UDC 629.021 DOI: 10.30977/AT.2219-8342.2022.51.0.04

Analysis of design features of systems and components of the Tesla Model S electric car

Smyrnov O.[1], Borysenko A.[1]

[1]Kharkiv National Automobile and Highway University, Ukraine

Abstract. Problem. *The article analyzes the design features of the systems and components of the Tesla Model S electric car, which allows choosing the initial characteristics for the mathematical model of the acceleration dynamics of the electric car, determines the cost characteristics of its power plant (electric motor) and battery.* ***Goal.*** *The purpose of the work is to determine the initial characteristics of the systems and components of a modern electric vehicle for their further use in a mathematical model of the acceleration dynamics of an electric vehicle.* ***Methodology.*** *The approaches adopted in the work to achieve the set goal include understanding the peculiarities of the initial characteristics of the systems and components of electric vehicles, which are the world leaders in the market of such vehicles.* ***Results.*** *In the work, a comparative analysis of the layout schemes for the implementation of transmissions in the designs of modern electric vehicles, the characteristics of their power plants (electric motors), the characteristics of energy converters (inventories), and the features of the power plant power plant of a modern electric car are determined.* ***Originality.*** *The conducted analysis of the design features of systems and components of the Tesla Model S electric car made it possible to form a general idea about the features of the implementation of work processes in the electric drive of an electric car, which can be used as initial parameters or characteristics during the simulation of the acceleration dynamics of an electric car.* ***Practical value.*** *The obtained results make it possible to formulate recommendations for the use of the characteristics of the systems and components of the electric vehicle during the simulation of the dynamics of its acceleration and to determine the energy consumption in the power system of its traction electric drive.*

Key words: *electric car, power, power supply system, battery, energy capacity, characteristics of the electric drive.*

Introduction

At the current stage of the development of vehicles with an electric drive, their sales in the automotive equipment market in the world are growing rapidly, as evidenced by the analysis conducted by the BloombergNEF company [1].

According to forecasts of this company, by 2025 the number of sales of electric vehicles will reach 10 million, and by 2030 - 28 million, while the projected percentage of sales of electric vehicles is expected at the level of 57% [2] of the total number of vehicles with traditional power units (internal combustion engines).

Since electric cars have started to be sold more often on the automotive market, it is important to determine the features of the structure of their components and systems.

Analysis of publications

The relevance of this study lies in the fact that to model the acceleration dynamics of an electric vehicle, it is necessary to have the initial characteristics of its electric drive, which at this stage of the development of electric vehicle design technologies are a secret of leading companies and corporations that manufacture electric vehicles [3-5].

It is known from the scientific and technical literature [3-15] and the Internet [16] that modern electric cars, thanks to the peculiarities of the implementation of their electric drives and power systems, allow an electric car to accelerate to 100 km/h in almost 2 seconds, for example, the Tesla Model S Plaid electric car [3], while modern electric cars can reach speeds of up to 300 km/h [3, 16].

From the analysis of works [5-7, 13-15], it is known that electric vehicles of leading companies [3] have a reserve of electric energy for 840 km of mileage according to the NEDC cycle [17, 18].

Such electric cars have an additional option of quick charging in a time of about 15 minutes to ensure the mileage of the electric car at a distance of up to 300 km [12].

Purpose and Tasks

The purpose of the work is to determine the initial characteristics of the systems and components of a modern electric vehicle for their further use in a simulated mathematical model of the acceleration dynamics of an electric vehicle.

To achieve the goal, the following tasks must be solved:

– to perform an analysis of layout schemes for the implementation of transmissions in the designs of modern electric vehicles;

– compare the characteristics of power units (electric motors) of modern electric cars;

– to determine the features of the characteristics of energy converters (inverters) in the power system of an electric vehicle;

– to determine the features of the implementation of the power system of the power unit of a modern electric vehicle.

Materials for the analysis of design features of systems and components of the Tesla Model S electric car

In modern Tesla electric cars, the traction electric drive is structurally performed as a unit that cannot be mechanically separated and which consists of three main elements: a power unit (electric motor), a mechanical gearbox and an energy converter (inverter). The component parts of this node are highly integrated and use common unified connections and interfaces, which simplifies the structure of the system and increases its reliability.

Depending on the implementation of traction electric drives of modern electric vehicles, different dynamics of electric vehicles and consumption characteristics of their power supply systems can be implemented.

