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CHANGELOG

| Rule | Version | Change |
|----------|---------|---|
| DE2.2.1 | 1.0 | Updated slot count for FSG 2020. |
| DE2.2.2 | 1.0 | New reserved slots. |
| DE2.2.5 | 1.0 | Updated slots for DV class. |
| DE3.2.3 | 1.0 | Relaxed DV VSV. |
| DE4.1.5 | 1.0 | No more specific truck parking area. |
| DE5.1.1 | 1.0 | Updated DBOM for FSG 2020. |
| DE5.2.1 | 1.0 | Updated CBOM for FSG 2020. |
| DE5.3.1 | 1.0 | No VGA input for BPP. |
| DE6.2 | 1.0 | Defined Endurance Running Order |
| DE6.3.5 | 1.0 | Added note on spare cones at trackside. |
| DE6.3.6 | 1.0 | Removed section about Autocross scoring (moved to Rules). |
| DE7.3.1 | 1.0 | Updated preliminary datalogger specification for 2020. |
| DE7.4.11 | 1.0 | Added note on HW manipulation and official logs. |

ABBREVIATIONS

| | | | |
|-------------|------------------------------------|-------------|---|
| AAIR | ASF Add Item Request | ESF | Electrical System Form |
| ADR | Autonomous Design Report | ESO | Electrical System Officer |
| ASF | Autonomous System Form | ESOQ | Electrical System Officer Qualification |
| ASR | Autonomous System Responsible | EV | Electric Vehicle |
| ASRQ | ASR Qualification | FSG | Formula Student Germany |
| BPP | Business Plan Presentation Event | FTO | Fuel Type Order |
| BPPV | Business Plan Pitch Video | HIC | Health Insurance Certificate |
| CBOM | Costed Bill of Material | IAD | Impact Attenuator Data |
| CEST | Central European Summer Time | LV | Low Voltage |
| CET | Central European Time | LVMS | Low Voltage Master Switch |
| CRD | Cost Report Documents | MU | Magazine Uploads |
| CTMD | Cell Temperature Monitoring Device | NMT | Network Management Protocol (CANopen) |
| CV | Internal Combustion Engine Vehicle | PDO | Process Data Object (CANopen) |
| DBOM | Detailed Bill of Material | RES | Remote Emergency System |
| DL | Data Logger | SDO | Service Data Object (CANopen) |
| DLDS | Data Logger Download Station | SE3D | Structural Equivalency 3D Model |
| DQ | Disqualified | SES | Structural Equivalency Spreadsheet |
| DSS | Design Spec Sheet | SESA | SES Approval |
| DV | Driverless Vehicle | TMD | Team Member Designation |
| EAIR | ESF Add Item Request | TS | Tractive System |
| EBS | Emergency Brake System | VSV | Vehicle Status Video |
| EDR | Engineering Design Report | | |

DE FORMULA STUDENT GERMANY COMPETITION HANDBOOK 2020

DE 1 GENERAL INFORMATION

DE 1.1 One Site - Three Competitions

DE 1.1.1 Three competitions will be organized by Formula Student Germany (FSG). These are for the Internal Combustion Engine Vehicle (CV) class, the Driverless Vehicle (DV) class and the Electric Vehicle (EV) class. All three competitions will take place during the same week at the same location.

DE 1.2 Competition Dates and Place

DE 1.2.1 FSG 2020 will be held from 17th until 23rd of August 2020 in Hockenheim, Germany.

DE 1.3 Competition Website

DE 1.3.1 The URL of the FSG competition website is <https://www.formulastudent.de>.

DE 1.4 Date and Time Format

DE 1.4.1 The competition date/time format is “YYYY-MM-DD hh:mm” according to ISO 8601¹.

DE 1.4.2 The competition time zone is Central European Time (CET)² or Central European Summer Time (CEST) from last Sunday of March to last Sunday of October, Europe/Berlin.

DE 1.4.3 The time of the competition website is the official time for all deadlines and decisions:
<https://www.formulastudent.de/time>.

DE 1.5 Vehicle Shipping

DE 1.5.1 Teams are advised to consult their shipping company or freight forwarder to ensure that their shipment fully complies with all relevant customs, import/export and aviation shipping requirements.

DE 1.5.2 Customs and other paperwork like ATA Carnet³, inspecting shipments as well as reporting and documenting damage of the shipment is the sole responsibility of the team.

¹https://en.wikipedia.org/wiki/ISO_8601

²https://en.wikipedia.org/wiki/Central_European_Time

³https://en.wikipedia.org/wiki/ATA_Carnet

DE 1.5.3 Detailed vehicle shipping procedures are published on the competition website.

DE 1.5.4 Teams should upload their shipping documents to the competition website.

DE 2 REGISTRATION

DE 2.1 Team Registration

DE 2.1.1 The team registration will take place in the form of a quiz. There will be one quiz for all three classes. The topic for the quiz is: Basic engineering knowledge and Formula Student Rules 2020.

DE 2.1.2 The URL of the registration website is <https://reg.formulastudent.de>.

DE 2.1.3 Teams must create a team account on the competition website and assign a team captain and two deputies. The deadline for this is 24 h before the registration starts, see DE 3.1. The team captain and his deputies may assign team members as participants simultaneously. Only one person (the team captain or one of his deputies) may complete the registration quiz.

DE 2.1.4 The quiz starts as defined in DE 3.1.

DE 2.1.5 Only one question will be visible at a time and can only be answered once.

DE 2.1.6 Questions will have a fixed duration during which an answer has to be provided by the team. The duration will be 5 min to 15 min.

DE 2.1.7 When entering the quiz late, depending on the delay, the first questions will not be visible anymore.

DE 2.1.8 Within teams with the same amount of correct quiz answers, the quiz result order will depend on the time needed for completion of the quiz. This time starts with the opening of the quiz for all teams (see DE 3.1). Teams with less correct quiz answers will be sorted behind teams with more correct answers.

DE 2.1.9 Once the quiz has been successfully completed, the team captain or one of his deputies must register the team for the competition by agreeing to the rules and by selecting a free vehicle number. Requests for changing the vehicle number are only possible within 168 hours (7 days) after the start of the registration.

| | EV | CV | DV(EV) | DV(CV) |
|-----------------|---------|---------|---------|---------|
| vehicle numbers | 001-199 | 201-399 | 401-499 | 501-599 |

DE 2.1.10 The quiz will close after the time to answer the last question has expired.

