Belt StarterGenerator(BSG)

Software Requirements

Daniel Sarmento
Lucas Emanuel
Paulo Dantas
Pedro Bichara
Rafael Lima

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1.Requirements

2.1 **Functional Requirements**

[TL-01] BSG CONTROL SYSTEM: All broadcast signals for the BSG (Belt Starter Generator) will have 50ms baud rate.

[FR-01] TORQUE ASSISTANCE: In TORQUE ASSISTANCE mode, the BSG must provide torque to the vehicle, actively acting on the movement when requested through the energy stored in the batteries;

- **[SyR-01] TORQUE REQUEST SIGNAL:**In the TORQUE ASSISTANCE mode, the BSG must be able to receive a signal indicating a TORQUE REQUEST.
- **[SyR-02] GEAR SHIFT SIGNAL:** in the TORQUE ASSISTANCE mode, the BSG must be able to receive a signal indicating the vehicle's current gear;
- **[SyR-03] TORQUE ASSISTANCE ENERGY SOURCE:** The TORQUE ASSISTANCE mode must function using energy from the 48V battery primarily.
- **[SoR-01] TORQUE ASSISTANCE ACTIVATION CRITERIA:** If the BSG receive a TORQUE REQUEST signal, the system must act as a motor by providing the torque rate as defined by the input signal.
- **[SoR-02] TORQUE ASSISTANCE AFTER SOFT START:** After the application of the START/STOP function, the TORQUE ASSISTANCE mode must be activated in order to move the vehicle from a stationary position;
- **[SoR-03] TORQUE DURING GEAR SHIFT:** when the gear shift signal indicates the value 0, the BSG must comprehend this as a gear shift, and therefore must function in the TORQUE ASSISTANCE mode in order to increase efficiency during the process of gear shift;

- **[FR-02] RECHARGE MODE**: In the RECHARGE mode, the BSG must use the ALTERNATOR FUNCTION or the REGENERATIVE BRAKING FUNCTION to recharge both the 48V and 12V main batteries of the vehicle:
- **[FR-03] ALTERNATOR FUNCTION:** While in RECHARGE MODE and while the engine is working and BSG is not functioning in one of the specified modes, the system must work providing charge to the batteries through the belt;
- **[FR-04] REGENERATIVE BRAKING FUNCTION**: regenerative brake functions:
  - **[SyR-04] BRAKE ACTIVATION SIGNAL:** In the REGENERATIVE BRAKING mode, the BSG must be able to receive a signal indicating the activation of the brake pedal for adjustment.

    - **[SyR-05] VEHICLE SPEED SIGNAL:** In the REGENERATIVE BRAKING mode, the BSG must be able to receive a signal indicating the vehicle's speed.

    - **[SoR-04] REGENERATIVE BRAKING ACTIVATION CRITERIA:** If BSG receives a signal indicating that the braking system was activated and another that indicates that the car is moving, the BSG must actuate in REGENERATIVE BRAKING mode;

- **[FR-05] STARTER MOTOR MODE:** In the STARTER MOTOR mode, the BSG must, upon request, start the vehicle's engine or provide a soft start**:**

    - **[SyR-06] ENGINE START SIGNAL:** In the STARTER MOTOR mode, the BSG must be able to receive a signal indicating that the driver turns on the engine.

    - **[SyR-07] ENGINE SOFT START SIGNAL:** In the STARTER MOTOR mode, the BSG must be able to receive a signal indicating that the engine should be activated, coming from the START/STOP system;

    - **[SyR-08] STARTER MOTOR ENERGY SOURCE:** The STARTER MOTOR mode must function using energy from the 48V battery primarily;

    - **[SoR-05] ENGINE START CRITERIA:** If the BSG receives the signal specified in SyR-05, it must function in STARTER MOTOR MODE assisting the engine in its start;

    - **[SoR-06] ENGINE SOFT START CRITERIA:** If the BSG receives the signal specified in SyR-06, it must function in STARTER MOTOR MODE assisting the engine in its soft start;

Parallel to the control of the electric machine, supervisory processes must take place, ensuring that all functions and systems integrated with the BSG operate harmoniously.

- **[FR-06] BATTERY MONITORING:** The BSG must monitor and control the charge level of both batteries, preventing either of them from discharging excessively;

    - **[SyR-09] 12V BATTERY CHARGE SIGNAL:** The BSG must be able to receive a signal indicating the current charge of the 12V battery;

    - **[SyR-10] 48V BATTERY CHARGE SIGNAL:** The BSG must be able to receive a signal indicating the current charge of the 48V battery.