As confirmation of what has been said, we will provide comparative technical characteristics of various models of the Tesla Model S electric car, in the form of Table 1, for the convenience of their comparison and analysis.

Table 1. Technical characteristics of some Tesla Model S electric cars

The parameter	60D	75D	85D	90D	P100D	Plaid
Battery capacity, kWh	60	75	85	90	100	100
Power, kW	245	350	311	311	568	750
Total torque, Nm	525	600	660	660	950	1428
Acceleration to 100 km/h, s	5.4	4.4	4.0	3.8	2.4	2.0
Max. speed, km/h	209	225	250	250	250	320
Mileage on the NEDC cycle, km	408	490	528	557	613	840

Analysis of layout schemes for the implementation of transmissions in the designs of modern electric vehicles

Let's consider the features of the structure of traction electric drives using the example of layout schemes for the implementation of transmissions of the Tesla Model S electric car (Fig. 1).

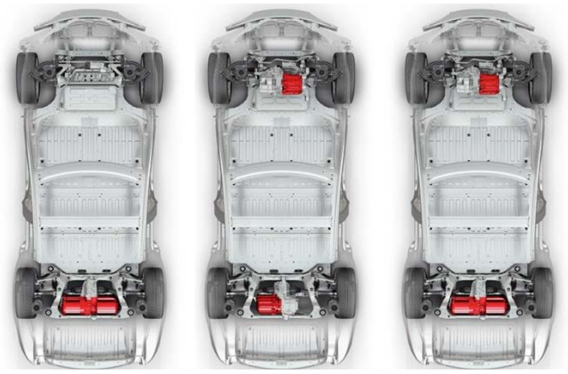

Fig. 1. Implementation scheme of electric vehicle transmission Tesla Model S [20]

It can be seen from Figure 1 that structurally, the traction electric drive of the wheels of an electric car can be presented in three versions: rear-wheel drive, all-wheel drive, reinforced all-wheel drive.

Asynchronous electric motors (Fig. 2) are used for the Tesla electric car transmission implementation options (Fig. 1).

Fig. 2. Appearance of Tesla asynchronous electric motors: single (left); double (right) [20]

In the case of prospects for the development of drives (Fig. 1), in order to reduce the cost of electric vehicles while preserving their dynamic characteristics, schemes (Fig. 3) with a smaller number of options for the implementation of electric drives are considered.

So, for example, for some models of Tesla electric cars, it is proposed to use PRMS (Raven) synchronous electric motors, which are also called impulse jet motors with permanent magnets. In this case, the implementation scheme of the electric car transmission can be presented in two versions (Fig. 3): reinforced rear-wheel drive and reinforced all-wheel drive.

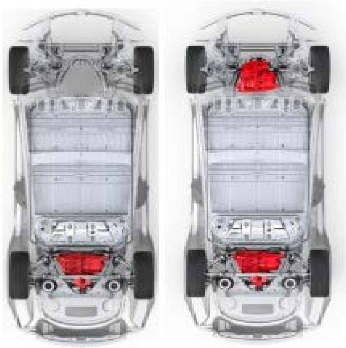

Fig. 3. Implementation scheme of Tesla electric car transmission with PRMS (Raven) synchronous electric motors [20].

Let's consider the peculiarities of the implementation of the characteristics of the electric drive of the wheels of the electric car Tesla Model S P100D [4, 5]. For the front drive of the wheels of such an electric car, a 270 HP type electric motor with a capacity of 200 kW with max revolutions (n_e^{max}) – 18.000 rpm. For rear-wheel drive, a more powerful engine is a 503 HP type, which has a power of 370 kW and a maximum revolutions of 16.000 rpm.

Since the rotation of the wheels of an electric car with revolutions of 16.000 – 18.000 rpm is not advisable and can provoke their skidding, a reducer is installed after each of the electric motors, which reduces its revolutions by approximately 10 times, thanks to the ratio (i_r) of the reducer 9.73. A simpler calculation, performed according to equation (1), based on the data shown in Figure 5, shows that the maximum speed of the electric vehicle, which has wheels with a radius of r_k = 0.34 m, is limited only by the revolutions of the electric motor at the selected ratio of the reducer 9.73.

$$V_{\max} = \frac{3600 \cdot r_k \cdot P_e^{V_{\max}}}{M_e^{V_{\max}} \cdot i_r} = 0{,}377 \cdot \frac{r_k \cdot n_e^{V_{\max}}}{i_r}. \quad (1)$$

The construction of the gearbox is shown in Figure 4.

