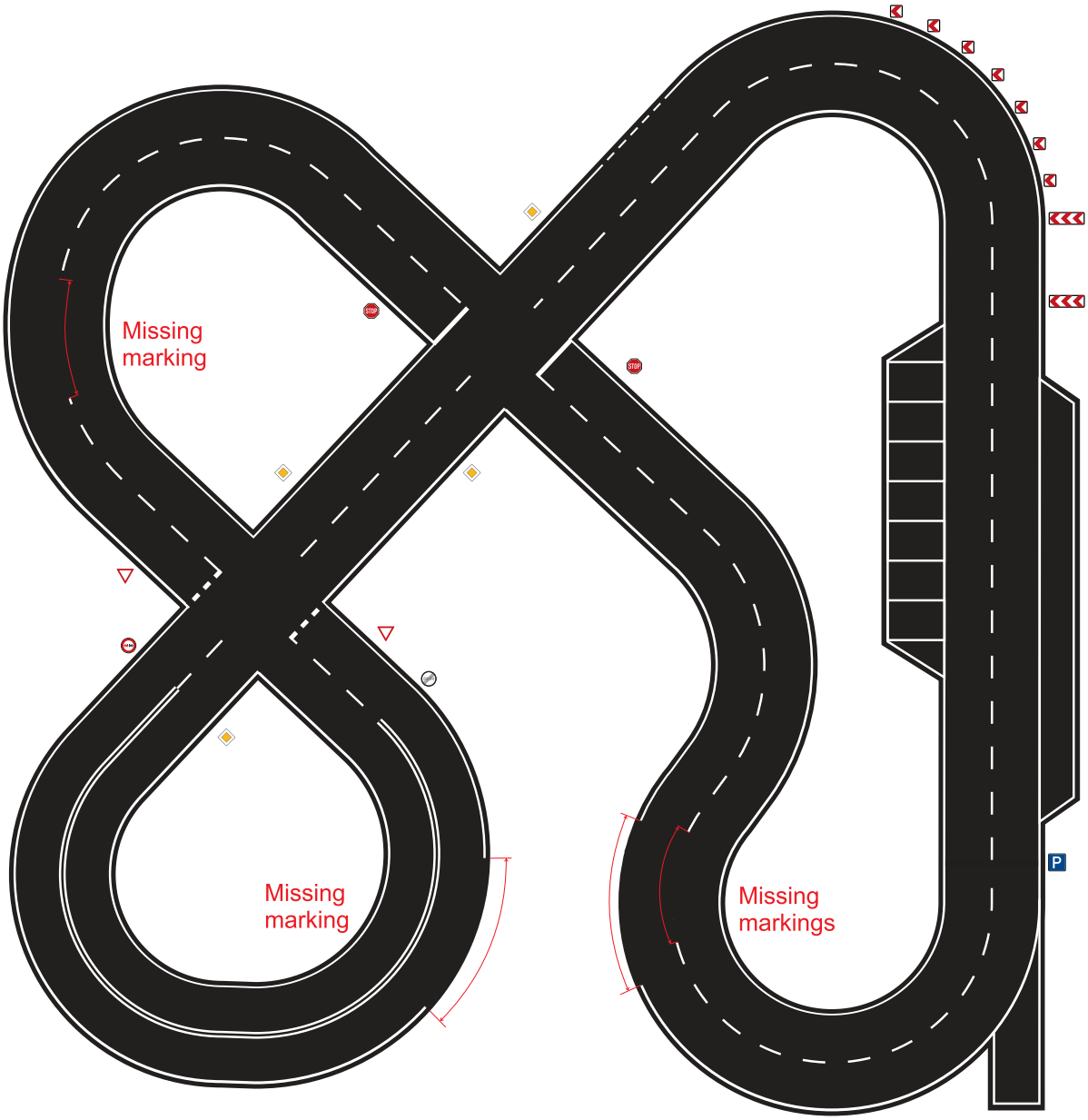
Landmarks are additional "traffic signs" serving as navigation points for the vehicle. Each landmark will depict a QR code with a unique identifier.


Landmarks
landmark 0
landmark 1
landmark 2
landmark 3
landmark 4
landmark 5
landmark 6
landmark 7
landmark 8
landmark 9
50
50

A.11. Markings of the Start Box Gate



A.12. Example Circuit



A.13. Example Circuit for Navigation Course