DE 2.1.11 No feedback if the answer was correct will be provided until the results are published on Saturday 2020-02-01 13:00 CET on the registration quiz page, see DE 2.1.4. After the results are published, teams have two hours to hand in protest until 2020-02-01 15:00 CET on <https://www.formulastudent.de/fsg/feedback-quiz/>. Protests by e-mail will be ignored. Quiz times and the resulting rankings will be published on Monday 2020-02-03 13:00 CET.

- DE2.1.12 Reserved slots (see DE2.2.2 and DE2.2.5) will be assigned to the teams based on past achievements and home countries. All remaining and unused reserved slots will be assigned to all other teams, with regard to their quiz result.
- DE2.1.13 All assigned teams will be placed on the pending list on the competition website. In order to move to the participating list, they have 72 h to pay the registration fee (see DE 2.3). Once all slots have been filled, all additional teams will be placed on a waiting list (see DE 2.4). Once this process is completed, the registration for those who missed the quiz will open. The period to pay the registration fee starts 2020-02-03 18:00 CET.
- DE2.1.14 The technical inspection order at the competition will be based on the quiz result.

DE 2.2 Registration Slots

- DE2.2.1 FSG 2020 is limited in total to 45 CV slots, 45 EV slots and 25 DV slots.
- DE2.2.2 Reserved slots for the CV and EV class will each be assigned to the following teams:
- Four top teams from FSG 2019
 - Four top teams from Europe according to latest World Ranking List⁴
 - Four top teams from outside of Europe according to latest World Ranking List⁴
- The top team slots will be assigned in the above order. Duplicate teams will be filled up with the next team from the respective category.
- DE2.2.3 The following international slots will be reserved for each the CV and EV class:
- Three teams from Australia, China, Japan and New Zealand
 - Three teams from Canada and the United States of America
 - Three teams from the rest of the world outside of Europe
- In case a team qualifies for both a top and an international slot it will use up both slots.
- DE2.2.4 In case a team with a reserved international slot doesn't pay the registration fee in time (see DE 2.3) its slot is given to the next team of its world region.
- DE2.2.5 Reserved slots for the DV class will be assigned to the following teams:
- Three top teams from FSG 2019
- DE2.2.6 The following international slots will be reserved for the DV class:
- Three teams from outside of Europe
- In case a team qualifies for both a top and an international slot it will use up both slots.
- DE2.2.7 All remaining and unused reserved slots will become available for all other teams after the registration quiz has been closed on the registration website (see DE 2.1.10).
- DE2.2.8 Europe is defined to consist of the following countries:
Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania-

⁴<https://fs-world.org>

nia, Luxembourg, Macedonia, Malta, Moldova, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Russia, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, Vatican City.

DE 2.3 Registration Fee

- DE 2.3.1 The registration fee is 1000 € and includes a 20-person team. More team members can be registered for 50 € per participant until the TMD deadline (see DE 3.2). Team members may register after this deadline for a fee of 100 € per participant. There is no limit in team size and no deadline for late bookings.
- DE 2.3.2 The registration fee must be paid online within 72 h by a verified PayPal account after the team has been moved to the pending list in order to move to the participating list. Otherwise the team will be de-registered.
- DE 2.3.3 Registration fees are not refundable for any reason.

DE 2.4 Waiting List & Withdrawals

- DE 2.4.1 Teams on the waiting list may move to the participating list until 2020-07-31 13:00 CEST. This is possible if registered team withdraw from the competition. Once a slot on the participating list has become available again, the next team on the waiting list will move to the pending list and has 72 h to pay the registration fee in order to move to the participating list.
- DE 2.4.2 Teams on the waiting list are required to submit all documents and forms by the same deadlines as teams on the participating list.
- DE 2.4.3 Teams on the waiting and participating lists who find that they will not be able to attend the competition are requested to officially withdraw by notifying the officials.

DE 2.5 Team Member Designation (TMD)

- DE 2.5.1 Participating team members must be assigned prior to the competition by the team captain or his deputies.
- DE 2.5.2 If there are any team members who are studying at a different university, they must choose the team's university during their registration process as a team member.
- DE 2.5.3 Team members may only be selected as participants by the team captain, if they have entered the following personal information in their user profiles:
- Personal address
 - Clothing size
 - Valid Health Insurance Certificate (HIC) for Germany (e.g. travel insurance)
 - Current target degree of study
- DE 2.5.4 All participants who passed the HIC-check, will find personalized standard terms in their account overview. This document must be printed out, signed by the participant and brought to the on-site registration in alphabetical order by the team captain.

DE 2.6 Visa for Participants

- DE 2.6.1 All participants which passed the HIC-check, will find a personalized letter of invitation with a digital signature in their account overview.
- DE 2.6.2 An invitation letter with a hand signature can be ordered on the competition website. Once a fee of 90 € has been paid, the letter will be sent out within two weeks.

DE 3 IMPORTANT DATES**DE 3.1 Team Registration**

- DE 3.1.1 Team registration (see DE 2.1) for all teams starts on 2020-01-31 13:00 CET and ends 336 hours (14 days) later.