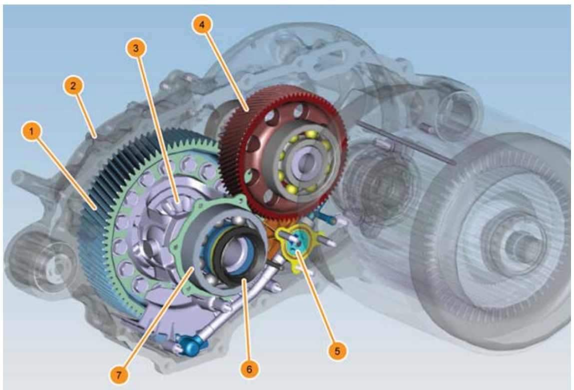

Fig. 4. Construction of the reducer: 1 – crown gear; 2 – gearbox housing; 3 – bevel gears; 4 – reducer of the intermediate shaft; 5 – oil pump; 6 – cardan shaft seal; 7 – bearing

The reducer in the transmission of the electric car also allows to increase the torque on the wheels in relation to the torque on the electric motor shaft, which allows to reduce the load on the bearings of the traction electric motor, especially in conditions of maximum loads that occur from the side of the road on the driving wheels of the electric car.

Comparison of the characteristics of power units (electric motors) of modern electric cars

A comparison of the results of the calculation of the maximum speed of the electric car with the real characteristics of the electric motors (Fig. 5) confirms the judgments given above.

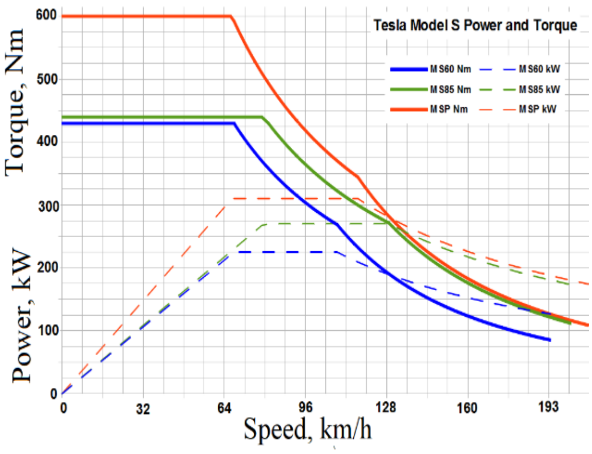

Fig. 5. Comparison of external speed characteristics of Tesla Model S electric motors (model 60, 85, P85) [19].

From the external speed characteristics of the asynchronous electric motors used on the Tesla Model S electric cars with the transmission implementation schemes shown in Figure 1, it can be seen that, other things being equal, the dynamic properties of the electric drive of the Tesla car are slightly different.

From the characteristics shown in Figure 5, it can be seen that when Tesla Model S60 and Tesla Model S85 electric cars are moving at a speed of up to 70-80 km/h, their torque is almost the same, which is provided by the same power of electric motors. The situation changes significantly for these cars in the case of their movement at speeds of more than 100 km/h, it can be seen from Figure 5 that the power of the electric motor of the Tesla Model S60 decreases, which leads to a decrease in the torque and a decrease in the traction force on the wheels of the electric car. The Tesla Model S85 electric car loses power at a higher speed, around 128 km/h, which allows it to accelerate to a top speed of 200 km/h, which is 4.5% faster than the top speed of the Tesla Model S60 electric car.

Comparing the external characteristics of the electric motors of the Tesla Model S85 and Tesla Model S P85 electric cars, it can be seen that with a slight increase in the power of the electric motor on the Tesla Model S P85 electric car by 6.5%, its torque is increased by 27%. The increase in torque allows for greater tractive forces to be realized on the wheels of the Tesla Model S P85 when driving at speeds up to 100 km/h. Comparing the external speed characteristics of the electric motors of these cars at speeds of more than 128 km/h, it can be seen that the power of the electric motors of these electric cars become the same and the Tesla Model S P85 electric car can accelerate, like the Tesla Model S85, to a speed of 200 km/h. It should be noted that due to the power reserve of the Tesla Model S P85 electric car, its maximum speed can be increased to 209 km/h, which cannot be done on the Model 85.

