Technical Inspection

FSG Academy 2020/2021 powered by

Technical Inspection – Organization

Chassis / SES

Jet
Tuitert

M-Inspection

Christoph
Beißwanger

D-Inspection

Martin
Stollberger

Driverless

Christian
Amersbach

A-Inspection

Sarah
Battige

E-Inspection

Mathias
Gebhardt

Technical
Inspection

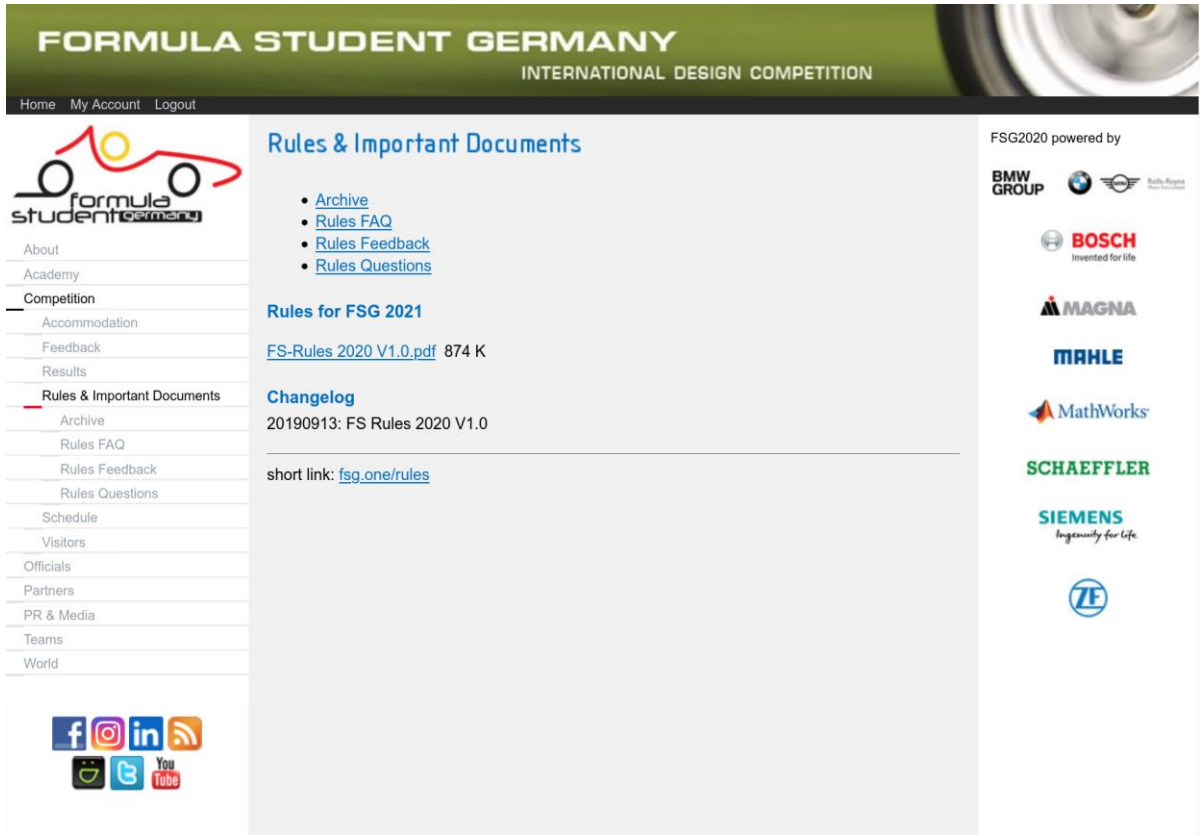
Simon
Densborn

Rules and important documents

- All information, documents and advices published on the FSG website (www.formulastudent.de) in the section "Rules & Important Documents" are **OFFICIAL documents** for the FS Germany events.
- All advice given in this presentation are rule clarifications that support the FSG 2020 rules.
- Further rules clarification can be found in the FAQ section and support the interpretation of the intent of the rules.