DE 3.2 Deadlines

- DE 3.2.1 All required documents and information must be uploaded to the competition website by the team captain and/or his/her deputies by the deadlines as stated in Table 2.

| Date | Deadline | Class |
|-----------------------|--|-------|
| 2020-02-28 13:00 CET | ASF Add Item Request (AAIR) | DV |
| 2020-02-28 13:00 CET | ESF Add Item Request (EAIR) | EV |
| 2020-03-13 13:00 CET | Autonomous System Form (ASF) | DV |
| 2020-03-13 13:00 CET | Electrical System Form (ESF) | EV |
| 2020-03-20 13:00 CET | Impact Attenuator Data (IAD) | ALL |
| 2020-03-20 13:00 CET | Structural Equivalency 3D Model (SE3D) | ALL |
| 2020-03-20 13:00 CET | Structural Equivalency Spreadsheet (SES) | ALL |
| 2020-04-17 13:00 CEST | SES Approval (SESA) | ALL |
| 2020-06-05 13:00 CEST | Autonomous Design Report (ADR) | DV |
| 2020-06-05 13:00 CEST | Business Plan Pitch Video (BPPV) | ALL |
| 2020-06-05 13:00 CEST | Design Spec Sheet (DSS) | ALL |
| 2020-06-05 13:00 CEST | Engineering Design Report (EDR) | ALL |
| 2020-06-05 13:00 CEST | Magazine Uploads (MU) | ALL |
| 2020-06-26 13:00 CEST | ASR Qualification (ASRQ) | DV |
| 2020-06-26 13:00 CEST | Electrical System Officer Qualification (ESOQ) | EV |
| 2020-06-26 13:00 CEST | Fuel Type Order (FTO) | CV |
| 2020-06-26 13:00 CEST | Team Member Designation (TMD) | ALL |
| 2020-07-10 13:00 CEST | Vehicle Status Video (VSV) | ALL |
| 2020-07-31 13:00 CEST | Cost Report Documents (CRD) | ALL |
| 2020-07-31 13:00 CEST | Final dbc file upload | DV |

Table 2: Document deadlines

- DE 3.2.2 All documents must comply with a maximum size of 40 MB.
- DE 3.2.3 [DV ONLY] In the Vehicle Status Video (VSV), the vehicle does not have to perform a full stop as mentioned in A 5.6.2.

DE 4 COMPETITION SITE ORGANIZATION

DE4.1 Entering the Competition Site

- DE4.1.1 A pink “team truck” entrance pass with a green “unload card” attached to it is handed to each team at the registration. This entrance pass must be filled out completely and displayed behind the windscreen of the “team truck” used to transport the competition vehicle and equipment to the pits.
- DE4.1.2 The driver may queue the “team truck” only after the entrance passes are filled out.
- DE4.1.3 The total length of the “team truck” including a possible trailer must not exceed 12 m.
- DE4.1.4 The team is entitled to enter the competition site only once with their “team truck” for a maximum of 30 min for the purpose of unloading their competition vehicle and equipment.
- DE4.1.5 Afterwards the “team truck” must be moved outside of the Hockenheimring.
- DE4.1.6 It is not possible to drive to the pit area again with the “team truck” during the event before loading on Sunday.
- DE4.1.7 On Sunday 2020-08-23 the team is entitled to enter the pits once with the “team truck” for a maximum of 30 min for the purpose of loading.
- DE4.1.8 On request, teams may receive an additional yellow entrance pass that allows one passenger vehicle to enter the pit area for the next hour. These passes are only given out from Wednesday 2020-08-19 until Sunday 2020-08-23 11:00 CEST.

DE4.2 Announcements

- DE4.2.1 All announcements can be found on the competition website
<https://today.formulastudent.de/>.

DE4.3 Competition Site

- DE4.3.1 The use of motorcycles, quads, bicycles, scooters, skateboards or other similar mobility devices as well as self-propelled devices in general by team members and spectators is prohibited.
- DE4.3.2 No tents or pavilions are allowed on the entire competition site.
- DE4.3.3 Lost & found items must be picked up until Sunday 2020-08-23 20:00 CEST at event control.
- DE4.3.4 Confiscated goods must be picked up until Sunday 2020-08-23 18:00 CEST in the dynamic area near the “Scruti House”. Confiscated items that are not picked up in time will not be kept.
- DE4.3.5 No music speakers or devices with a total power over 20 W are allowed on the camp site at any time during the competition. Teams generating more noise may be excluded from the competition.

DE4.4 Event Control

- DE4.4.1 The team captain will receive a package containing shirts, programs, etc. at event control. Large teams may bring one or two extra people to help carrying.

DE4.5 Welding

- DE4.5.1 FSG provides an approved welder. Outside of the opening hours it is possible to weld with own equipment in the welding area only, using appropriate safety gear.

DE4.6 Tyres

- DE4.6.1 FSG provides a tyre changing service.

DE4.7 Fuel Station

- DE4.7.1 Open fuel containers are not permitted at the event.
- DE4.7.2 All fuel containers must be DOT approved.
- DE4.7.3 Refueling is only allowed at the fuel station.
- DE4.7.4 Waste oil is to be taken to the fuel station for disposal.

DE4.8 [CV ONLY] Engine Test Area

- DE4.8.1 Engines may only be run in the designated engine test area during the opening times and only after passing the tilt test.

DE4.9 Driver Registration

- DE4.9.1 Drivers must register personally at the event control where they have to show their valid driver's license and a student ID.

DE4.10 Team Briefing (A 6.3)

- DE4.10.1 Each team member required in a certain briefing will receive a RFID-wristband which will be scanned at the entrance to log him/her as attendant on the present day.
- DE4.10.2 Drivers without the RFID scan cannot participate at the dynamic events of this particular day.

DE4.11 Technical Inspection

- DE4.11.1 On Monday 2020-08-17 the mechanical, electrical and driverless inspection will take place in the pits. From Tuesday 2020-08-18 on it will take place in the technical inspection area.

DE 4.12 Technical Inspection Time Schedule

- DE 4.12.1 The technical inspection parts pre-inspection, accumulator inspection, mechanical inspection, electrical inspection and driverless inspection will be conducted within a strict time schedule where every team will get a predesignated time slot based on the registration quiz order. The time schedule will be published on the website shortly before the start of the competition.

DE 4.13 Transponders / Timekeeping

- DE 4.13.1 Three RFID-tags will be mounted on the vehicle during the event using velcro tape. The size of each tag is 104 mm x 33 mm.
- DE 4.13.2 After the competition, these tags must be returned to the event control.
- DE 4.13.3 The tags must not be fixed in any other way than done by the officials initially. This especially includes safety wiring or tape, as both interfere with the detection of the tags. In the unlikely event that a tag loosens from its mounting, this will never be treated as the team's fault.
- DE 4.13.4 Live-timing is provided at <https://tk.formulastudent.de>. The shown data is unofficial.

DE 5 STATIC EVENTS**DE 5.1 Detailed Bill of Material (DBOM)**

- DE 5.1.1 For FSG 2020 a DBOM (see S 2.5) for the "Suspension System" must be submitted.