Determination of the features of the characteristics of energy converters (inverters) in the power system of electric vehicles

The inverter (voltage converter) receives power from the traction battery with a voltage of 400 V and converts direct voltage into alternating current to power the electric motor. The peak values of the current can reach 1400 A. Such a current, such as the maximum compatible power of electric motors of 570 kW, is only peak and rather short-lived. During movement, in practice, lower power and supply current are observed.

The inverter in the Tesla Model S electric car is also designed to create a negative torque and the corresponding current to charge the battery in regenerative braking mode. Regenerative braking is allowed only when the stability control system and the anti-lock braking system are activated. Thrust control is implemented in the stability control system with torque limitation commands sent to the inverter when thrust is reduced.

The voltage converter contains two digital signal processors (DSP) on the control board. The main DSP controls the engine, monitors the performance of the drive system and processes the driver's requests. The second DSP (called the "Pedal Monitor") is a safety monitor that can stop torque generation if motor currents, speed, or accelerator pedal conditions indicate that the primary DSP is malfunctioning. A programmable gate array (FPGA) on the control board controls various security and protection schemes at the hardware level.

The inverter monitors the temperature of the motor and power electronics. It sends requests to the thermostat to cool the engine and internal electronics. When the inverter is working, there is no direct control of the flow of coolant or the speed of rotation of the fan from the converter. The thermostat controls the system for targets that are optimized for range and efficiency. If the temperature limits are exceeded, the drive inverter limits the torque of the electric motor until the temperature returns to the nominal operating range.

The electric motor, gearbox and inverter have a common liquid cooling system. The cooling liquid enters the side of the electric motor and passes through the reducer into the inverter through the internal cavities of the electric drive housing. A mixture of glycol and water is used as a coolant, which circulates in the cooling circuit of the electric drive. The scheme of the cooling system of the traction electric drive of the Tesla Model S electric car is shown in Figure 6. From the stator, the coolant flows through the drive converter, and then exits the drive through the coolant outlet. Heat is transferred from these components to the coolant. The coolant is returned to the radiator, where the temperature of the coolant is reduced by the air passing through the fins of the radiator before it flows around the circuit again. The system temperature is maintained below 85 °C.

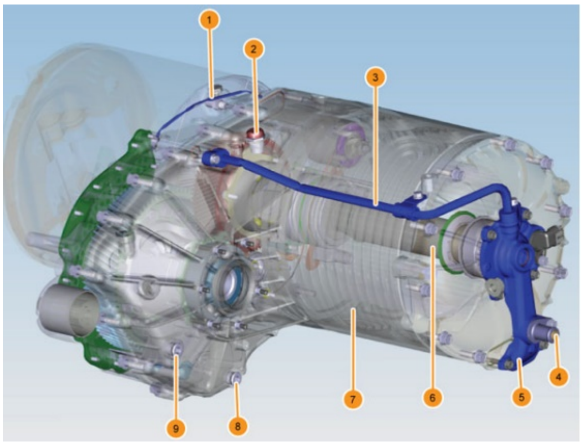

Fig. 6. Cooling system of the electric drive: 1 – air removal; 2 – breather; 3 – coolant pipe; 4 – coolant inlet; 5 - coolant collector; 6 – rotary fan; 7 – stator cooling jacket; 8 – plug for draining transmission oil; 9 – transmis-sion oil level plug

The cooling liquid enters the shaft, returning back along the inner wall. This direct cooling of the rotor is a new innovation for the Model S. The coolant returning from the rotor exits the top of the manifold and flows through the coolant pipe to the gear cooler before exiting through the coolant outlet. The air vent tube connecting the top of the stator cooling jacket and the coolant outlet removes any air pockets present in the drive unit.

Determination of the features of the implementation of the power system of the power unit of a modern electric vehicle

The success and growth of the introduction of electric vehicles is due to the use of advanced lithium-ion batteries with improved performance, long service life and reduced cost (Fig. 7).