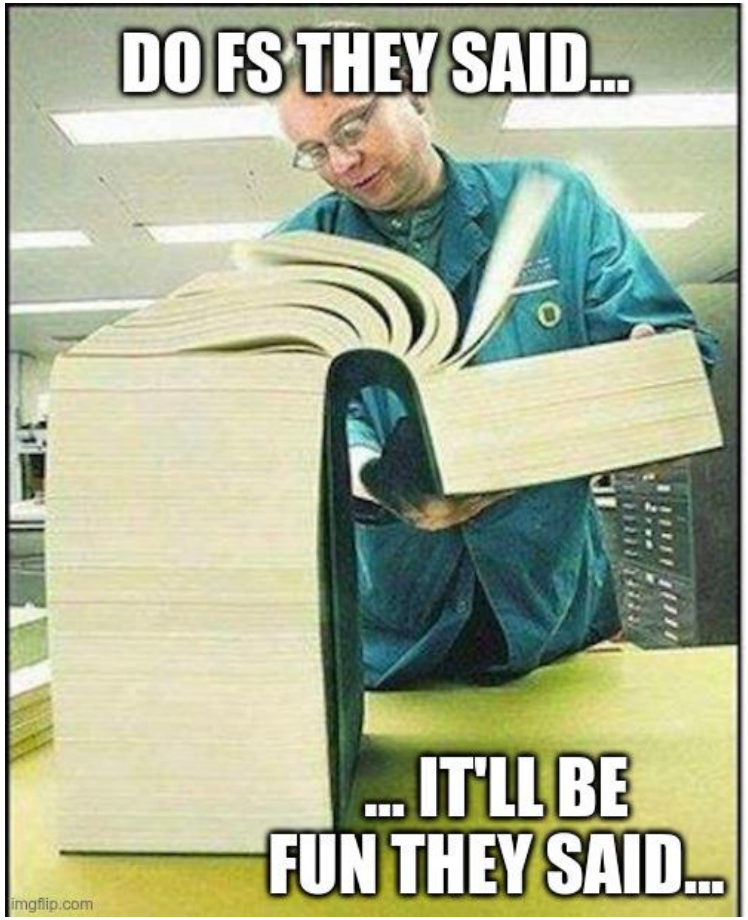
Rules 2021

- FS-Rules 2020
- Rules Questions still valid



Rules Questions

- Only via www.formulastudent.de
- ≈ 5,5 requests per day
- Designed for questions about rules understanding



Registration 2021

- New Quiz
- New Registration
- New Chance

But why?

- What about newly founded teams?
- What if 2021 can only offer less slot?
- Team members change

Last years Academy

- Technical Inspection Talks from FSG 2019 Academy: https://www.formulastudent.de/academy/20191116-magna/

E-Inspection

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Technical Inspection – in General

- The number of EVs will increase
- Every team needs feedback within the first days

- We stick to fixed slots

➔Need to speed up Tech Inspection

➔Use ESF to eliminate show stoppers

Technical Inspection – ESF

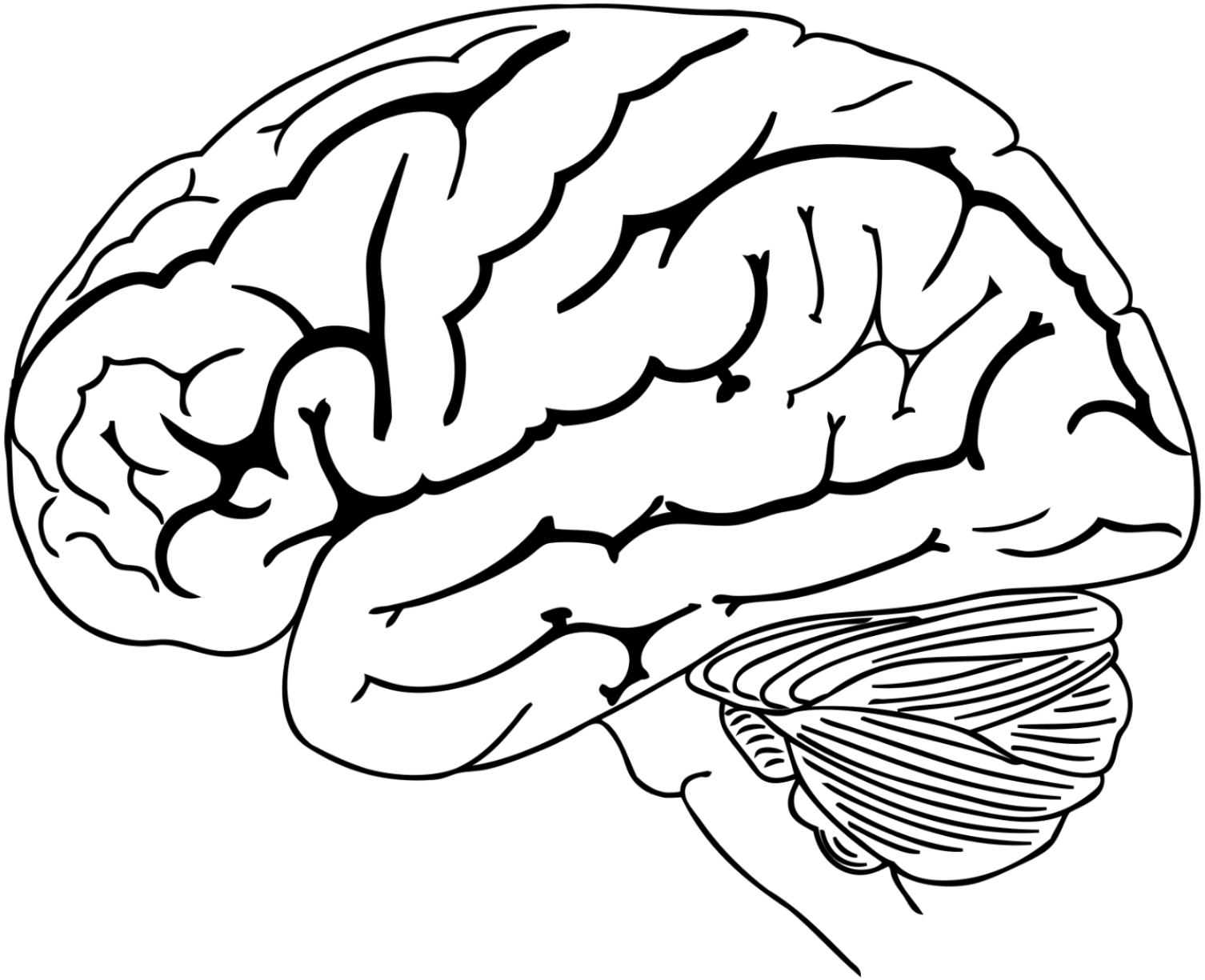
- Aim:
  - Check safety critical points which cannot be checked onsite
  - Check show stoppers which cannot be fixed onsite
- Review effort: roughly **1 hour** per form/attempt
  - Must be much faster in future
  - Number of attempts may be limited – do it right the 1st time
- Be aware of the safety of your colleagues when working or going for testing