    - **[SyR-11] 12V BATTERY CHARGING CURRENT SIGNAL:** The BSG must be able to receive a signal indicating the current charging current provided by the 12V battery;

    - **[SyR-12] 48V BATTERY CHARGING CURRENT SIGNAL:** The BSG must be able to receive a signal indicating the current charging current provided by the 48V battery;

    - **[SoR-07] CHARGING PRIORITY:** If both batteries have the same charge, priority should be given to charging the main 12V battery of the car.

    - **[SoR-08] TORQUE ASSISTANCE 48V LIMITATION:** If the 48V battery's charge is below a reference value, the TORQUE ASSISTANCE mode must not operate;

    - **[SoR-09] 12V BATTERY USE LIMITATION:** If the 12V battery's charge is below a reference value,it should not be used to provide energy to any of the BSGs functions;

    - **[SoR-10] STARTER MOTOR USE OF 12V BATTERY:** If the 48V battery is unable to provide energy for the execution of the STARTER MOTOR mode, the 12V battery must supply the necessary energy for the required actions, given its charge is within the referenced value specified.

    - **[SoR-11] STARTER MOTOR CRITICAL SCENARIO:** If the 48V battery's charge is below a reference value, the STARTER MOTOR may still operate if necessary;

    - **[SyR-13] 12V BATTERY VOLTAGE SIGNAL:** The system must be able to receive a signal indicating the 12V battery voltage

    - **[SyR-14] 48V BATTERY VOLTAGE SIGNAL:** The system must be able to receive a signal indicating the 48V battery voltage;

    - **[SoR-12] BATTERIES UNCOUPLING:** If both batteries are fully charged, they must be uncoupled from the system in order to preserve their lifespan;

    - **[SoR-13] BATTERIES CHARGE WARING:** The system must provide a warning on the drivers panel that informs that both batteries have low charge and this can compromise engine start;

- **[FR-07] SAFETY SWITCH:** the BSG must be able to be shut down in case there are abnormalities in the system that prevent the mechanism to work safely;

    - **[SyR-15] SAFETY SIGNAL:** The BSG must be able to receive a signal indicating failures in the system;

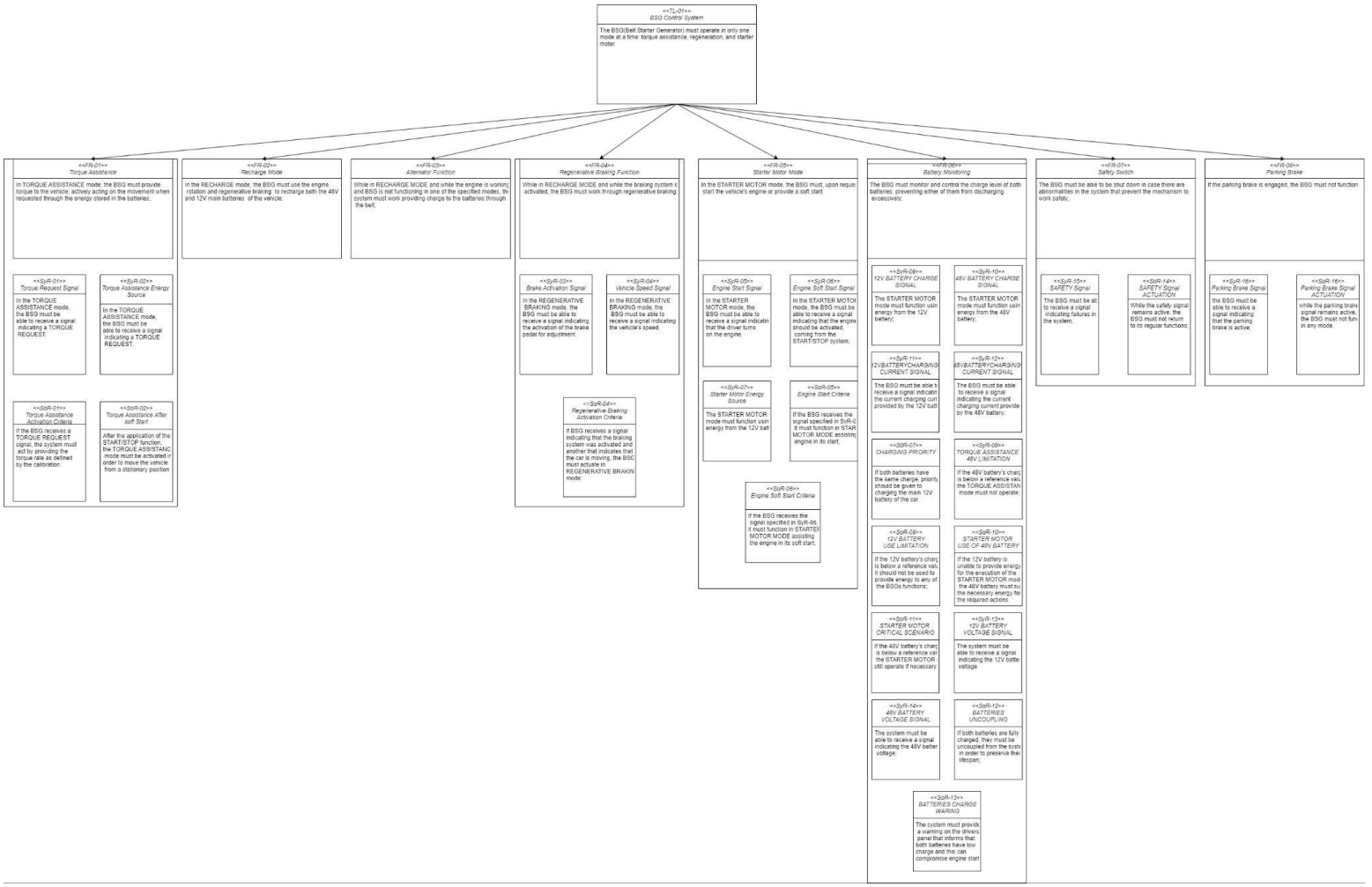
    - **[SoR-14] SAFETY SIGNAL ACTUATION:** While the safety signal remains active, the BSG must not return to its regular functions;