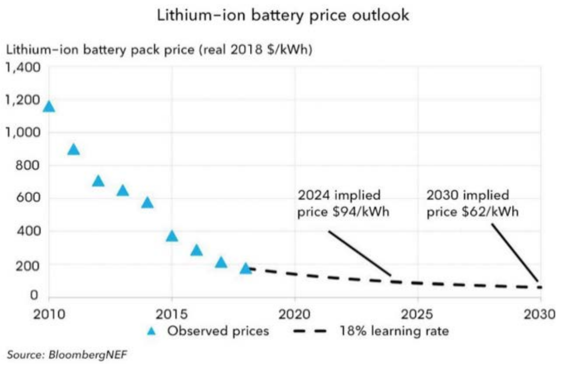

Fig. 7. Evolution of battery prices over the last 10 years and future projections (Goldie-Scot 2019). BloombergNEF 2019 [7]

It is known from operational practice that the Tesla Model S electric car is equipped with batteries of different energy capacities from 40 kWh to 100 kWh [6].

Fuel cell vehicles (FCV) are a revolutionary innovation [8]. But due to the limited network of gas stations for such cars and the high cost, they have little demand. Therefore, the most popular today are classic electric cars, the electric drive of which receives power from a rechargeable lithium-ion battery [9-15].

Power systems of various modifications of the Tesla Model S differ in battery capacity (see Table 1), but have the same design (Fig. 8).

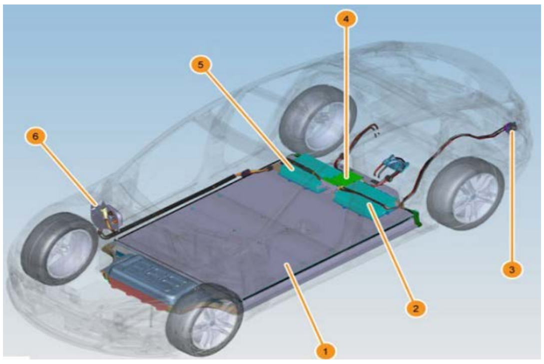

Fig. 8. Design of the power supply system: 1 – battery; 2 – on-board charger (10 kW); 3 – charging port; 4 – distribution box; 5 – the main charger; 6 – voltage converter (inverter)

The Tesla Model S60 battery consisted of 12 or 16 sections. The 16-section battery received the designation "NEW" and was significantly modified. The 70/75 kWh battery was installed on the Model S60 (S60D), it was also installed on the S70 (S70D) and S75 (S75D), but with enhanced features. The 60 kWh battery for the 60th model was distinguished by the absence of 77 batteries, for the 70s Model S all 16 sections were completely filled with batteries, due to which the total battery capacity was increased.

The Tesla Model S 85, 90 and 100 kWh battery consists of 16 sections. Each cell consists of 444 batteries and has its own battery management system (BMS) board, which controls the balancing of all batteries. The most popular battery comes with the Tesla Model S 85 (85 kWh), containing 7104 18650 batteries.

In 2015, Panasonic changed the anode design, increasing the battery capacity by about 6%, allowing the battery packs to store up to 90 kWh of energy. As a result, a 90 kWh battery differs from an 85 kWh battery not only in capacity:

- a Panasonic 18650 battery with an energy capacity of 85 kWh weighs 46 g, and a 90 kWh battery weighs 48.5 g;

- current output in the 85 kWh battery is 10C, in the 90 kWh – 25C (for this reason, the

Ludicrous mode is available only in Model S 90 and 100, so the technical capabilities allow to give the car more lively dynamics);

In the 100 kWh battery, the internals were reconfigured to accommodate 516 Panasonic 18650 batteries in each module. In total, the battery housed 8,256 batteries capable of storing just over 100 kWh of energy and allowing the EV to travel over 600 km.

To further improve battery efficiency and lower costs, Tesla has built a large battery factory in Sparks, Nevada, called Gigafactory 1. The factory produces a new battery design called the 2170. It has a diameter of 21 mm and a height of 70 mm, and was originally used in Tesla Powerwall and Powerpack, as well as in the new Tesla Model 3 sedan, which is smaller and cheaper than the Model S. The 2170 battery is 46% larger than the 18650 and 15% more energy efficient.

An electric vehicle has a 12V battery that provides a power source for the 12V electrical system when the high voltage system is inactive. In the event of a high-voltage system failure, it acts as a power reserve for the entire 12 V system, but its main task is to supply critical vehicle control and safety systems. Such systems include:

- external and internal lighting;
- windshield wipers;
- door handles and glass lifters;
- electric power steering;
- anti-lock braking and dynamic stability control;
- instrument panel.