DE 5.2 Costed Bill of Material (CBOM)

- DE 5.2.1 For FSG 2020 a CBOM (see S 2.6) for the "Electrical System" must be submitted.

DE 5.3 Business Plan Presentation Event (BPP)

- DE 5.3.1 Data projectors or screens with HDMI (type A) input connectors will be provided for video signal transmission. Teams planning to use audio or other presentation equipment are responsible for bringing it themselves.

DE 6 DYNAMIC EVENTS**DE 6.1 [EV ONLY] Dynamic Area and Dynamic Vests (D 1.2)**

- DE 6.1.1 The charging area is a separated dynamic area including separate entrance restrictions.
- DE 6.1.2 Only three members per team may enter the charging area at the same. One of them must be a Electrical System Officer (ESO) or Autonomous System Responsible (ASR), respectively.
- DE 6.1.3 Inside the charging area, team members must not wear any conductive jewelery and must not wear any conductive objects of any kind which could touch the accumulator.

DE 6.1.4 CEE charging connectors 16 A, 32 A and CEE 7/3 “Schuko” are available in the charging area.

DE 6.2 Endurance Running Order

DE 6.2.1 The running order for the endurance according to D 7.3 will be published before the start of the endurance.

DE 6.2.2 At least the five next vehicles according to the running order must queue up at any time during the endurance.

DE 6.2.3 The queue must be continuously filled up by the following vehicles.

DE 6.2.4 A vehicle is defined as running out of order and penalized according to D 9.2.1 if it missing from the queue.

DE 6.3 [DV ONLY] Track Marking

DE 6.3.1 The markings of all dynamic events will have the following characteristics:

- The track is marked with cones.
- The left borders of the track are marked with small blue cones.
- The right borders of the track are marked with small yellow cones.
- Exit and entry lanes are marked with small orange cones.
- Big orange cones will be placed before and after start, finish and timekeeping lines.
- If not defined otherwise in chapter D of the rules, the maximum distance between two cones in driving direction is 5 m. In corners, the distance between the cones is smaller for a better indication.
- The start, finish and timekeeping lines as well as keep out zones around the timekeeping equipment are marked with red, orange or pink paint.
- Additionally for skid pad and trackdrive, track limit lines on either side of the track and entry/exit lanes may be marked with yellow, green or white paint.
- There are no track limit lines for acceleration and Emergency Brake System (EBS)-test.

DE 6.3.2 All lines are spray painted with the chalk-based marking paint “Soppec - Tempo T.P.”⁵.

DE 6.3.3 The cones used at the competition are equal to the cones listed in Table 3 despite that there will be letters “FSG” on the black/white band of the cones (white/black respectively).

DE 6.3.4 The manufacturer WEMAS⁶ does not sell the cones to end customers, but they may be purchased from baustellenabsicherung24.de⁷.

DE 6.3.5 There are the following limitations mainly resulting from the Hockenheim track conditions and organizational/authorizational issues:

⁵<https://soppec.com/gb/construction-marking-spray-paints/13-tempo-tp.html>

⁶<https://www.wemas.de>

⁷<https://baustellenabsicherung24.de/leitkegel-titan-180-1934.html>





| | | | |
|---|---|--|---|
|  |  |  |  |
| big orange cone two white stripes | small orange cone single white stripe | small yellow cone single black stripe | small blue cone single white stripe |
| WEMAS 307.610500.00.00 | WEMAS 400.000013.00.00 | WEMAS 400.000013.01.10 | WEMAS 400.000043.00.00 |
| 285 mm × 285 mm × 505 mm 1.05 kg | 228 mm × 228 mm × 325 mm 0.45 kg | | |

Table 3: Cone specs

- The lines may not be perfectly and continuously drawn.
- There may be further markings, to those mentioned above, that are not part of the track (e.g. markings, including cone position markings, lines from other events or different colored surface, etc.) on or close to the track which will not be removed by the officials.
- There may be (stacked) spare cones standing at the trackside at distinguishable distance.
- No special artificial landmarks are provided by officials. The team must not place additional landmarks on the track or inside the dynamic area.
- No map data is provided by the officials.

DE6.3.6 Figures 1, 2 and 3 visualize the track layout descriptions given in D4.3, D5.1, and D8.1.