Technical Inspection – Onsite

- Be well prepared → practice more than once
- Know the inspection sheet
- “LV” inspection will be done in parallel
- Bring in
  - Tools needed
  - Datasheets/calculations/proofs
  - Connector breakouts
  - APPS/spring demonstrator (spare pedal)

Safety Measures

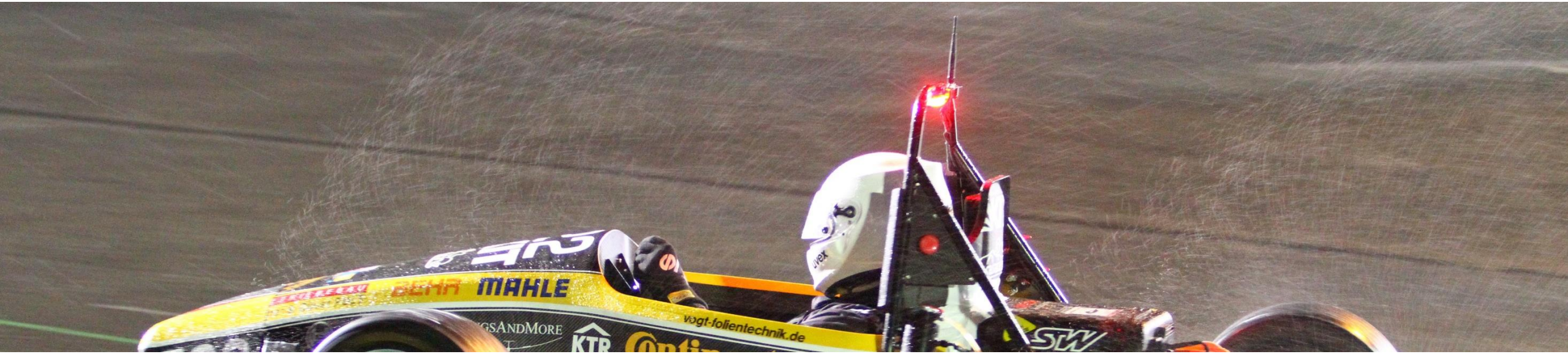
- ESO
  - Always knows the state of the EV
  - Is able to bring it back into the safe state
- IMD
  - detects the 1st insulation fault
  - 2nd fault is harmful – danger to life!
- BSPD
  - Motor torque can override the brakes
  - Disables the torque in a panic situation
- All of them must work properly before going for testing



Rules Questions

- Aim: possibility to check if you interpretation of a (single) is within the intent of the rule(s)
- Not:
  - “Is my design within (all) rules”
  - “We already did it last year, so it should (must) be allowed this year, too”
- There is an FAQ available

TSAL



TSAL States

Green	Red	Off / Both
TS Deactivated & LV on	TS Activated & LV on	unknown / failure

Safe State of TSAL

- „Single Point of Failure“ must not result in green TSAL
- Redundant voltage measurement

  Implausibility must result in TSAL off
- Open circuit detection not required when
  - the inteted relay state is open (relay state evaluation)
  - no voltage is present (voltage measurement)