The 12V battery is lead-free, maintenance-free, and charged with high-current battery power via a DC-to-DC converter.

The level of battery charge and statistical data on the consumption of electrical energy allow you to calculate the approximate mileage of the Tesla Model S before the complete failure of the power system of the electric vehicle. This calculation does not take into account altitude differences and possible wind. It is known from the research of leading companies that the slower a car moves, the less air resistance it has and the longer its mileage.

The graph (Fig. 9) shows the comparative dependence of Efficiency and Range for Tesla Model S 85 kWh and Tesla Roadster.

The graphs show that the most economical movement of electric vehicles occurs in the range from 15 km/h to 60 km/h. A speed of more than 120 km/h is economically unprofitable in terms of efficiency and mileage.

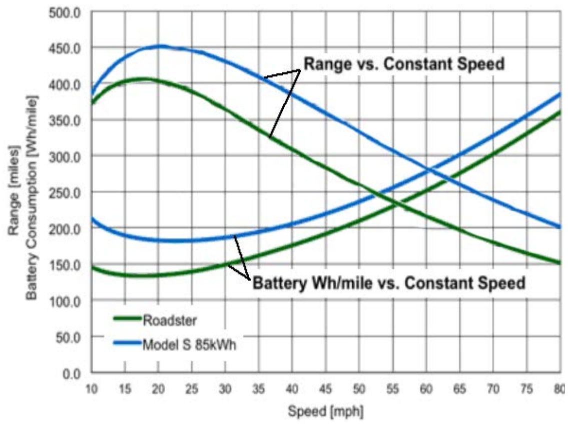

Fig. 9. Tesla Model S Efficiency and Range [21].

Conclusion

An analysis of the design features of systems and components of the Tesla Model S electric car showed that:

- in recent years, the energy capacity of electric vehicle batteries has increased (from 40 kWh to 105 kWh), while the range on a single charge has increased from 224 km to 840 km. It was determined that, in order to increase the range of an electric car, it must move at a speed of up to 60 km/h, since increasing its speed to 120 km/h and above reduces the range by more than 2 times, from 640 km to 320 km;
- to reduce the acceleration time of electric cars with asynchronous motors, it is necessary to increase the power of electric motors.

The maximum speed of electric vehicles is limited by a mechanical gearbox installed between the wheels and the electric motor, with a gear ratio close to 10.

The peak current values of the Tesla Model S P100D inverter can reach 1400 A. Such a current, as well as the maximum compatible power of electric motors of 568 kW, is only peak and rather short-lived. During movement, in practice, lower power and supply current are observed. Regenerative braking is achieved by using an inverter to create negative torque and a corresponding current to charge the battery.

The peculiarity of the Tesla Model S P100D power system is that its battery consists of 8.256 Panasonic 18650 batteries. This allows the electric car to travel more than 600 km.

Acknowledgement

The work was carried out as part of the research work "Development of an energy-efficient machine complex for the transport support of the Armed Forces and the National Guard of Ukraine" and the scientific and technical work