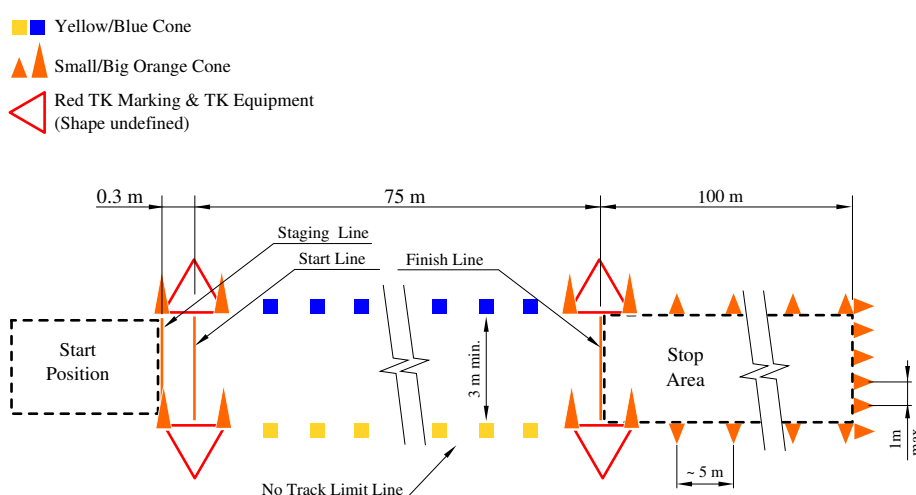


Figure 1: Acceleration

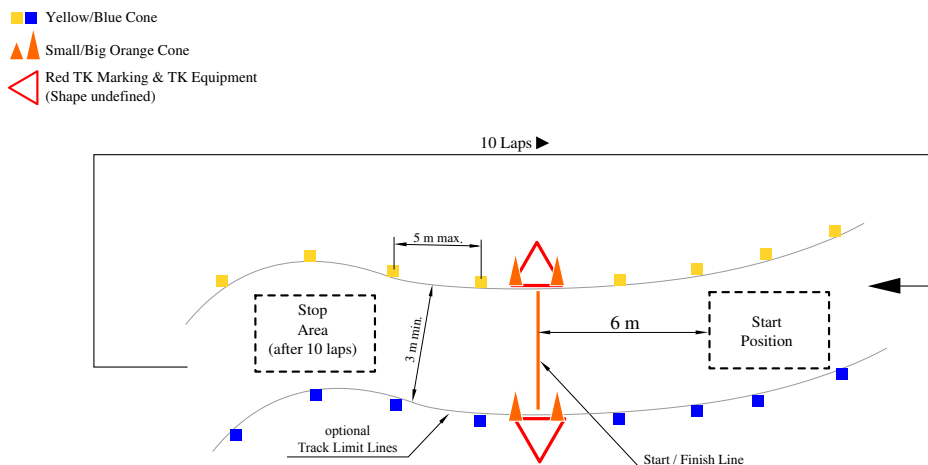


Figure 2: Trackdrive

DE 7 VEHICLE REQUIREMENTS AND RESTRICTIONS

DE 7.1 Technical Inspection Sticker (IN 1.3)

DE 7.1.1 For the competition technical inspection sticker, a space 50 mm tall × 180 mm wide must be made available on the nose of the vehicle directly in front of the cockpit opening.

DE 7.2 [EV ONLY] Cell Temperature Monitoring Device (CTMD) (EV 5.8.5)

DE 7.2.1 A Cell Temperature Monitoring Device (CTMD) has to be installed inside the Tractive System (TS) accumulator container. It consists of a single box which is connected to three temperature sensors. The Cell Temperature Monitoring Device (CTMD) as well as the temperature sensors are provided by the officials.

DE 7.2.2 The CTMD must be properly fastened and mounted inside the accumulator container. A step file showing the dimensions will be provided on the competition website.

DE 7.2.3 Every TS accumulator container must be equipped with a separate CTMD.

DE 7.2.4 The exceptions listed in EV 5.4.3 are extended to the CTMD.

DE 7.2.5 The CTMD must be supplied by a voltage of 7 VDC to 60 VDC. It must be directly connected to the Low Voltage Master Switch (LVMS) and must be reasonably fused in the supply wiring. It draws a maximum power of 2.5 W.

DE 7.2.6 The CTMD's CAN bus interface has to be directly connected to the corresponding datalogger CAN bus interface.

DE 7.2.7 The CAN bus interface operates on a data rate of 1Mbit/s and is not terminated internally.

DE 7.2.8 The CAN message layout can be obtained from a dbc-file provided on the competition website prior to the competition.

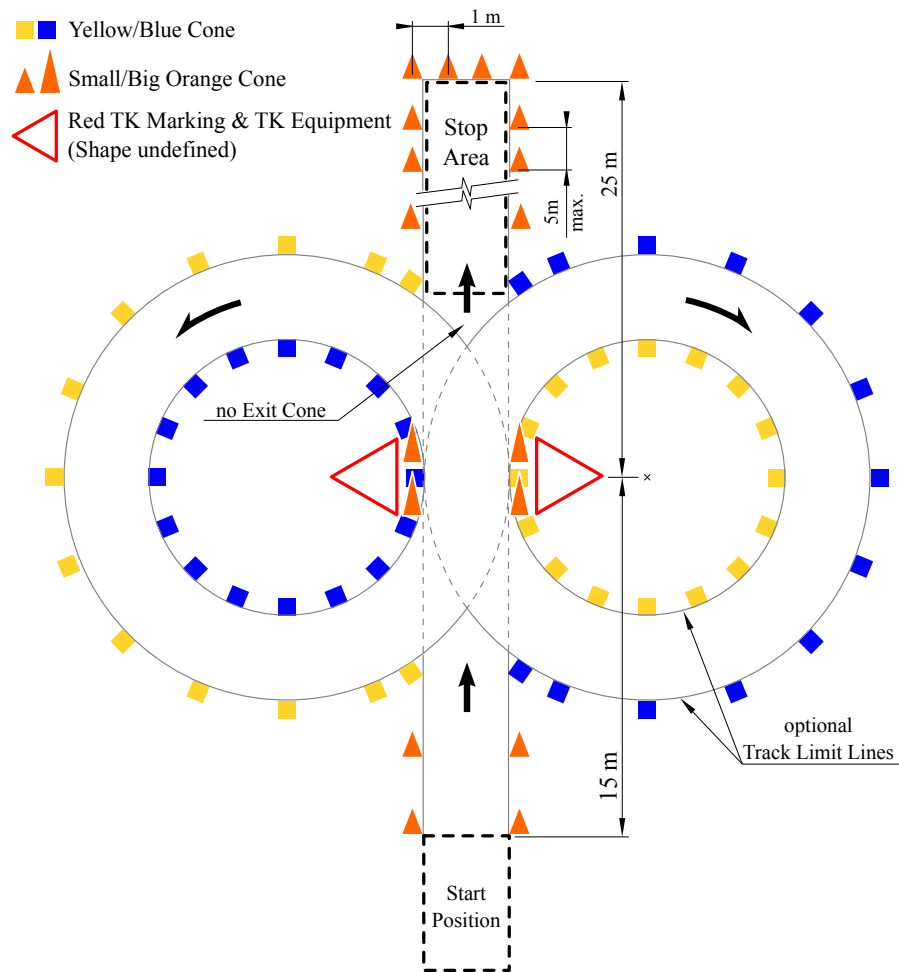


Figure 3: Skidpad base configuration according to rule D4.3

DE7.2.9 NTC Thermistors (Vishay NTCAFLEX05) are used for the measurement. These sensors will be glued in the accumulator during accumulator inspection. The position will be defined in the Electrical System Form (ESF) and in accumulator inspection.