TSAL and Commercial Off-The-Shelf Inverter

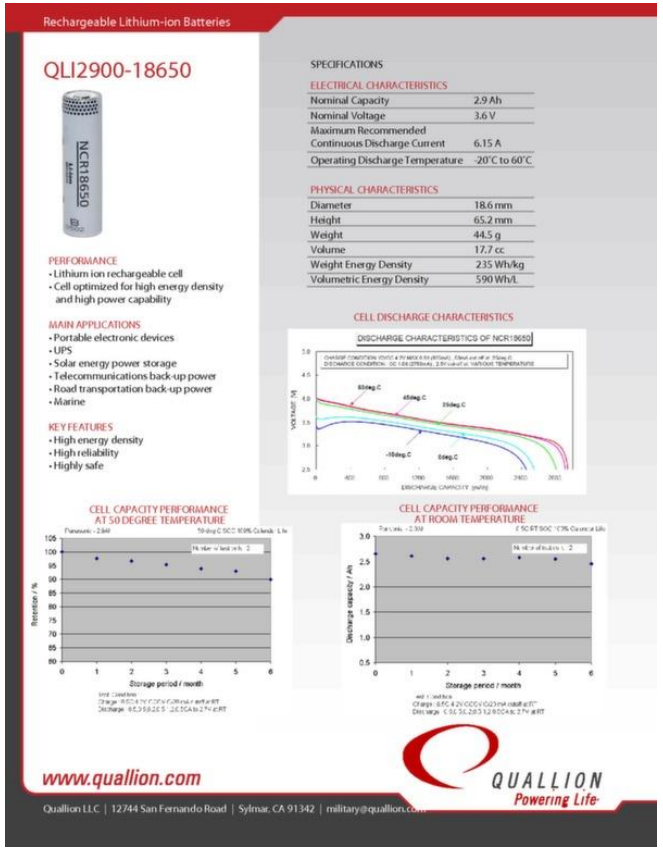
Event	FSG20
Rule	FS-EV 4.10.13
Subject	TSAL Voltage measurement
Question	We are using a commercial off-the-shelf inverter, to the manufacturer's specification. For the TSAL, will we need to open the inverter housing to fit voltage measurement points to the DC-link capacitor? We'd prefer to maintain our warranty and take the inverter voltage measurement from the connection points. Is this allowed?
Answer	Dear Team, placing the voltage measurement inside the next hosing is OK as long as at least two of the following points are fulfilled: * tooling, * time, and * knowledge to open the connection. Regards
Uploads	

<M4 bolts right

- the cell tab bolts have to designed according to the rules and do not carry any mechanical loads →not considered structural parts
- The bolts must still comply with T10 with the exception of T10.1.2,
- your design satisfies the requirements when the bolts do not carry any load

FS-EV 9.1

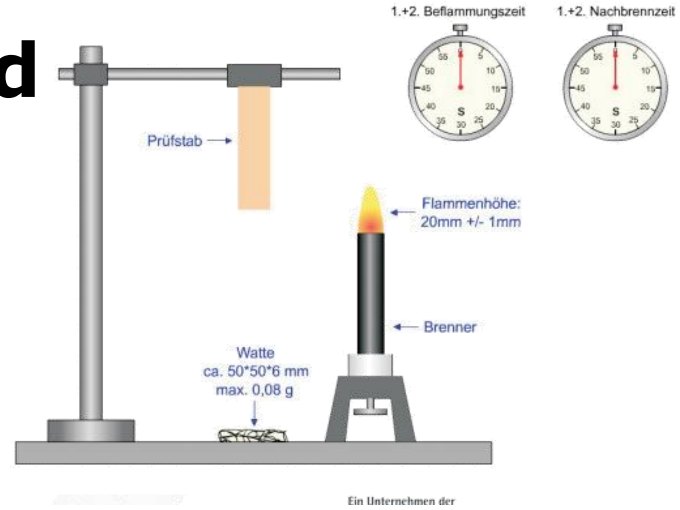
- We accept only official datasheets for general use published by the manufacturer. Datasheets which are restricted to a special use, e.g. "Formula Student only" or a special customer, e.g. "FS Team Metropolis only", will not be accepted



S-EV 5.5

EV 5.5.3 All TS accumulator container materials must be fire retardant, see T 1.2.1.

The TS accumulator container is referring to the container itself and all parts needed to meet the rules for the container. The content of the container is not generally part of the container itself, if it isn't structural.



Quelle: https://www.apra.de/wp-content/uploads/2017/12/UL_94_Brandklassifikationstest_apra_plast_de.pdf

Hand Cart

- New Rules:
- EV 8.1
  - maximum dimensions
  - Brakes
  - Min.4 wheels
  - The TS accumulator container(s) must be mechanically fixed to the hand cart
  - ...

Documents, Certificates, …

- Provide all documents in English
- Just do it!