"Development of an experimental model of an energy-efficient wheeled compact dual-use vehicle", financed by the Ministry of Education and Science of Ukraine.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Goldie-Scot L (2019) A behind the scenes take on lithium-ion battery prices Bloomberg New Energy Finance, https://about.bnef.com/ blog/behind-scenes-take-lithium-ion-battery-prices/ (Accessed 10.11.2022)
2. Electric Vehicle Outlook (2022) Retrived from: https://about.bnef.com/electric-vehicle-outlook/ (Accessed 10.11.2022).
3. Tesla Model S. Retrived from: https://www.tesla.com/models (accessed 10.11.2022).
4. Tesla Model S Plaid breaks all the records in first independent test, but 0-60 mph has a caveat. Retrived from: https://electrek.co/2021/06/17/tesla-model-s-plaid-breaks-records-in-first-independent-test-but-0-60-mph-caveat/ (Accessed 10.11.2022).
5. Tesla Model S Plaid Is Today's Quickest Production Car. Retrived from: https://www.hot-cars.com/2021-tesla-model-s-costs-facts-and-figures/ (Accessed 10.11.2022).
6. Ehrenberger, S., Dasgupta, I., Brost, M., Gebhardt, L. & Seiffert, R. (2022). Potentials of Light Electric Vehicles for Climate Protection by Substituting Passenger Car Trips. *World Electric Vehicle Journal*. 13(10):183. https://doi.org/10.3390/wevj13100183
7. Muratori, M., Alexander, Marcus, Arent, Doug, Bazilian, Morgan, Dede, Ercan M., Farrell, John, Gearhart, Chris, Greene, David, Jenn, Alan, Keyser, Matthew, Narumanchi, Sreekant, Pesaran, Ahmad, Sioshansi, Ramteen, Suomalainen, Emilia, Tal, Gil, Walkowicz, Kevin, Ward & Jacob. (2021). The rise of electric vehicles – 2020 status and future expectations. *United States*. https://doi.org/10.1088/2516-1083/abe0ad
8. Ding, N., Prasad, K. & Lie, T. (2017). The electric vehicle: a review. *International Journal of Electric and Hybrid Vehicles*, 9 (1), 49-66. https://doi.org/10.1504/IJEHV.2017.082816.
9. Sharma, S., Amrish K. & Tripathi M. (2020). Storage technologies for electric vehicles. *Journal of Traffic and Transportation Engineering* (English Edition). 7 (3), 340-361. https://doi.org/10.1016/j.jtte.2020.04.004
10. Gaddipati, G., Kuthuri, N. (2021) Technological developments in batteries: a survey of modelling, estimation, and management strategies for EV application. *International Journal of Electric and Hybrid Vehicles*, 13 (2), 194-209. https://doi.org/10.1504/IJEHV.2021.117881/
11. Gupta, A., Kumar, H. (2022). Multi-dimensional perspectives on electric vehicles design: A mind map approach. *Cleaner Engineering and Technology*. 8. https://doi.org/10.1016/j.clet.2022.100483.
12. Rahul, C., Savier, J., (2022) An overview on hybrid energy storage systems for electric vehicles. *International Journal of Electric and Hybrid Vehicles*, 14 (1/2), 56–64. https://www.inder-scienceonline.com/doi/abs/10.1504/IJEHV.2022.125248
13. Смирнов, О.П., Борисенко, А.О., Марченко А.В., Романенко, А. В., & Євтушенко С. В. (2019). Дослідження та діагностика електричних систем електромобіля BMW i3. *Автомобільний транспорт*, 44, 5-13. Smyrnov, O.P., Borysenko, A.O., Marchenko A.V., Romanenko, A. V., & Yevtushenko S. V. (2019). Doslidzhennia ta diahnostyka elektrychnykh system elektromobilia BMW i3 [Research and diagnostics of electrical systems of the BMW i3 electric car]. Avtomobilnyi transport, 44, 5-13. https://doi.org/10.30977/AT.2219-8342.2019.44.0.5 [in Ukrainian]
14. Смирнов, О.П., Борисенко, А.О., & Марченко А.В., (2019). Розрахунок енергоємності тягових акумуляторних батарей для електричних транспортних засобів. *Автомобільний транспорт*, 45, 31-37. Smyrnov, O.P., Borysenko, A.O., Marchenko A.V., (2019). Rozrakhunok enerhoiemnosti tiahovykh akumuliatornykh batarei dlia elektrychnykh transportnykh zasobiv [Calculation of the energy capacity of traction batteries for electric vehicles.]. Avtomobilnyi transport, 45, 31-37. https://doi.org/10.30977/AT.2219-8342.2019.45. 0.31 [in Ukrainian]
15. Смирнов, О. П., Борисенко, А. О., & Марченко, А. В. (2019). Діагностика високовольтної акумуляторної батареї електромобіля Nissan Leaf. *Автомобіль і електроніка. Сучасні технології* , 16, 19-25. Smyrnov, O. P., Borysenko, A. O., & Marchenko, A. V. (2019). Diahnostyka vysokovoltnoi akumuliatornoi batarei elektromobilia Nissan Leaf [Diagnostics of the high-voltage battery of the Nissan Leaf electric car]. Avtomobil i elektronika. Suchasni tekhnolohii, 16, 19-25. http://veit.khadi.kharkov.ua/article/view/187283 [in Ukrainian]
16. Tesla. Retrived from: https://www.caranddriver.com/tesla (Accessed 10.11.2022).
17. Regulation No 101 of the Economic Commission for Europe of the United Nations (UN/ECE) (2013) Uniform provisions concerning the approval of passenger cars powered by an internal combustion engine only, or powered by a hybrid electric power train with regard to the measurement of the emission of carbon dioxide and fuel consumption and/or the measurement of electric energy consumption and electric range, and of categories M1 and N1 vehicles powered by an electric power train only with regard to the measurement of electric energy consumption and electric range: on condition 12.04.2013 – Official Journal of the European Union – UN/ECE.