DE7.2.10 The CTMD is a single box with the following four connectors:

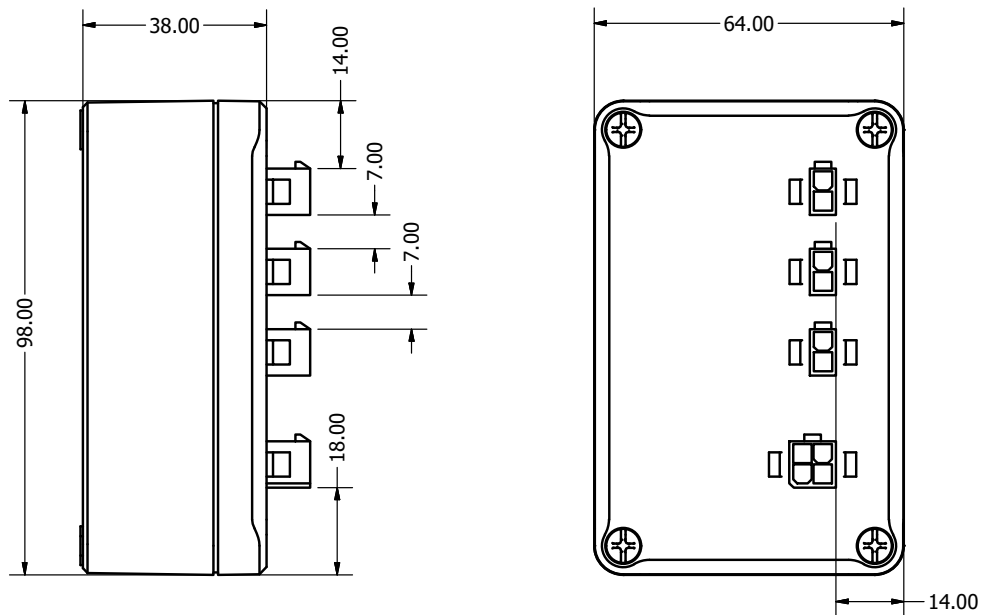
- 3x Molex Mini-Fit Jr. 39-30-0020 (CTMD-side)
 - Connector to each temperature sensor
 - Sensors, connectors and wiring harness will be provided by the officials
- 1x Molex Mini-Fit Jr. 39-30-0040 (CTMD-side)
 - Power and CAN interface

DE7.2.11 The pinout of the Low Voltage (LV) connector has to be according to Table 4.

DE7.2.12 The position of the connectors can be deduced from Figure 4.

| Pin | Description |
|-----|-------------|
| 1 | LV+ |
| 2 | LV- |
| 3 | CANH |
| 4 | CANL |

Table 4: Pinning LV connector CTMD

Figure 4: Dimensions of the CTMD. **Positions of the connectors are preliminary.**

- DE 7.2.13 Teams are advised to check the status messages, as they provide the status of the CTMD.
- DE 7.2.14 Missing data due to not checking the status messages will be treated as a fault of the team.
- DE 7.2.15 Status messages are sent with a frequency of 5 Hz.
- DE 7.2.16 The temperature data will be sent from the CTMD to the Data Logger (DL), see EV 4.6, and stored there. This data will be used for scoring.

DE7.3 [EV OR DV ONLY] Data Logger (EV 4.6 and DV 1.3)

- DE 7.3.1 A DL according to this specification will be used and provided by the officials as official measuring system according to EV 4.6 and DV 1.3. **The DL specification is considered preliminary and will be updated in a later version of this document. The outer dimensions of the DL are final.**
- DE 7.3.2 The DL must be mounted according to EV 4.6. It must be properly fastened and mounted at a location where it is protected from water. Its housing is of the type “Bopla Euromas II ET212” with outer dimensions of 100 x 100 x 57mm and a weight of approximately 400 g. CAD-data of the DL can be found on the competition website.⁸

- DE7.3.3 The DL must be supplied by a voltage of 7 VDC to 60 VDC. It draws a maximum power of 9 W. It must be reasonably fused in the supply wiring.
- DE7.3.4 The CAN bus interface operates on a data rate of 1 Mbit/s and is not terminated internally.
- DE7.3.5 The CAN message layout can be obtained from a dbc-file provided on the competition website.⁸
- DE7.3.6 The Ethernet interface is according to the 100BASE-TX standard and requires a cable at least adhering to ISO/IEC 11801 Cat 5 with an RJ-45 connector. It must be easily accessible for data download.
- DE7.3.7 The sensor used by the DL is an Isabellenhütte IVT-500-U3-TOI-CAN2-12.⁹
- DE7.3.8 The pinout of the connectors has to be according to Tables 5, 6 and 7.
- DE7.3.9 The DL is a single box with two LED and the following five connectors:

M10 nickel-plated brass bolts

- TS- in current path
- Must be connected fulfilling EV 4.6.4
- **Maximum tightening torque:** 22 Nm.

Connector to be determined (DL-side)

- TS+ voltage measurement
- Must be connected fulfilling EV 4.6.5

Binder 99 3431 202 04 (DL-side)

- Power and CAN interface
- Must power the DL according to EV 4.6.6.
- Can be connected to a vehicle CAN bus to obtain status messages.
- Teams are advised to check the status messages, as they provide the status of the data logger.
- Missing data due to not checking the status messages will be treated as a fault of the team.
- Status messages are sent with a frequency of 50 Hz.
- Status messages contain maximum values (Voltage, Current, Power) of the respective time interval.
- Status messages are provided as a general reference only, only the data stored on the DL will be used for scoring.

⁸<https://formulastudent.de/rules>

⁹<https://isabellenhuette.de/en/precision-measurement/standard-products/ivt-series>

- [DV ONLY] CAN Interfaces must be connected to the bus shared with the Remote Emergency System (RES).

| Pin | Description |
|-----|-------------|
| 1 | LV+ |
| 2 | LV- (GND) |
| 3 | CANH |
| 4 | CANL |

Table 5: DL side Power & CAN Connector (Binder 99 3431 202 04)

Connector to be determined (DL-side)

- 100 Mbit/s Ethernet interface used for connecting to the DL
- Must be routed to a shielded RJ-45 plug with pinout specified in Table 7.
- The cable must be long enough to reach the top of the Main Hoop.

