

# **R&D of Racing EVs for FSAE**

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#### Introduction

Formula SAE is a student design competition organized by SAE International (formerly Society of Automotive Engineers).
 Tohoku University Formula Team (TUFT) has joined in electric class of Student Formula Japan (SFJ) since 11<sup>th</sup> competition at 2013, but our first machine "TF-13" and 2nd machine "TF-14" had technical problems and were not passed a specific car inspection before dynamic events.
 To revenge at 13<sup>th</sup> SFJ, we decided to make the completely new machine "TF-15".

#### Objectives

Pass the inspection and run on the corse.
Win the first position at electric class.

#### Design of TF-15

#### "Simple & Light"

We could not make an electric system of TF-14, so we drew focus to design its system perfectly. A reliability of electric system is very important, because TF-14 had many troubles and we could not get adequate time to gather data. So we design electric system simply and improve reliability of our machine.

A power of drivetrain system of TF-15 is powerless compared with other teams, so we designed most parts lightly.

TF-15 has been more advanced car than TF-14 and TF-13, and is the best car of our machines.





1. The 3-view drawing of TF-15



Fig2. The exterior of TF-15

	Table1. The specific	Table1. The specification of TF-15			
	Overall Length x Height(mm)	2519 x 1041			
	Wheel Base(mm)	1650			
Dimension	Table1. The specification of TF-15         Overall Length x Height(mm)       2519 x         Wheel Base(mm)       160         Track Width(mm) Front x Rear       1250 x         Weight (kg)       30         Weight distribution       49:         Cowling       GFF         Body       Steel spa         Suspension Type       Double A-ar         Steering       Rack &         Wheels       13i         Brake System       Hydraulic ou         Motor       Permanent magnet         Peak power(KW)       31         Rated power(KW)       1         Peak Torque of Motor (N·m)       9         Battery Type       Li-i         Battery Capacity(kWh)       5.5         Max Voltage(V)       99	1250 x 1250			
	Weight (kg)	301			
	Weight distribution	49:51			
Chassis	Cowling	GFRP			
	Body	Steel space frame			
	Suspension Type	Double A-arm Push rod			
Chassis	Steering	Rack & Pinion			
	Weight distribution         49:51           Cowling         GFRP           Body         Steel space frame           Suspension Type         Double A-arm Push rod           Steering         Rack & Pinion           Wheels         13inch           Brake System         Hydraulic outboard disk           Peak power(kW)         30           Rated power(kW)         12	13inch			
	Brake System	Hydraulic outboard disk			
Steering         Rack & Pinion           Wheels         13inch           Brake System         Hydraulic outboard           Permanent magnet synchron         Peak power(kW)           Rated power(kW)         30           Rated power(kW)         12           Tractive         Peak Torque of Motor (N·m)           Battery Type         Li-ion           Battery capacity(kWh)         5.58           Max Voltage(V)         99.6           Drive Train         1 speed gearbox & Charles	Motor	Permanent magnet synchronous motor			
	Peak power(kW)	30			
	Rated power(kW)	12			
	Peak Torque of Motor (N • m)	90			
	Battery Type	Li-ion			
	Battery capacity(kWh)	5.58			
	Max Voltage(V)	99.6			
	1 speed gearbox & Chain drive				

#### Performance

#### Well considered performance

In the development of this year's competition vehicle, we placed great emphasis on the car's kinematical performance. Also Improving rigidity, saving unspring mass and improving reliability are specific features of the TF-15. These struggles made it possible to achieve 1.5G lateral grip, so TF-15 showed good performance at cornering.

Doubled spring mass natural frequency and strengthened chassis increased vehicle roll stiffness. Because of these changes, vehicle stability and also steering response had improved.

#### One trouble occurred by one screw

Our vehicle was retired at Endurance Run Event, because of significant slowdown which resulted from a mechanical trouble. By loosed one screw of the gearbox, spinning friction had increased.

Results of 13<sup>th</sup> Student Formula Japan & Summery of This Season

## Results are listed below. Report

We eventually passed the inspection, and our machine run the Endurance Run Event for the first time, but our first run did not succeed. When our machine run about 8km, a gearbox of TF-15 got trouble. A bolt which fixed a gear worked loose, so the gear scraped an inside wall of the gearbox. Because of this trouble,TF-15 slowed down. With sincere regret, we retired Endurance Run Event.



On the other hand, we get an award of most light weight EV. It is the first podium for TUFT.

#### For Improvement

TF-15 is limited accelerating force and top speed, so we must have a more powerful motor or reduce vehicle weight.

Table2. The result of 13 <sup>th</sup> SFJ					
Event	Overall Ranking (86 teams)	EV Ranking (9 teams)	165		
Technical Inspection (Mechanical) Passed (5 EVs were passed)					
Technical Inspection (Electrical)	Passed (4 EVs were passed)				
Acceleration DNA					
Skid pad	DNA				
Autocross	canceled				
Endurance	9LAPS				
Efficiency	DNA				
Presentation	69 <sup>th</sup>	6 <sup>th</sup>			
Design	37 <sup>th</sup>	1 <sup>th</sup>			
Cost	66 <sup>th</sup>	2 <sup>th</sup>			
Overall	65 <sup>th</sup>	3 <sup>th</sup>	Sec. of		



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