18. Regulation No 83 of the Economic Commission for Europe of the United Nations (UN/ECE) (2015) Uniform provisions concerning the approval of vehicles with regard to the emission of pollutants according to engine fuel requirements: on condition 04.02.2015 – Official Journal of the European Union – UN/ECE.
19. Sieklucki, G. (2018) An Investigation into the Induction Motor of Tesla Model S Vehicle, *International Symposium on Electrical Machines (SME)*, 1-6, https://doi.org/10.1109/ISEM.2018.8442648 .
20. Where does Tesla's surging power come from? https://www.laitimes.com/en/article/2oxjw_33omd.html (Accessed 10.11.2022).
21. Musk E. and Straubel JB (2012) Model S Efficiency and Range. Retrived from: https://www.tesla.com/blog/model-s-efficiency-and-range (Accessed 03.11.2022).

Smyrnov Oleh[1], DSci (Engineering), professor, professor of the Vehicle Electronics Department,
e-mail: smirnov1oleg@gmail.com ,
Phone: +38 068-60-99-458,
ORCID: https://orcid.org/0000-0003-4881-9042
Borysenko Anna[1], Ph.D., Assoc. Prof. Vehicle Electronics Department,
e-mail: anutochka2111@gmail.com,
Phone: +38 096-11-06-949,
ORCID: https://orcid.org/0000-0001-5992-8274

[1]Kharkov National Automobile and Highway University, 25, Yaroslava Mudrogo str., Kharkiv, 61002, Ukraine

Аналіз особливостей конструкції систем та компонентів електромобіля Tesla Model S

Анотація. Проблема. *В публікації виконано аналіз особливостей конструкції систем та компонентів електромобіля Tesla Model S, який дозволяє обрати вихідні характеристики для математичної моделі динаміки розгону електромобіля, визначити витратні характеристики його силової установки (електродвигуна) та акумуляторної батареї.* ***Мета.*** *Мета роботи полягає в тому, щоб визначити вихідні характеристики систем та компонентів сучасного електромобіля для подальшого їх використання в імітаційній математичній моделі динаміки розгону електромобіля.* ***Методологія.*** *Прийняті в роботі підходи для досягнення поставленої мети полягають в осмисленні особливостей вихідних характеристик систем та компонентів електромобілів, які є лідерами в світі на ринку таких транспортних засобів.* ***Результати.*** *В роботі виконано порівняльний аналіз компонувальних схем реалізації трансмісій в конструкціях сучасних електромобілів, характеристик їх силових установок (електродвигунів), характеристик перетворювачів енергії (інвентарів), визначені особливості системи живлення силової установки сучасного електромобіля.* ***Оригінальність.*** *Проведений аналіз особливостей конструкції систем та компонентів електромобіля Tesla Model S дозволив сформувати загальне уявлення про особливості реалізації робочих процесів в електроприводі електромобіля, які можна використати в якості вихідних параметрів або характеристик під час моделювання динаміки розгону електромобіля.* ***Практичне значення.*** *Отримані результати дозволяють сформувати рекомендації щодо використання характеристик систем та компонентів електромобіля під час моделювання динаміки його розгону та визначити енергетичні витрати в системі живлення його тягового електропривода.*

Ключові слова: *електромобіль, потужність, система живлення, акумулятор, енергоємність, характеристика електропривода*

Смирнов Олег Петрович[1], д.т.н., професор, професор кафедри автомобільної електроніки,
e-mail: smirnov1oleg@gmail.com,
тел.: +38 068-609-94-58,
ORCID: https://orcid.org/0000-0003-4881-9042
Борисенко Анна Олегівна[1], к.т.н., доцент, доцент кафедри автомобільної електроніки,
e-mail: anutochka2111@gmail.com,
тел. +38 096-110-69-49,
ORCID: https://orcid.org/0000-0001-5992-8274

[1]Харківський національний автомобільно-дорожній університет, 61002, Україна, м. Харків, вул. Ярослава Мудрого, 25.