Driverless Inspection

By Christian Amersbach, Martin Stollberger

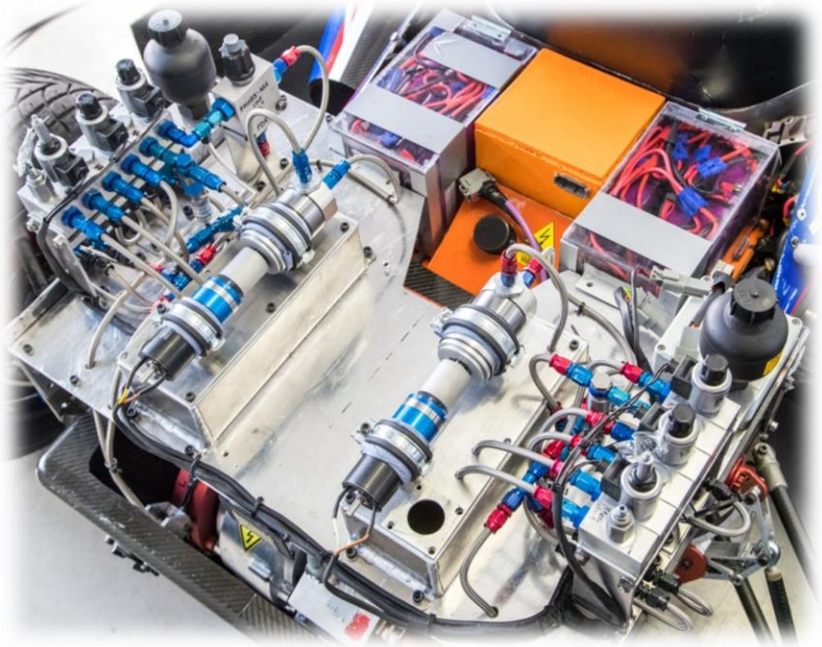
Steering Actuator Rules

- Steering system actuation must only happen if the vehicle is R2D. (DV2.3.1)
- It may remain active after R2D state was left, until vehicle is at standstill. (DV2.3.2)
- Manual steering must be possible, immediately after ASMS is switched off (DV2.3.3)

Steering Actuator Important points

- Make sure that the cockpit template is fitting
- Cover moving parts from the driver
- Make sure your actuator does not need to move for position referencing, as this will only be allowed while the vehicle is R2D.
- Consider the impact to the steering forces while manual driving

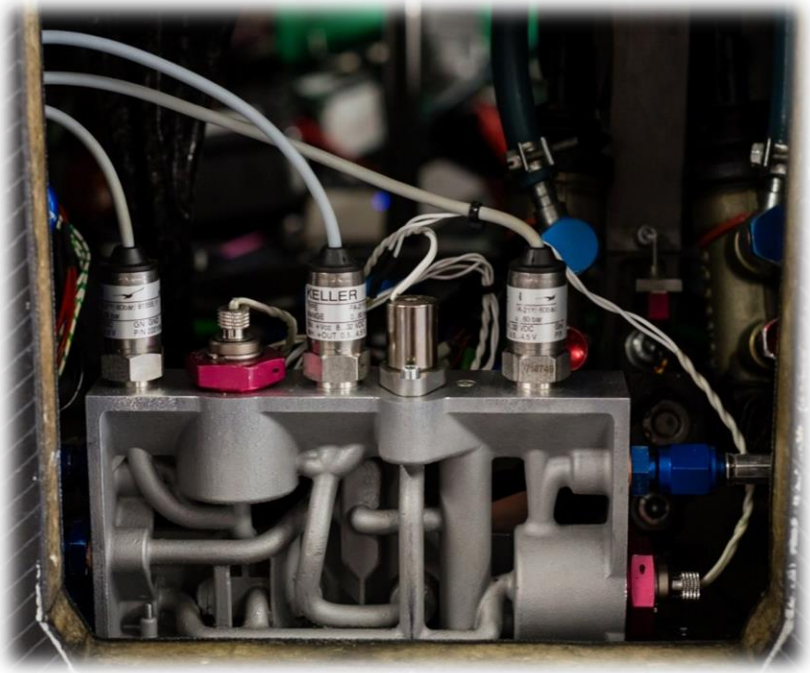
EBS (Emergency Brake System)



- The last chance to save your vehicle from a crash
  - Brings the vehicle to a safe state (standstill with brakes closed)
  - Must be designed under the aspects of functional safety (DV3.2)
    - Continuous monitoring for failures
    - Redundancy for single faults
  - Must work in absence of electrical power (DV3.1.3)

