Formula 1 – Electronic Safety System

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Formula 1 is a motor sporting event where highly advanced custom made formula 1 cars compete against each other in-order to cross the finish line in least possible time.[1][2] The International Automobile Federation also known as The Fédération Internationale de l'Automobile (FIA) is the governing body which is responsible for laying rules for this sport.[1]

F1 cars are one the most complicated pieces of technology, and with extreme level of competitiveness between teams, it makes it one of the most innovative and fastest evolving competition. These cars are contributed in developing a lot of technology which are used in engines, body parts, safety systems (electronics and mechanical), etc. which are used in today's road cars.[3][4]

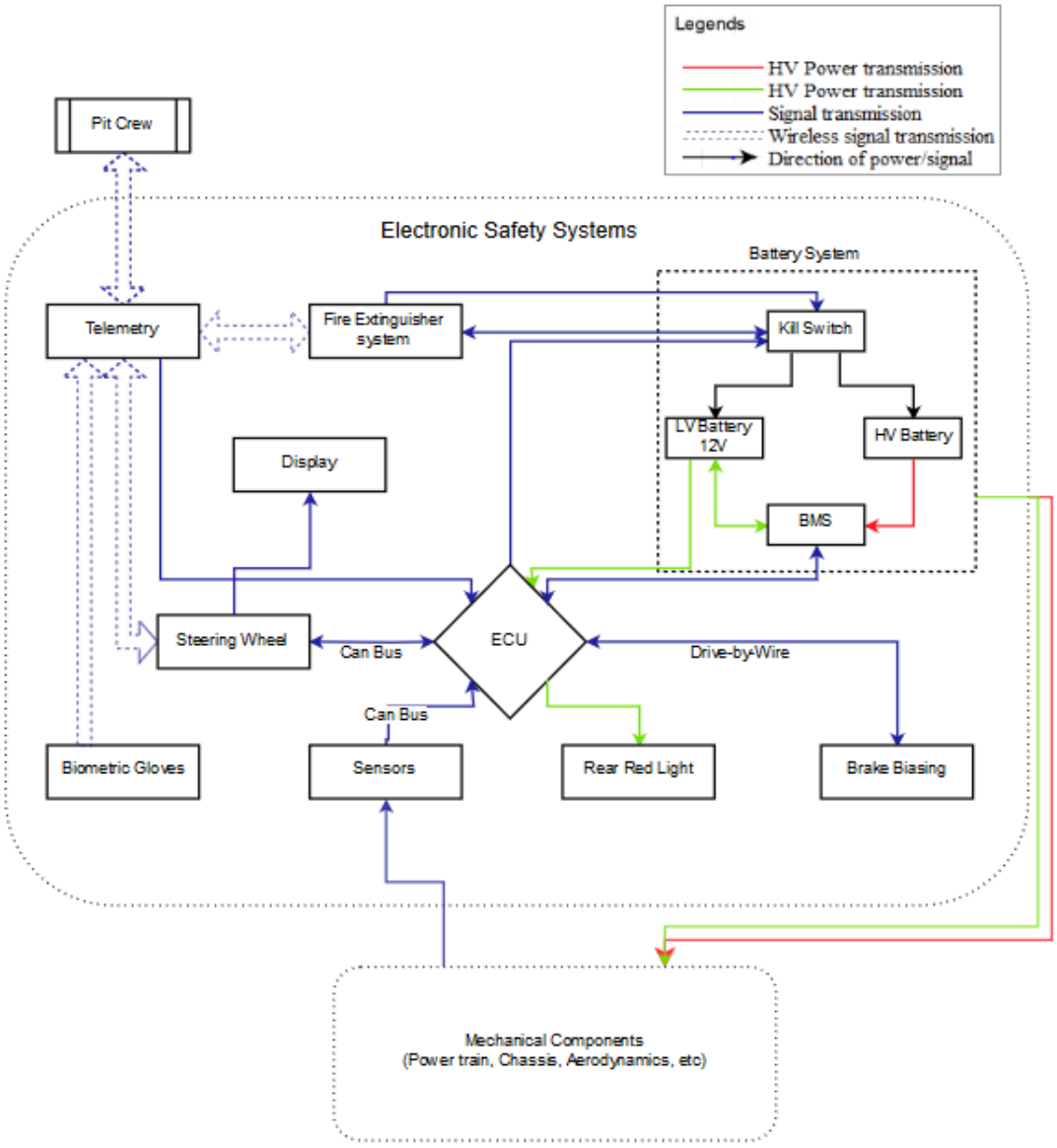

Figure 1. Safety System.

