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Model Ba ed De ign of Rob Vehicle Po er Ne ork

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ABSTRACT

Electrical power requirements for vehicles continue to increase. Future vehicle applications require the development of reliable and robust power supply strategies that operate over various ambient temperatures and driving conditions. Insufficient charge balance is one of the major concerns for conventional lead-acid battery systems when operated with limited charging times during short journeys or extreme climate

weight and the power drawn from the engine. Automotive manufacturers such as Jaguar and Land Rover, often develop power management techniques and integrate various electronic components (battery monitoring systems etc.) to accommodate the increase of vehicle electrical power consumption whilst minimizing any adverse effect upon the electrical components and the whole vehicle.

The development of dynamic simulation models that are based upon vehicle electrical systems provides a basis for analyzing complicated systems and predicting their performance and behavior when operating under a variety of different conditions. Modeling and simulation of various electrical power system configurations, combined with the development of new techniques for the optimization and control of a vehicle power network, can provide a competitive advantage to a vehicle manufacturer. Reduced manufacturing costs in terms of reduced delivery time of the product, improved engineering processes during operating voltage. More details on alternators may be found in [3]. Figure 3 shows typical alternator current output characteristics depending on temperature.

VEHICLE EQUIPMENT AND ELECTRICAL LOADS

A detailed and thorough examination was made of the electrical loads that were present on a high-end luxury automobile. These loads are separated into five main

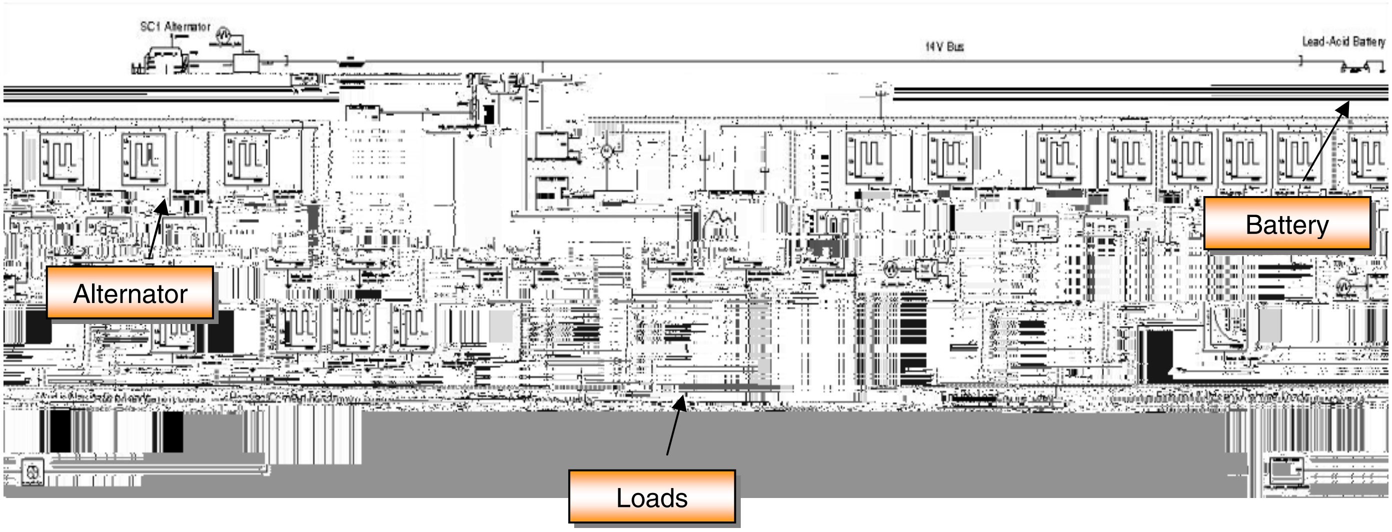

Fig re 5: O erall Sim la ion Model of Vehicle Po er Ne S em

such as Joule heat loss effects related to the charging/discharging life cycle of the battery. In order to complete the parameterization of the model for a specific type of battery, the SABER battery model provides a parameterization page including all the necessary parameters. In addition to manually entering the parameters SABER also provides a characterization tool that allows to graphically characterize the model. The input for the tool is measurements applied to the battery. Typical information like charge, discharge and step response is being used to automatically parameterize the model. The graphical user interface for the characterization tool is shown in figure 6. Models can be considered on different levels of abstraction including or excluding thermal effects depending on the available set of data. The tool uses an optimizer to automatically extract the required parameter values from the measurements and feeds that into the simulation.

VEHICLE ALTERNATOR MODEL

In this study, a model is sought which provides good accuracy, fast simulation time and is relatively easy to set up. Alternator models that represent equivalent magnetic and electrical circuits provide sufficiently accurate emulation of alternator performance. However, such models generally require detailed information regarding alternator parameters, such as winding resistance,