- **[FR-08] PARKING BRAKE**: If the parking brake is engaged, the BSG must not function.

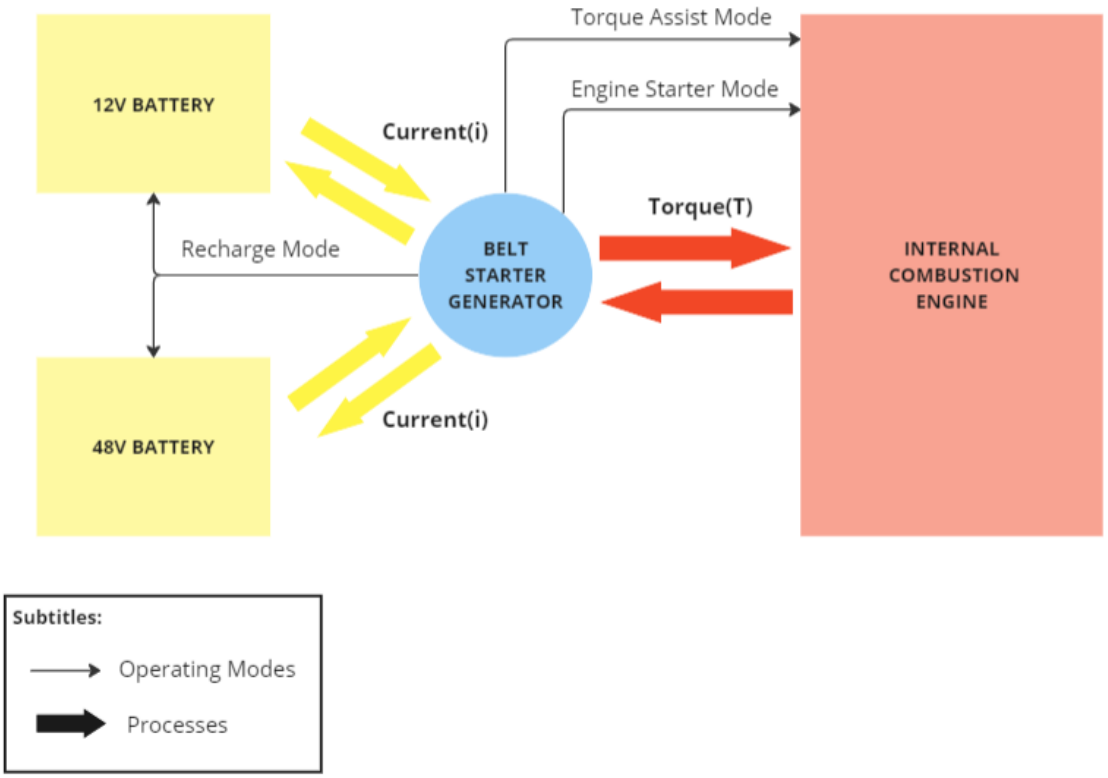
    - **[SyR-16] PARKING BRAKE SIGNAL:** the BSG must be able to receive a signal indicating that the parking brake is active;