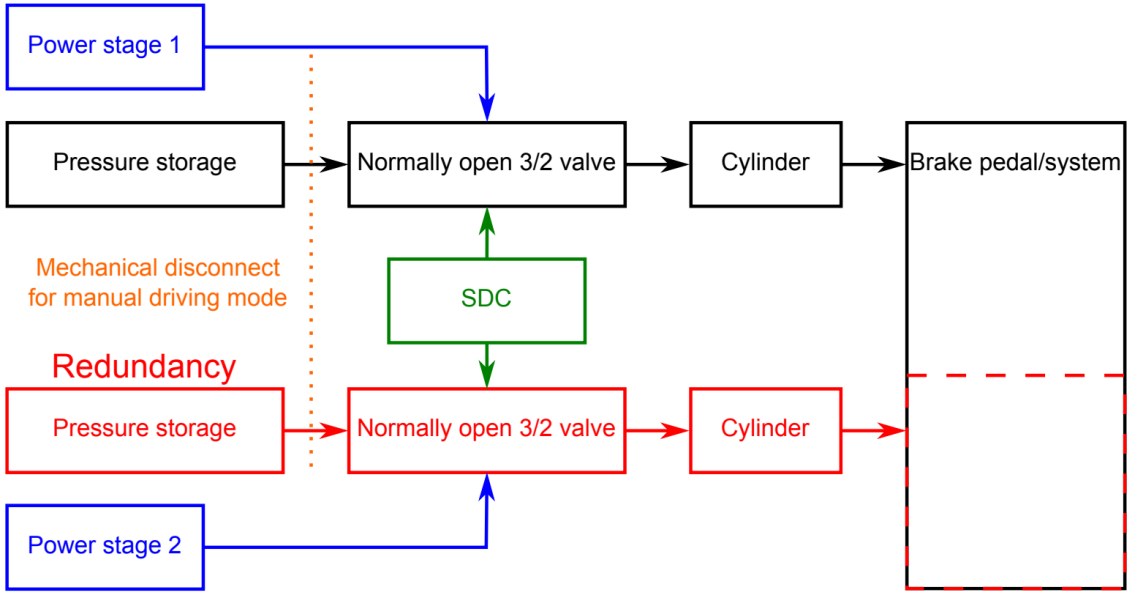
Monitoring

- The health checker (DV 3.2.1)
  - Initial checkup
    - Check all activation path to ensure proper function
    - Crosscheck different sensors for plausibility (e.g. pneumatic pressure vs. resulting brake pressure)
  - Continuous monitoring
    - Check the state of the energy storage
    - Check sensors for valid signals etc.
  - Redundant paths need to be monitored as well

