**Coversheet**

**The Coversheet must contain the following:**

* **Heading “Hybrid System Description FSN, FSCZ 2022”**
* **University and Team Name**
* **Car number**

Feel free to add team logo, car picture, and the like.

1. **Requirements (delete this section after you have read and understood it):**
2. Complete all sections and tables of the HSD. If a section is not applicable to your design state that in the document, do not delete any sections.
3. Remove instructions (orange) from document as you complete the sections.
4. Provide hyperlinks to all datasheets.
5. If you are unsure with respect to feedback of the reviewer, do not hesitate to ask the Lead E-scruti via E-mail
6. Parts of the HSD which are changed because of reviewer’s feedback must be marked in red.
7. Following these guidelines will guarantee a swift review process.

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# System Overview

Include a brief description of the vehicle (1 paragraph).

Complete the information in the table below.

|  |  |
| --- | --- |
| Maximum Hybrid System Voltage: | 40VDC |
| Nominal Hybrid System Voltage: | 30VDC |
| Grounded Low Voltage System Voltage: | 24VDC |
| Number of Hybrid Storage Containers: | 2 |
| Total Hybrid Storage Capacity: | 500Wh |
| Motor Type: | AC Induction |
| Number of Motors: | Total 1 |
| Maximum Combined Motor Power: | 5kW |

Table 1‑1 - High Level Specifications

Insert a system overview block diagram showing major electrical components and system interactions

# Hybrid System Schematics

## Tractive System Schematic (Power Electronics ONLY)

Insert a large (full page) schematic of the Hybrid system. This schematic should focus on the components that are not within the accumulator. Provide boxes and 1st level interfaces, when details will be provided later in this document. Some detail of components within the accumulator may be included for better understanding (ie AIRs).

Figure must include the following:

* Wire Size (AWG or mm2)
* Relative fuse location (end of wire vs middle)
* Fuse rating (Amperage and Voltage)
* Motor controller (1st level interfaces...inputs & outputs)
* Motor
* Connection to GLVS (if any)
* Inline connectors and interfaces for charging
* Show enclosures as dashed lines

### Fuse Specifications

Complete the information in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fuse Location** | **Current Rating** | **Voltage Rating** | **Interrupt Rating** | **Datasheet** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Table 2‑2 - Fuse Specifications

### Conductor Specifications

Complete the information in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Conductor Location** | **Size** | **Voltage Rating** | **Ampacity** | **Rating of fuse providing protection** | **Datasheet** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Table 2‑3 - Conductor Specifications

### Connector Specifications

Complete the information in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Connector Location** | **Ampacity** | **Voltage Rating** | **Includes Interlock** | **Accepted wire gauge** | **Wire gauge connected** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Table 2‑4- Connector Specifications

# Shutdown Circuit

## Shutdown Circuit Schematic

Insert a large (full page) schematic of the shutdown circuit.

The schematic must include the following:

* All shutdown circuit switches/devices (indicate Normally Open or Closed)
* Hybrid Measurement System connection to shutdown circuit
* BSPD connection to shutdown circuit
* BOTS
* Inertia switch
* AIR coils
* Pre-charge relay coil (if used)
* GLV battery
* Fuse(s)
* Wire Size (AWG or mm2)

# Hybrid Storage Container

## Hybrid Storage Container

Insert a large image (top or nearly top view) of the complete Hybrid Storage Container assembly without cover.

Figure must include the following:

* attachment points to car chassis
* HV electronics (at least one PCB mock-up)
* AIRs
* Main fuse
* Main power connector

(additional images may be needed to provide clear views of all elements)

Figure 5‑1 - Accumulator Schematic

## Segments

### Segment Overview

Insert a large image of the complete segment assembly. Describe segment materials and how design provides a safe environment from dropped tools.

### Segment Specifications

Complete the information in the table below.

|  |  |
| --- | --- |
| # of Segments: | 5 |
| Cells per segment: | 15 |
| Cell configuration in segment: | 5S3P |
| Energy in segment: | 2.8MJ / 0.78 kWhr |

Table 5‑2 - Segment Specifications

### Cell Connections

Describe how the electrical connections are made to the cells (welded/bolted/clamped)?  Define what kind of weld (resistance/laser), what kind bolt (copper w/deforming nut), material of clamp.  If bus bars are used what is the cross-sectional area and ampacity?

### Temperature sensors

Provide images showing where the temperature sensors are placed and how they are in direct contact with the busbar. How many sensors are used and which percentage of cells is monitored?

## Cells

### Cell Specifications

Complete the information in the table below.

|  |  |
| --- | --- |
| Cell Make / Model / Style: | Kokam XYZ- pouch, cylindrical, or metal can |
| Cell nominal capacity: | 5.4 Ah |
| Maximum Voltage: | 4.2 V |
| Nominal Voltage: | 3.7V |
| Minimum Voltage:  | 2.8V |
| Maximum output current: | 12A for 10s |
| Maximum continuous output current: | 5A |
| Maximum charging current: | 1A |
| Maximum Cell Temperature (discharging) | 65°C |
| Maximum Cell Temperature (charging) | 55°C |
| Cell chemistry: | LiFePO4 |
| Datasheet | [Datasheet](http://www.fsaeonline.com) |

*Table 5-1 - Cell Specifications*

Explain how the power sinking elements of the precharge circuit are cooled.