Figure 1 shows the layout of safety system in a F1 car.

Safety System.

Safety is given high degree of importance and due to very strict norms and regulations, these cars go through stringent load tests making F1 cars one of the safest vehicles in case of an accident. [5]

The biggest safety feature of F1 races are strict and mandatory regulation of mechanical components used in the vehicle. The main component tub or monocoque, which is made with carbon fibre and includes the cockpit and the driver's survival cell has made a great impact in the safety of modern F1 cars.[6] The driver's suit, helmet and gloves are made up of fireproof and abrasion resistant material which protects the driver in case of accidents. The aerodynamics, suspensions, antiroll bar, etc. plays a vital role in keeping the vehicle stable even in worst scenarios.

Electronic Safety systems.

ECU- Electronic Control system is the brain of a Formula 1 car. It controls various parameters and processes in real time. It's also responsible for collecting and transmitting the data between the car and the Pit crew.[7]. The ECU receives signals from the sensors and transmit it to pit crew through telemetry. ECU is powered by the LV battery. It controls the electronic safety equipment installed in the vehicle.

Battery System – Every team has their own specification and layout of their battery system. With the inclusion of hybrid drive train and energy recovery system the capacity of batteries has been ever increasing.[8] The battery system is well protected in a fireproof and leak proof enclosure with adequate shock resistance. Cooling system is incorporated in order to keep the batteries safe from overheating. Teams either use Air cooling, Liquid cooling or two-phase cooling.[10].

BMS or Battery Management System is the device responsible for ensuring the health of each and every single cell and of the battery as a whole. It monitors the voltage, temperature and performance of each cell and transmit the data to ECU.

LV or Low voltage battery carries a potential difference of 12V across it's terminals and is responsible for powering electronic components, ECU, BMS, rear light, etc. in the car.

HV or High voltage battery is responsible for running the motor and collects energy from the energy recovery system. The specification of this battery varies for all teams.

Kill switch/ Electrical Masters switch is a switch in the electrical circuit which isolates the battery from the electrical and electronic components when it is activated.[11]

Brake biasing- It is a technique of changing the force applied on front and rear brakes. It can be done by changing the dial in the steering wheel. For the safety of the car in high speed and in different surfaces the driver can adjust the brake ratio of front and rear breaks manually. [12] F1 cars use Drive-by-wire system to actuate brakes.

Rear Red Light- The cars are equipped with red tail lights to make the car visible during bad weather. Since 2019 FIA had mandated the use of the rear wings rain lights which further increases the visibility in bad weather.[13]

Sensors – Every formula 1 car has more 300 sensors which take various inputs such as temperature, pressure, frequency, voltages, etc from different components of the vehicle. [7][14] Majority of the sensors are connected to ECU using CAN BUS.

Biometric Gloves – These gloves have sensor in finger tips and at palm region to monitor real time data such as blood oxygen level, heart rate, etc. This can help in assessing the driver's condition during a crash.[15][16]

Telemetry- It is a method of sending data from car to the Pit, which analyses the real time data such as temperature, frequency, vibration, etc and gives the input to the driver, which are very essential for safety as well as for the better performance. Usually a 1.5GHz frequency is used for the communication.[17]

Steering wheel and Display – Steering wheel is one of the most complicated part in the car. It has around 25 different controls, display, indication led, etc. It's the central control unit of a F1 car. [18] Apart from direction control of the vehicle, the display gives information about various aspects of the car and the LED indicates about DRS/ERS usage and about status of any flag, which uses GPS marshalling system. The steering wheel uses CAN bus module to relay data to ECU. [19]

Fire Extinguisher System – All the cars are equipped with fire extinguisher custom made by teams. It has 2 discharge nozzles facing the engine and 1 output at the cockpit. This is a standalone system with its own battery. It can be operated from either the cockpit or by pulling a lever mounted on the outer shell. Activating the system kills the engine as well as disconnect the batteries.[20]

References

[1]"Formula One - Quick Guide - Tutorialspoint", *Tutorialspoint.com*, 2019. [Online]. Available: https://www.tutorialspoint.com/formula_one/formula_one_quick_guide.htm. [Accessed: 25- Oct- 2019].

[2]"Formula One", *En.wikipedia.org*, 2019. [Online]. Available: https://en.wikipedia.org/wiki/Formula_One. [Accessed: 25- Oct- 2019].

[3]"10 Everyday Car Technologies That Came From Racing", *HowStuffWorks*, 2019. [Online]. Available: https://auto.howstuffworks.com/under-the-hood/trends-innovations/top-10-car-tech-from-racing.htm. [Accessed: 25- Oct- 2019].