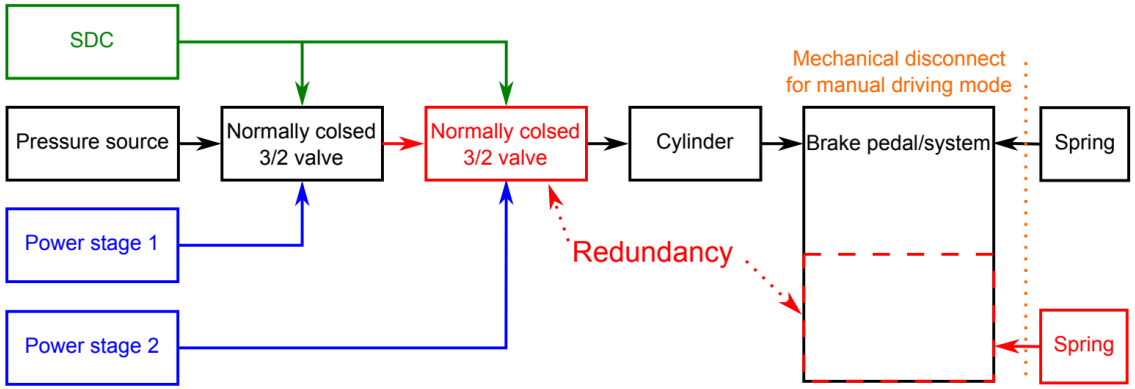


Redundancy

Actively applied braking energy

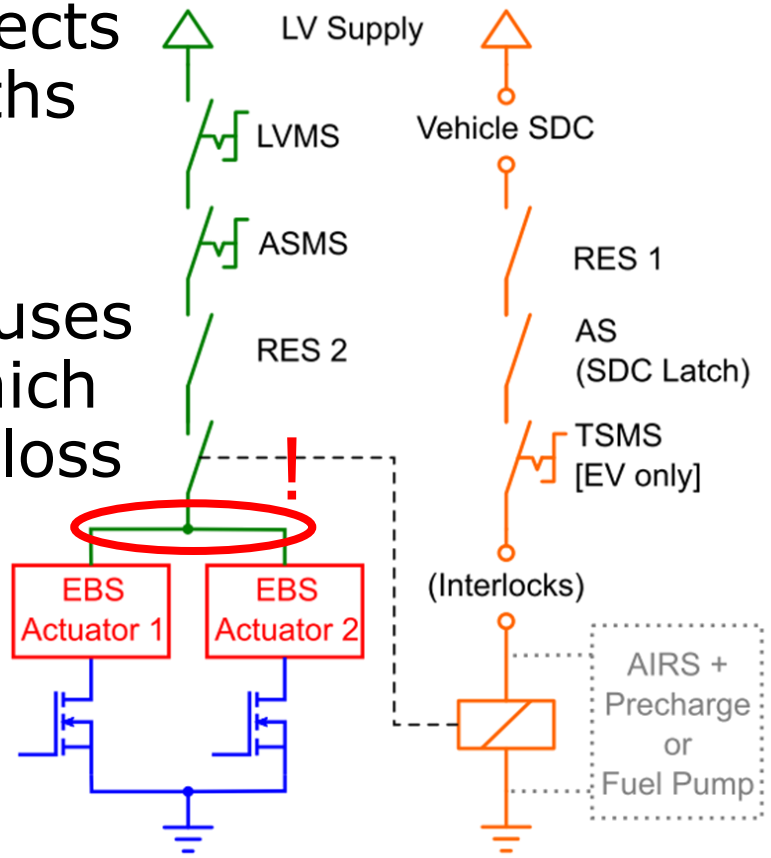


Removal of counterforce, which keeps the brakes opened

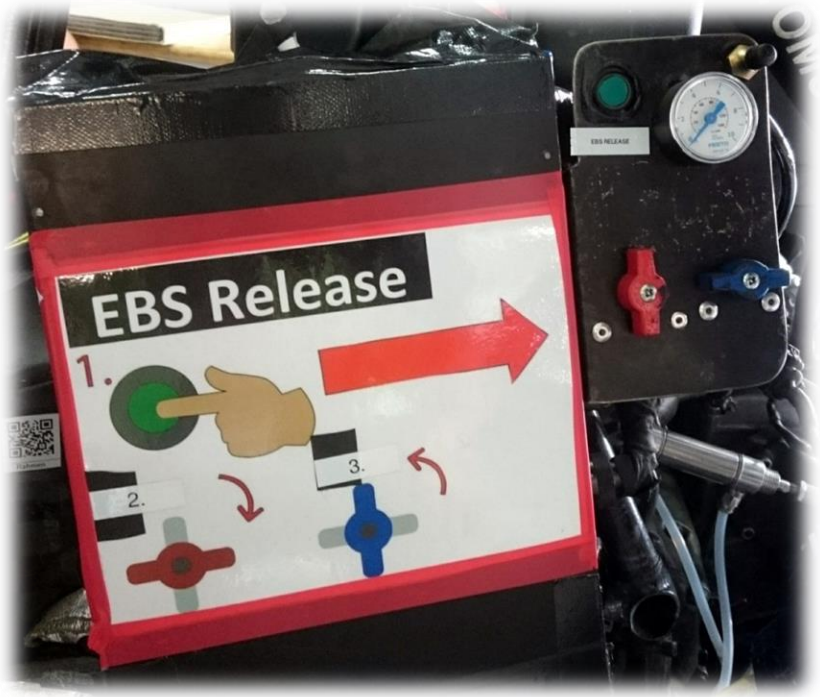


Common Cause Failure

- The ones to keep an eye on
  - One failure that affects both redundant paths directly.
  - Or a failure that causes a chain reaction which will end up in total loss of function.
    (e.g. overpressure which destroys all actors
    at once)



Deactivation



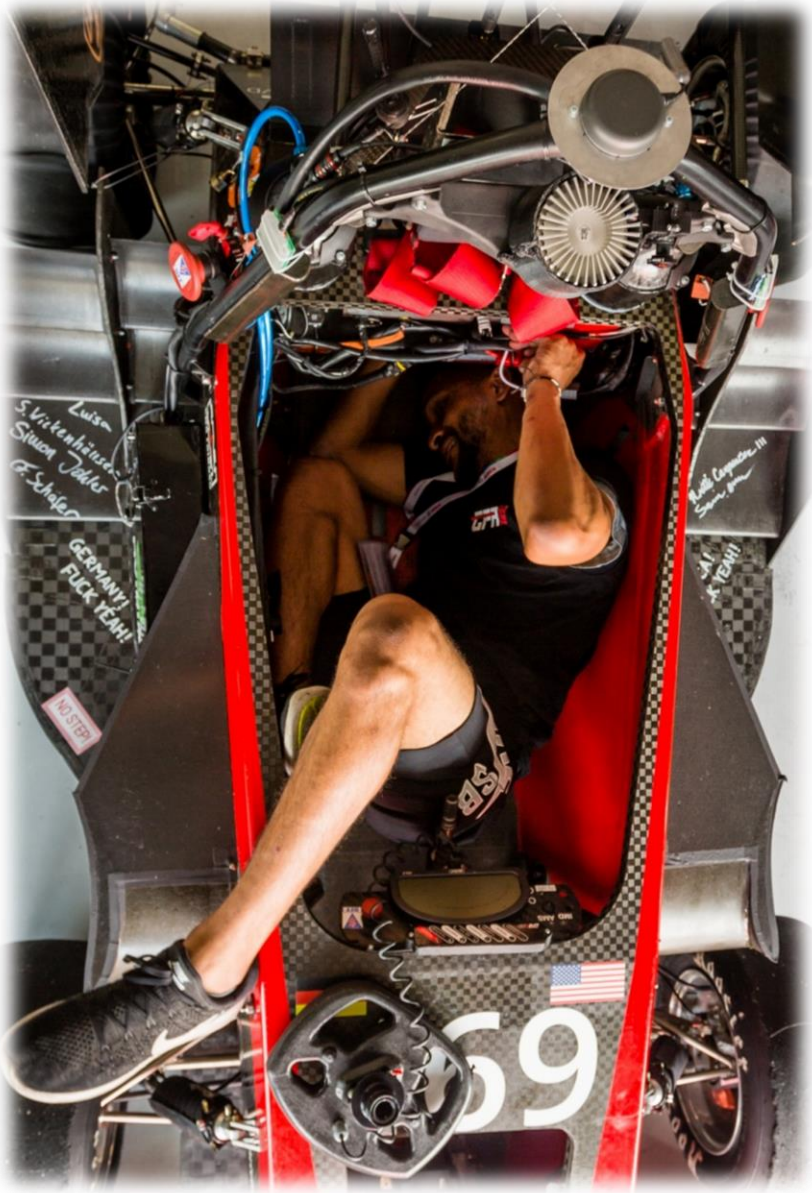
- The way to get your car off the track
  - The EBS must be designed so that any official can easily deactivate it. (DV3.1.6)
  - A pictographic description of the release points in proximity to the ASMS.
  - The necessary steps must be clearly marked
  - The release points must be marked by a red arrow of a given size with “EBS release” in white letters on it.