| Pin | Description |
|-----|------------------|
| | to be determined |

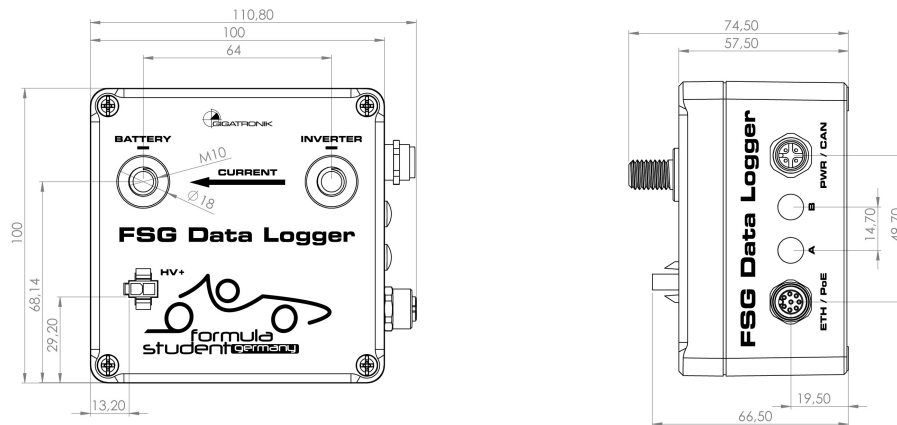
Table 6: DL side Ethernet connector (**Connector to be determined**)

| to be determined

Table 7: Team/Officials side Ethernet connector (RJ-45)

| Status | LED A | LED B |
|--------|------------------|-------|
| | To be determined | |

Table 8: DL status LEDs



(a) DL top view (not final, connector positions might change) (b) DL side view (not final, connector positions might change)

Figure 5: DL drawings (dimension in mm)

- DE7.3.10 At the competition, several Data Logger Download Station (DLDS) will be provided as self-service terminals.
- DE7.3.11 It is the responsibility of the team to ensure that the DL data from each event is made available to the officials by having it downloaded at a DLDS one hour after the closing of the respective event latest.
- DE7.3.12 Failure to make the data available within the specified time period due to the team's fault will result in the team not being scored for the respective event.
- DE7.3.13 Non-availability of DL data due to excessive electromagnetic emission by the vehicle will be treated as a power and voltage violation according to D9.4.1.
- DE7.3.14 [DV ONLY] The communication described in section DE7.4.8 must be traceable in the logs.
- DE7.3.15 [DV ONLY] Beside RES messages (see DE7.4.8), the messages defined in Table 9 must be provided to the DL with a cycle time of 100 ms each. Steering angle δ and vehicle coordinate system is defined in figure 6.

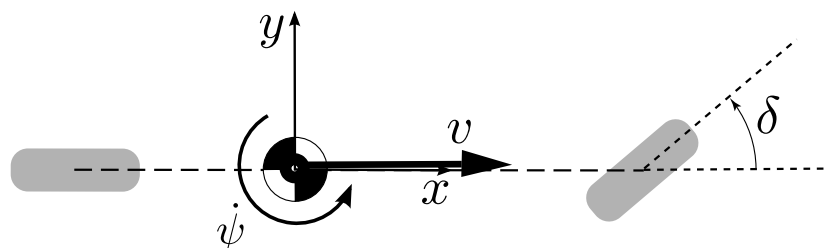


Figure 6: Bicycle model defining steering angle δ (drawn in positive direction after “ISO 8855” coordinate system \Rightarrow z up) and speed v .

- DE7.3.16 [DV ONLY] All signals are little-endian (Intel). Scale, if not defined, is 1.

| CAN-ID | Name | Length | Format | Unit | Scale |
|--------|--------------------------------|-----------|----------|------------------|-----------------|
| 0x500 | DV driving dynamics 1 | 8 B | | | |
| | Speed_actual | bit 0-7 | unsigned | km/h | |
| | Speed_target | bit 8-15 | unsigned | km/h | |
| | Steering_angle_actual | bit 16-23 | signed | ° | 0.5 |
| | Steering_angle_target | bit 24-31 | signed | ° | 0.5 |
| | Brake_hydr_actual | bit 32-39 | unsigned | % | |
| | Brake_hydr_target | bit 40-47 | unsigned | % | |
| | Motor_moment_actual | bit 48-55 | signed | % | |
| | Motor_moment_target | bit 56-63 | signed | % | |
| 0x501 | DV driving dynamics 2 | 6 B | | | |
| | Acceleration longitudinal | bit 0-15 | signed | m/s ² | $\frac{1}{512}$ |
| | Acceleration lateral | bit 16-31 | signed | m/s ² | $\frac{1}{512}$ |
| | Yaw rate | bit 32-47 | signed | °/s | $\frac{1}{128}$ |
| 0x502 | DV system status | 5 B | | | |
| | AS_state_off | | 1 | | |
| | AS_state_ready | | 2 | | |
| | AS_state_driving | bit 0-2 | 3 | | |
| | AS_state_emergency_brake | | 4 | | |
| | AS_state_finish | | 5 | | |
| | EBS_state_unavailable | | 1 | | |
| | EBS_state_armed | bit 3-4 | 2 | | |
| | EBS_state_activated | | 3 | | |
| | AMI_state_acceleration | | 1 | | |
| | AMI_state_skidpad | | 2 | | |
| | AMI_state_trackdrive | bit 5-7 | 3 | | |
| | AMI_state_braketest | | 4 | | |
| | AMI_state_inspection | | 5 | | |
| | AMI_state_autocross | | 6 | | |
| | Steering_state | bit 8 | bool | | |
| | Service_brake_state_disengaged | | 1 | | |
| | Service_brake_state_engaged | bit 9-10 | 2 | | |
| | Service_brake_state_available | | 3 | | |
| | Lap_counter | bit 11-14 | unsigned | | |
| | Cones_count_actual | bit 15-22 | unsigned | | |
| | Cones_count_all | bit 23-39 | unsigned | | |

Table 9: Message definition of logged general DV data

- DE7.3.17 [DV ONLY] Messages 0x500 and 0x502 must be filled in any case. If some values are not directly available, they should be interpolated or calculated (i.e. target values). 0x501 depends on available sensor data.
- DE7.3.18 [DV ONLY] All signals mentioned in the team's Autonomous System Form (ASF) have to be provided within the up to five messages with CAN-IDs 0x511 to 0x515. Each message can be up to 8 B of data length. Cycle time is 100 ms.

