# REV PROJECT FORMULA-SAE-Autonomous INFORMATION SHEET

*This sheet to be kept by inductee*

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## Driving an Electric Vehicle

Driving an electric vehicle is almost identical to driving a petrol/diesel equivalent. There are only a few differences to note.

**Before Driving the Formula-SAE-Autonomous** *(F-Auto)*

Check the following:

* The vehicle and you are in compliance with the vehicle usage procedures (R01).
* You have read and understood the induction documents (F03).
* That the medium-size, red autonomous power button is pressed down (off).
* For manual driving: that the toothed belt attached to the pulley on the steering column is detatched (optional), that the fuse at the rear right of the vehicle for the autonomous system is removed (optional), that the switch in the rear right is set to manual (**must**) and that the acceleration switch above the dashboard is set to manual (**must**).
* For autonomous driving: that the fuse at the rear right of the vehicle for the autonomous system is inserted, the belt connecting the steering column to the steering motor is tensioned, that the autonomous power swtich in the rear right is set to autonomous and that the acceleration switch above the dashboard is set to automatic (for automatic acceleration) or manual (for human control).
* The vehicle is not charging and the charger is disconnected.
* The vehicle is sufficiently charged (read TBS meter).
* A minimum of two people are present (driver and observer), and you have the ability to contact support if necessary (a mobile phone and contact information).
* A fire extinguisher and first aid kit are close by.
* You have fastened and adjusted the the seatbelt and are wearing a full-face helmet

**Starting the Vehicle**

The vehicle is started by lifting the master E-stop (big red) button above the battery pack, then releasing the driver’s E-stop button on the dash once all bystanders are clear.

**If the vehicle does not start check the following:**

* The vehicle is not currently charging.
* The emergency stop button is not down.
* The acceleration switch is in the correct mode (manual or auto).
* The brake is not engaged.
* The accelerator was not depressed at starting.
* The battery voltage is above 37V (if not, a warning buzzer should be sounding).
* The vehicle does not make a clicking sound when turned on: try driving the vehicle slowly with one foot on the brake to begin with.
* Check Kelly controller error codes against the table in the manual.

**Battery Level**

Electric vehicles use battery packs to supply energy to the vehicle engine.

The F-Auto vehicle is equipped with a BMS energy meter. Although battery voltage remains fairly steady, it can be used to estimate state of charge, where 50V is almost full and 48V almost empty.

Whenever the vehicle is not in use, both E-stop buttons (rear and dashboard) should be down. This avoids any quiescent loads on the pack. The F-Auto vehicle can be left safely for months in this state.

When not using the vehicle for a long period (over a week), it is best to fully charge before use. The F-Auto battery pack **should not go below 40V**, if it does: report the fault immediately to a REV instructor or the REV Project supervisor.

**Driving**

* The laboratory supervisor should be informed prior to any test drives which are to take place.
* A pre-drive check should be conducted comprising: batteries, electrical systems, autonomous system, suspension, drive-train, drivers PPE and driver’s ability to quickly exit the vehicle.
* The F-Auto has a single-speed reduction drive, with no reverse. To drive forwards simply depress the accelerator pedal slowly.
* To manouver the car backwards: depress the driver’s E-stop button and have someone push the car backwards. The car is very light so it is easy to push, but there should be a driver sitting in the car ready to use the brakes if necessary. When ready to move forwards again, release the E-stop button and drive away.
* The F-Auto should be driven with the right foot on the accelerator and left foot on the brake.
* Be aware that the driver cannot easily see the rear wheels of the vehicle and that the car is wider at the rear.

**Testing Area**

If the vehicle is being tested on University grounds it should be escorted to the testing area at a slow walking pace, preferably by pushing if the pathways are crowded. The testing area should be of sufficient size for safe operation and have a barrier of bollards and rope/tape along any sides that see regular pedestrian traffic. Traffic cones should be placed along the full circumference. Two (three for autonomous driving) people should be present and the car should only be driven in clear grassed areas at less than 20 km/h.

**Vehicle Charging**

The F-Auto vehicle is charged using an off-board Kingpan KP4810 charger, which plugs in to any 10A+ 240V wall socket, and on the vehicle connects to a grey Anderson-style connector near the vehicle control box (above the battery in the rear).

To charge the batteries:

* Ensure the charger is switched off (switch pointing to the “O” symbol)
* Press the dash mounted emergency stop
* Autonomous switch at the rear right of the vehicle is in MANUAL position.
* Connect the charger to a wall outlet and to the plug on the car
* Ensure the Isolation switch above the batteries is pulled up
* The pushbutton for BMS reset is not being pushed
* Switch on the external charger (switch pointing to the “ | ” symbol)

The charger will stop automatically when the battery is full. As a secondary safety measure, the vehicle includes a Battery Management System (BMS) which will interrupt the charge current in case of battery faults. There is a reset switch on the side of the control box which may have to be depressed to reset the BMS for charging to start.

The main rear emergency stop button interrupts all power to/from the battery pack so must be up for charging to occur. The button should be pushed down again when charging is complete as a safety precaution. Do not leave the car unattended for long periods (e.g. overnight) whilst charging.

**Breakdown Procedures**

In the event the electric vehicle has broken down or suffered a failure, press all three emergency stop buttons to isolate the autonomous system, motor controllers and battery then contact a REV instructor or the REV Project supervisor.

**Emergency Procedures**

In the event of an emergency it is important put the lives of yourself and others first. Any incidents or near misses must be reported to the laboratory supervisor.

**Emergency Stop**

To perform an emergency stop and cut off all power from the batteries to the vehicle, press the large red E-Stop buttons on/above the dash and/or above the battery pack (preferably both for redundancy). The E-stop buttons should both be pressed in whenever the vehicle is unattended.

**Vehicle Fire Extinguisher**

The F-Auto vehicle has a fire extinguisher on-boardto be used in case of emergency.

**Autonomous System Usage**

* Autonomous switch at the rear right of the vehicle is in AUTONOMOUS position.
* Turn on the vehicle by lifting the emergency stop button above the battery pack.
* Set the acceleration switch to autonomous or manual as desired.
* Turn on the autonomous system using the red auto/man twist switch. Ensure that no body parts are throught the steering wheel or any areas that could move unexpectedly.
* Ensure that the desired acceleration mode has been selected (manual or auto) and that the autonomous system is on.
* **After** this, turn on the Kelly motor controllers by releasing the red button on the dash.
* The Kelly motor controllers will not start if they are commanded to accelerate while they power up. **Do not** demand the autonomous system to accelerate until the Kelly motor controllers have finished turning on.
* **Do not** rapidly turn the autonomous system off and on.
* **Do not** leave the autonomous system in emergency brake mode for extended periods of time.
* If the blue safety mode light is lit on the Autonomous control panel, the drive system will not be able to be enabled unless all safety permissives (including presence of heartbeat) are met and the system has been “armed”. This functionality can be modified by a command to the Hardware Safety Supervisor or, *for testing purposes only,* disabled by disconnecting the safety relay from the drive enable loop (spade lugs beneath the autonomous control panel).
* Refer to the theses by Drage and Kalinowski for a full description of the autonomous safety functionality: http://robotics.ee.uwa.edu.au/theses/