Service Brake

- For well controlled braking while driving
  - May use the same components as the EBS (e.g. a pressure regulation valve instead of an EBS activation valve on the second path)
  - Must be monitored for failure if it is used as redundant path
  - Will be removed on the next rules version 2022. There will be only a general brake system with EBS functionality, to avoid the confusion we had in the past.

Accessibility for Inspection

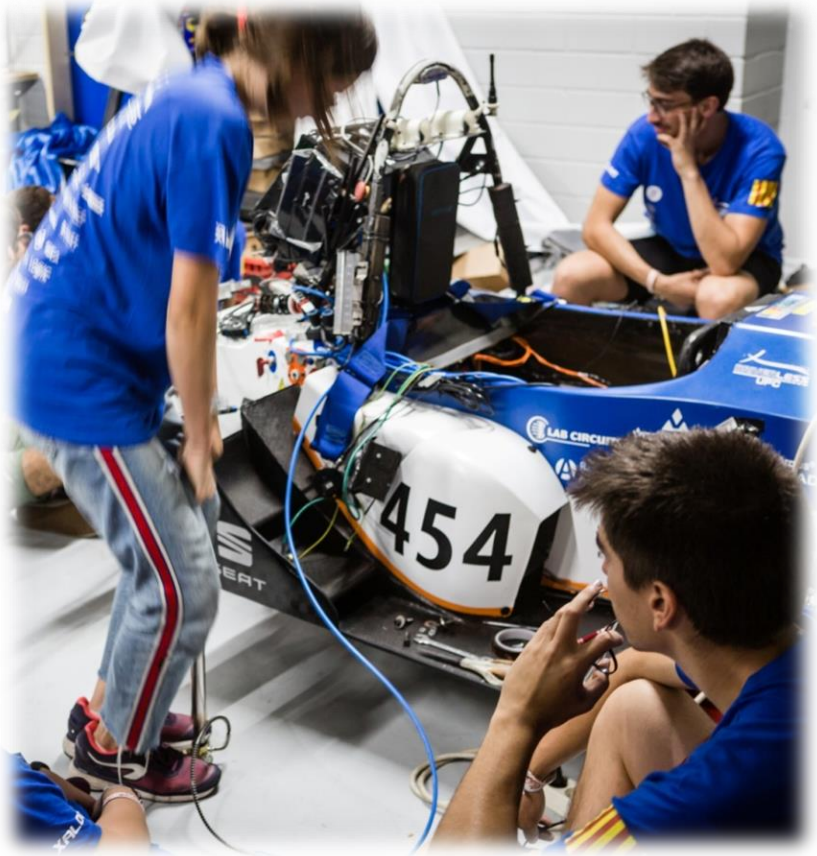
- Be prepared and save time
  - Especially the EBS will be checked quite intense (failure detection / handling). -> Different sensors / actors will be unplugged to see the reaction
  - The vehicle will be restarted multiple times
  - Check all imaginable failure cases already at home
  - Be sure that all parts of the EBS are accessible without dismantling the whole vehicle



General Aspects

- Keep the rain test (EV) and bad weather in mind.
- Be aware of spots without GPS reception, especially during Tech Inspection.
  - Don’t relay on a valid GPS signal to start the inspection mission.

Preparation before Start



- Keep it simple
  - No additional equipment is allowed at the staging/starting line. (D2.6.1)
  - The vehicle should enter “AS Ready” state within 1 min latest (D2.6.3)
  - The EBS may be armed already in the preparation area (D2.6.5)

FAQs concerning integration of DV to EV(CV) from 2022

- Will it be allowed to remove sensors/components for manual driving?
  - NO, because otherwise we would need a reinspection every time you add them again for driverless driving
- Will it be allowed to mechanicaly disconnect actuators for manual driving?
  - YES, if and only if
    - No parts are removed for disconnection and no tools are needed
    - Manual operation is still possible if the actuators are connected
    - The disconnection mechanism cannot block manual operation in any position and is securely locked in both positions

Further Information

- EBS Reference Guide
- FSG Driverless Workshop (slides and videos)
- Past FSG Academies

Read the rules!

See you at the starting line

Presentation was based on [FSG Rules 2020]

Thank you for your attention