## Hybrid Measurement System

### HMS Specifications

Describe the HMS that has been selected. Provide a datasheet, show the position of the Measurement System in your accumulator. What is the sampling rate of your measurements?

### Voltage Monitoring

Provide details of the voltage measurement system (accuracy, acquisition frequency, …).

Describe how and where the voltage sense leads are overcurrent protected (fused). What size are the sense leads? What is their ampacity? If your sense leads are not fused please reason why and how your system detects a malfunction of one of the measurements? Also include an error calculation how precise your system is.

### Temperature Monitoring

Provide details of the temperature measurement system (accuracy, acquisition frequency, …). Give details of the temperature sensors used. Also include an error calculation how precise your system is.

### HMS Limits

Complete the table below.

|  |  |
| --- | --- |
| Max Cell Voltage: | 6.8V |
| Min Cell Voltage: | 4.2V |
| Max Temperature: | 60°C |
| Min Temperature: | -5°C |

Table 5‑7 - HMS Setpoints

## Charging

### Charger Specifications

Complete the information in the table below.

|  |  |
| --- | --- |
| Make / Model: | ElectronPusher Inc 100V200 |
| Power: | 0.082kW |
| Output Voltage: | 30V |
| Output Current: | 0.273A |
| Input Voltage: | 120V |
| Input Current: | 1A |
| Datasheet: | [Datasheet](http://www.fsaeonline.com) |

Table 5‑9 - Charger Specifications

Provide images of the charger assembly and charging setup as it’ll be used during the events

### Charger Control

Describe how the BMS can control the charger, in particular how it can stop the charger.

### Charger Demonstration

Describe numbered steps you would use to demonstrate the safe operation of charging, include how to connect, and how to disconnect. Include any safe use practices, as well as what to look for proper operation vs. a faulted condition.

# Motor controller

## Motor controller 1

### Description, type, operation parameters

Describe important functions, provide table with main parameters like resulting voltages->minimum, maximum, nominal, currents etc.

Fill out the following table:

|  |  |
| --- | --- |
| Motor controller type: | ABC Controller |
| Maximum continous power: | 60kW |
| Maximum peak power: | 75kW for 10s |
| Maximum Input voltage: | 600VDC |
| Output voltage: | 250VAC |
| Maximum continuous output current: | 100A |
| Maximum peak current: | 200A for 5s |
| Control method: | PWM, analog signal... |
| Cooling method: | Air, water, oil... |
| Auxiliary supply voltage: | 24VDC |

Table 5.1 General motor controller data

### Wiring, cables, current calculations, connectors

Describe the wiring, show schematics, provide calculations for currents and voltages and show data regarding the cables and connectors used.

Additionally fill out table:

|  |  |
| --- | --- |
| Wire type: | Company A, 0.205 mm² |
| Current rating: | 150A |
| Maximum operating voltage: | 800V |
| Temperature rating: | 150 °C |

### Position in car

Provide CAD-renderings showing the relevant parts. Mark the parts in the rendering, if necessary.

## Motor controller 2

…

If identical parts are used, just refer to the corresponding sections, don’t copy and paste.

# Electrical Motors

## Electrical Motor 1

### Description, type, operating parameters

Describe the motor used, provide table with main parameters like resulting voltages->minimum, maximum, nominal, currents, resulting motor power, use figures to show important characteristics. Describe the casing and if the casing rotates the finger guards used. Please also include a picture of the Electrical Motor.

Additionally fill out table:

|  |  |
| --- | --- |
| Motor Manufacturer and Type: | ABC Motor |
| Motor principle | Asynchronous, permanently excitated |
| Maximum continuous power: | 25kW |
| Peak power: | 70kW for 5s |
| Input voltage: | 250VAC |
| Nominal current: | 50A |
| Peak current: | 70A |
| Maximum torque: | 60Nm |
| Nominal torque: | 20Nm |
| Cooling method: | Water, oil, air,... |

Table 6.1 General motor data

Give a plot of power vs. Rpm including a line for nominal and maximum power

give a plot of torque vs rpm including a line for nominal and maximum torque

### Wiring, cables, current calculations, connectors

Describe the wiring, show schematics, provide calculations for currents and voltages, and show data regarding the cables and connectors used.

### Position in car

Provide CAD-renderings showing all relevant parts. Mark the parts in the rendering, if necessary and clearly identify the structure used to protect all relevant parts. How do you integrate the electrical Motor into your System?

## Electrical Motor 2

…

If identical parts are used, just refer to the corresponding sections, don’t copy and pas

# Other Items

## Firewall

### Firewall Layer Specifications

Complete the information in the table below.

|  |  |
| --- | --- |
| Aluminum layer thickness: | 0.2mm |
| Insulating layer thickness: | 2mm |
| Insulating Material Make / Model: | Conductive Co. FLDPRDCT |
| Insulating Material Datasheet: | [Datasheet](http://www.fsaeonline.com) |
| Insulating layer side: | Driver |

Table 7‑1 - Firewall Specifications

### Firewall Location

Provide CAD rendering(s) or photographs showing the firewall components. Mark the parts in the renderings, if necessary.