[4]"Racing Tech That Migrated to Your Current Car | Digital Trends", *Digital Trends*, 2019. [Online]. Available: https://www.digitaltrends.com/cars/racing-tech-in-your-current-car/. [Accessed: 25- Oct- 2019].

[5]J. Golson, L. Goode and D. Nield, "How Today's F1 Cars Are So Amazingly Safe (And Horribly Uncomfortable)", *WIRED*, 2019. [Online]. Available: https://www.wired.com/2014/07/formula-one-car-safety-comfort/. [Accessed: 25- Oct- 2019].

[6]"Cockpit safety", *Formula 1® - The Official F1® Website*, 2019. [Online]. Available: https://www.formula1.com/en/championship/inside-f1/safety/cockpit-crash-tests/Cockpit_safety.html. [Accessed: 25- Oct- 2019].

[7]"THE BRAIN OF AN F1 CAR - McLaren Applied Technologies", *Mclaren.com*, 2019. [Online]. Available: https://www.mclaren.com/appliedtechnologies/lab/brain-of-an-f1-car-mclaren-ecu/. [Accessed: 25- Oct- 2019].

[8]"F1 Lithium Ion Battery Cells Energy Recovery System", *Pmbl.co.uk*, 2019. [Online]. Available: http://www.pmbl.co.uk/blog/f1-lithium-ion-battery-cells-energy-recovery-system. [Accessed: 25- Oct- 2019].

[9]"How to design a Motorsport Battery in 7 steps - Racecar Engineering", *Racecar Engineering*, 2019. [Online]. Available: https://www.racecar-engineering.com/tech-explained/how-to-design-a-motorsport-battery-in-7-steps/. [Accessed: 25- Oct- 2019].

[10]"Benefits and Drawbacks of Using Two-Phase Cooling Technologies in Military Platforms | Electronics Cooling", *Electronics Cooling*, 2019. [Online]. Available: https://www.electronics-cooling.com/2013/03/benefits-and-drawbacks-of-using-two-phase-cooling-technologies-in-military-platforms/. [Accessed: 26- Oct- 2019].

[11]"Kill switch", *En.wikipedia.org*, 2019. [Online]. Available: https://en.wikipedia.org/wiki/Kill_switch. [Accessed: 26- Oct- 2019].

[12]"Brake Balance or Brake Bias", *Formula1-dictionary.net*, 2019. [Online]. Available: http://www.formula1-dictionary.net/brake_balance.html. [Accessed: 26- Oct- 2019].

[13]J. Noble, "Formula 1 to use new rear wing rain lights in 2019", *Autosport.com*, 2019. [Online]. Available: https://www.autosport.com/f1/news/138347/f1-to-use-new-rear-wing-rain-lights-in-2019. [Accessed: 27- Oct- 2019].

[14]C. Reichert, "Formula 1: How sensor technology is changing the race | ZDNet", *ZDNet*, 2019. [Online]. Available: https://www.zdnet.com/article/formula-1-how-sensor-technology-is-changing-the-race/. [Accessed: 27- Oct- 2019].

[15]"Biometric Gloves Set for F1 Debut", *Federation Internationale de l'Automobile*, 2019. [Online]. Available: https://www.fia.com/news/biometric-gloves-set-f1-debut. [Accessed: 28- Oct- 2019].

[16]"F1 announce rule changes for 2019... including biometric gloves", *Mail Online*, 2019. [Online]. Available: https://www.dailymail.co.uk/sport/formulaone/article-5633813/F1-announce-rule-changes-2019-including-biometric-gloves.html]. [Accessed: 28- Oct- 2019].

[17]"Telemetry", *Formula1-dictionary.net*, 2019. [Online]. Available: http://www.formula1-dictionary.net/telemetry.html. [Accessed: 28- Oct- 2019].

[18]"Here's What Every Button on a Modern F1 Steering Wheel Does", *Road & Track*, 2019. [Online]. Available: https://www.roadandtrack.com/motorsports/a26827434/2019-mercedes-f1-steering-wheel-explained/. [Accessed: 28- Oct- 2019].

[19]J. Golson, "An Inside Look at the Insanely Complex Formula 1 Steering Wheel", *WIRED*, 2019. [Online]. Available: https://www.wired.com/2014/05/formula-1-steering-wheels/. [Accessed: 28- Oct- 2019].

[20]S. Groote, "Fire extinguisher - F1technical.net", *F1technical.net*, 2019. [Online]. Available: https://www.f1technical.net/features/2514. [Accessed: 28- Oct- 2019].