DE7.3.19 [DV ONLY] A valid dbc¹⁰ file containing the message definition of the ASF messages must be uploaded with the ASF. It may be updated afterwards until the deadline mentioned in 2.

DE7.4 [DV ONLY] Remote Emergency System (RES)

DE7.4.1 The RES that has to be used for the competition is a GF2000i-codec/T53R98 combination from Gross-Funk GmbH¹¹.

- SIL3 (EN61508) certified
- EMV certified
- communication in 430 MHz to 440 MHz band
- increased signal strength of 88 mW
- 12 V to 24 V supply voltage (0.26 A @ 12 V)
- 450 g, 173 mm × 113 mm × 35 mm
- IP20 (receiver) / IP65 (sender)



Figure 7: RES sender & receiver

DE7.4.2 Please contact Mr. Keller (christian.keller@grossfunk.de) at Gross-Funk for purchasing.

DE7.4.3 Regarding the increased signal strength, the BNetzA registration for Hockenheim will be provided by the officials.

DE7.4.4 The receiver includes a normally-open (NO) relay which must be part of shutdown circuit. It opens on switching shutdown, on signal loss, and on power loss. Maximum current rating is 4 A.

DE7.4.5 The CANopen interface of the receiver has the following properties:

- 1000 kbit/s, 125 kbit/s, 250 kbit/s and 500 kbit/s in standard configuration.
- Cyclic PDOs containing states of switches (Go-signal) and radio

¹⁰see https://fsg.one/dbc_format for more informations

¹¹https://f.fs-g.org/2017/important_docs/FSG2017_Gross-Funk_v20170126.pdf

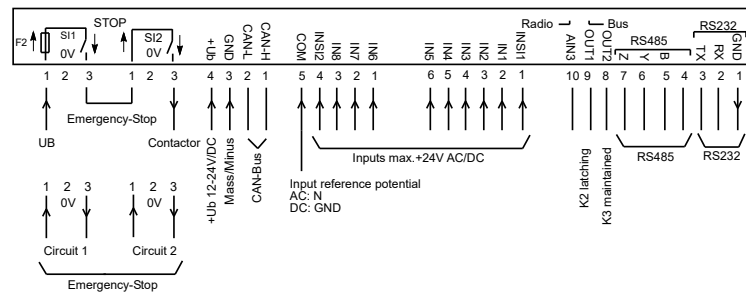


Figure 8: Connections at the RES receiver

- Warns if signal loss detected (200 ms in advance to shutdown, contained in cyclic PDO)

DE7.4.6 The Node-ID and baud rate settings of the vehicle-side installed receiver can be configured with the external DIP switch:

| DIP SW | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Baud Rate |
|---------|----|----|----|----|-----|-----|-----------|---|------------|
| Node-ID | +1 | +2 | +4 | +8 | +16 | +32 | 0 | 0 | 1 Mbit/s |
| Bit | 0 | 1 | 2 | 3 | 4 | 5 | 1 | 0 | 125 kbit/s |
| | | | | | | | 0 | 1 | 250 kbit/s |
| | | | | | | | 1 | 1 | 500 kbit/s |
| Node-ID | | | | | | | Baud Rate | | |

Table 10: DIP switch configuration RES.

- DE7.4.7 The Node-ID has to be set to 0x011 at the competition. Only in severe cases, there will be an exception. Please give a detail problem description with the request.
- DE7.4.8 The receiver is booted up and sends a message to signalize its initialization (NMT message with CAN-ID 0x700 + Node-ID and a single data byte 0x00). A CAN/CANopen master device must set the receiver to operational mode (NMT message CAN-ID = 0x000, byte 1 = 0x01 (requested state), byte 2 = addressed Node-ID or 0x00 for all). After setting to operational mode, the receiver starts sending a status message of 8 bytes containing PDOs 2000 - 2007 (one byte each, CAN-ID = 0x180 + Node-ID) every 30 ms.
- DE7.4.9 Manually resetting the RES before sending the operational mode message may be used to check if the device is online (NMT message CAN-ID = 0x000, byte 1 = 0x80 (requested state), byte 2 = addressed Node-ID). This will be answered with the boot-up message.
- DE7.4.10 Beside the CAN-IDs mentioned in DE7.4.8 and DE7.4.9, be aware not to use the CANopen-related IDs listed in Table 11 on the bus¹².
- DE7.4.11 System misbehavior and faulty logs caused by misuse of these messages eliminates the demand for a re-run and may lead to a Disqualified (DQ). Same counts for any kind of hardware manipulation to the sender and receiver or improper antennas modifications. In doubt, the logs available on the official DL (see Section DE7.3) count.

¹²https://www.can-cia.org/fileadmin/resources/documents/brochures/co_poster.pdf

| Communication object | CAN-ID | Slave nodes |
|----------------------|-----------------|-----------------|
| NMT node control | 0x000 | Receive only |
| Sync | 0x080 | Receive only |
| Emergency | 0x080 + Node-ID | Transmit |
| TimeStamp | 0x100 | Receive only |
| PDO | 0x180 + Node-ID | 1. Transmit PDO |
| | 0x200 + Node-ID | 1. Receive PDO |
| SDO | 0x580 + Node-ID | Transmit |
| | 0x600 + Node-ID | Receive |
| NMT node monitoring | 0x700 + Node-ID | Transmit |
| LSS | 0x7E4 | Transmit |
| | 0x7E5 | Receive |

Table 11: Reserved message IDs for RES.

- DE 7.4.12 The status of the switch (K2) and the button (K3) at the sender is contained in the PDO 2000 (bit 1 and 2) as well as on the digital outputs. The E-Stop is signaled by PDO 2000 bit 0 and PDO 2003 bit 7. PDO 2006 contains the radio quality (0 % to 100 %) whereas PDO 2007 summarizes several radio states, i.e. the pre-alarm radio communication interruption (bit 6, 200 ms in advance to shutdown).
- DE 7.4.13 Either K2 or K3 are allowed to be used to signalize the Go-signal for switching from “Ready” to “Driving” state, see DV 2.4, Figure 21. Both the CAN message or the digital outs can be used.