Fig re 6: Charac eri a ion of he Ba er Model

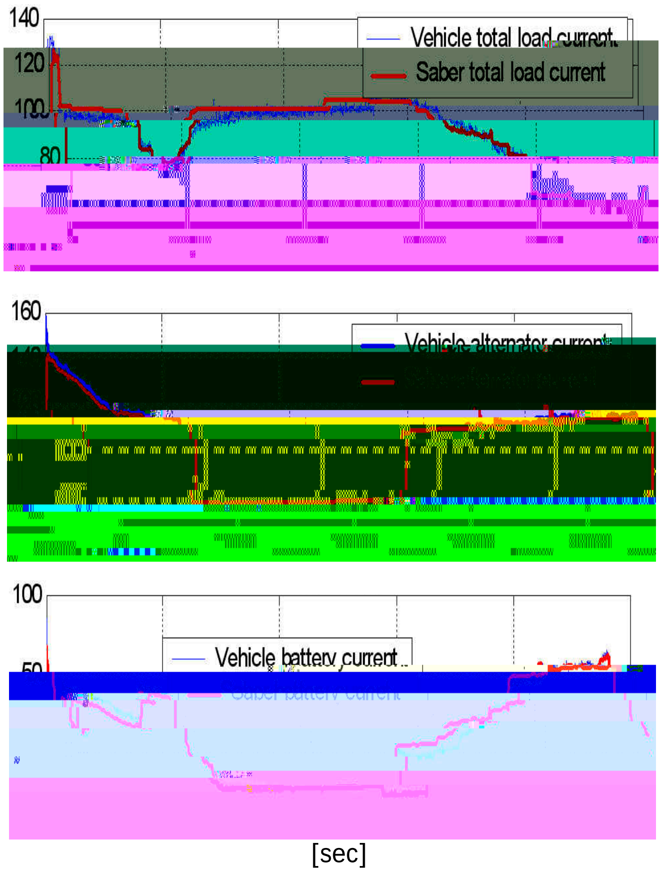

Fig re 10: Load, Al erna or and Ba er C rren DID C cle +40 C

drive cycle conditions. The ambient air temperatures of these tests ranged between 0°C and 40°C with the battery SOC at the start of the test being set to 50% for a DID (figure 9) test. For the DID tests the SOC of the battery model is set at 50%, because this is the expected capacity of the battery in a 'worst case scenario' (i.e. long stay car park with the vehicle at standstill for 31 days with all electrical loads switched off but alarm system on). The above tests provide the opportunity to compare how the different SOC levels affect the performance of the battery and the alternator models in a variety of conditions that may cause the battery to be charged and discharged. Figure 9 shows the profile of the vehicle speed for the DID cycle test, respectively. In the evaluation of the above system a variety of signals can be compared with experimental data. The selection of data for comparison was dependent upon the subject of the evaluation. In this study the following were selected in order to compare model performance with actual measured data.

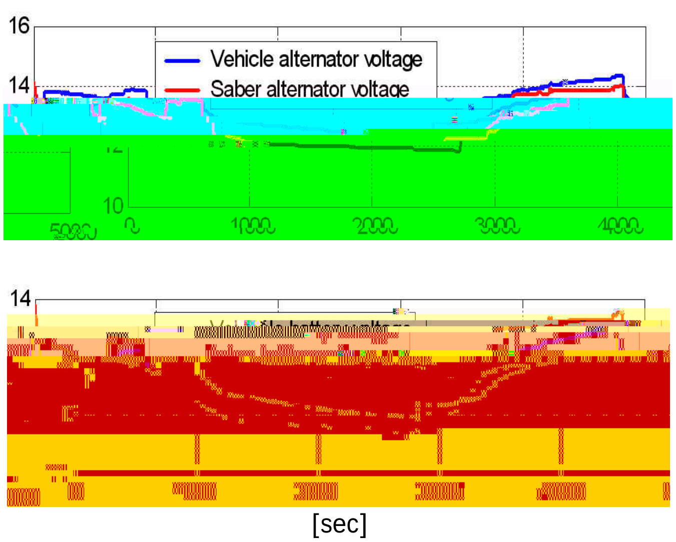

Fig re 11: Al erna or and Ba er Vol age DID C cle +40 C

- Alternator current output
- Battery current output
- Alternator voltage levels during charging & discharging cycles
- Battery voltage levels during charging & discharging cycles
- The total current consumption of the selected electrical loads

The simulation results for the electrical current and voltage for the DID cycle are shown in figure 10 to 13 under different temperature conditions. The resulted curves show a good agreement of the total simulated vehicle electrical load current to that measured from the test vehicle. It is worth noting that the actual vehicle load current is represented as a ‘noisy’ trace, particularly in lower ambient temperatures. This occurs because loads related to heating and passenger comfort, such as heated screens and heated seats, are repeatedly switched on and off to maintain a specific temperature. By comparison, such comfort loads in the simulation tool remain on all of the time with the electrical power being regulated to different levels according to ambient temperature. This issue could be addressed by modeling such temperature dependent loads differently, but after a careful consideration on the effect of such models on the overall accuracy of the SPS, this was considered to be minimal. It is also evident from the comparison of the simulated and the actual measured alternator currents that the alternator model current output shows a good agreement with the actual alternator output for the temperature range considered. The errors that are evident for the cold climate conditions are mostly caused by the repeated switching ON and OFF of the heating loads. However, the errors that occur in hot climate conditions, after the extended idle period, are related to alternator temperature for hot environmental climate conditions e.g. extremely high under-bonnet temperatures. In reality, it takes more time for the under-bonnet area to cool the alternator and this causes the actual alternator current to be lower than that predicted by the model. Finally, by examining the results, it is clear that the vehicle power net simulation model performed well.

ACCELERATING THE ENGINEERING PROCESS THROUGH SYSTEM SIMULATION

Validating new vehicle power net concepts are usually time consuming if they are done through real hardware prototyping approaches. Hardware prototypes are only available in the later design stages and a proof of concept in the very early design stage is in most of the cases not possible. Detail2.108n018 Tc.1214 TTTw1c27.8(i)3he

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