    - **[SoR-15] PARKING BRAKE ACTUATION:** while the parking brake signal remains active, the BSG must not function in any mode

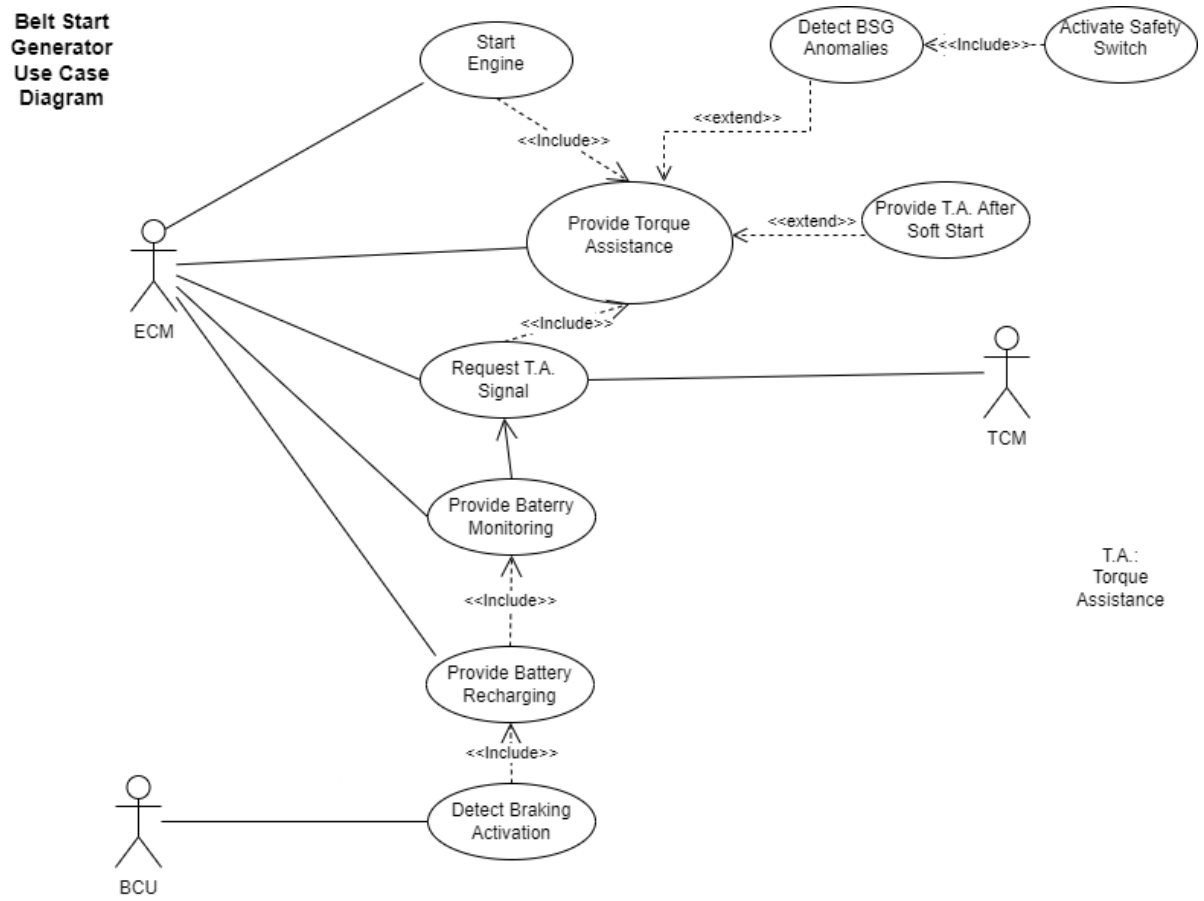
2. Requirements Diagram



3.1 Operating Modes Diagram



3.2 Use case Diagram



3.3 Requirements traceability table

Req.	Affected Requirements							
TL-01	FR-01	FR-02	FR-03	FR-04	FR-05	FR-06	FR-07	FR-08
FR-01	FR-03	FR-04	FR-06					
FR-02	FR-03	FR-04	FR-06					
FR-03	FR-02	FR-04						
FR-04	FR-02	FR-03						
FR-05	FR-06							
FR-06	FR-01	FR-02	FR-03	FR-04	FR-05	FR-07	FR-08	
FR-07	FR-01	FR-02	FR-03	FR-04	FR-05	FR-08		
FR-08	FR-01	FR-02	FR-03	FR-04	FR-05			