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# Importance of CAN Protocols in Electric Vehicles

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**ABSTRACT:** CAN Protocol in electric vehicles has the potential to revolutionize the way these vehicles operate and communicate. By implementing the CAN protocol, electric vehicles can achieve enhanced efficiency, improved safety, and more advanced features that contribute to a seamless driving experience. The use of the Controller Area Network protocol in electric vehicles can have a significant impact on various aspects of their operation and functionality.

One of the key benefits of the CAN protocol in electric vehicles is its ability to facilitate seamless communication between different components and subsystems within the vehicle. This allows for efficient sharing of information and data, enabling better coordination and control of various functions such as power management, regenerative braking, battery monitoring, and motor control. Furthermore, the CAN protocol also enables real-time monitoring and diagnostics of the electric vehicle's systems. By utilizing CAN, electric vehicles can gather data from various sensors and subsystems in real-time, allowing for rapid identification and resolution of any potential issues or malfunctions.

Another advantage of implementing the CAN protocol in electric vehicles is its robustness and reliability.

## I. INTRODUCTION

The CAN protocol, or Controller Area Network protocol, is a widely used communication standard in modern electric vehicles. It was first introduced in the automotive industry in the early 1990s and has since become the preferred protocol for communication between various electrical control units in electric vehicles. CAN protocols are highly valued in the electric vehicle industry for several reasons. Firstly, CAN protocols are known for their robustness and reliability.

This makes them well-suited for the demanding and safety-critical applications required in electric vehicles. Additionally, CAN protocols are also preferred in the automotive industry due to their low cost and flexibility. They are a cost-effective solution for implementing communication networks in electric vehicles, allowing for seamless integration of multiple electrical control units. Furthermore, CAN protocols support multiple data rates, making them suitable for both critical and non-critical network segments within the vehicle. This flexibility allows for efficient and optimized communication between various components of an electric vehicle. Moreover, CAN protocols have been extensively used in the automotive industry for their ability to handle large amounts of data.

This is especially important in electric vehicles, where there are numerous electrical control units responsible for integrating, operating, and analyzing loads of internal vehicle components and electrical systems. The CAN protocol ensures that data is transmitted accurately and efficiently between these control units, enabling effective communication and coordination between different vehicle systems. In conclusion, the CAN protocol plays a crucial role in enabling efficient and reliable communication in electric vehicles. The CAN protocol is widely used in electric vehicles due to its robustness, reliability, low cost, flexibility, and ability to handle large amounts of data cost-effectively. The Controller Area Network protocol is widely used in the electric vehicle industry due to its robustness, reliability, low cost, and flexibility. Additionally, CAN protocols are able to handle large amounts of data efficiently, which is crucial in the electric vehicle industry where there are numerous electrical control units responsible for integrating, operating, and analyzing loads of internal vehicle components and electrical systems (Pant & Lee, 2019). Therefore, the implementation of CAN protocols in electric vehicles ensures accurate and efficient communication, allowing for seamless integration and coordination of various vehicle systems. In summary, the use of CAN protocols in electric vehicles is beneficial due to their low cost, flexibility, robustness, reliability, and ability to handle large amounts of data efficiently.

The Controller Area Network communication protocol is widely used in the automotive industry, including electric vehicles. This protocol has several advantages that make it suitable for use in electric vehicles. Firstly, the CAN protocol is known for its robustness and reliability. It can handle large amounts of data efficiently, making it ideal for

the numerous electrical control units found in electric vehicles. Additionally, the CAN protocol is cost-effective and flexible, allowing for easy integration into electric vehicle systems. Furthermore, the CAN protocol enables effective communication and coordination between different vehicle systems. This is crucial for the operation and monitoring of electrical devices in electric vehicles, as it ensures that data is transmitted accurately and efficiently between control units. Overall, the CAN protocol is widely used in electric vehicles due to its robustness, reliability, low cost, flexibility, and ability to handle large amounts of data effectively.

In conclusion, the use of Controller Area Network protocols in electric vehicles is highly beneficial due to their robustness, reliability, low cost, flexibility, and efficient data transmission capabilities. These protocols enable smooth integration and operation of the numerous electrical control units in electric vehicles, allowing for accurate monitoring and control of various systems. Furthermore, the CAN protocol plays a crucial role in facilitating human-machine interaction within electric vehicle systems.

It enables seamless integration of bio-signals for improved human-machine interaction. One example is the use of CAN protocols in electric vehicles to integrate biometric sensors and data. These sensors can monitor the driver's vital signs, such as heart rate and blood pressure, and transmit this data through the CAN protocol to the vehicle's management system. By analyzing this data, the vehicle can make real-time adjustments to optimize the driving experience for the driver. Moreover, the CAN protocol is also used in autonomous vehicles for controlling and coordinating various functions. For example, the CAN protocol enables autonomous vehicles to enable or disable brakes and coordinate the actions of different electrical control units. Overall, the CAN protocol is a crucial communication protocol in electric vehicles, enabling effective coordination, control, and monitoring of various electrical systems. In addition to its use in the automotive industry, the Controller Area Network protocol has also found applications in other industries such as military, aviation, factories, and industrial automation. The Controller Area Network protocol is widely used in electric vehicles for its numerous benefits and applications. The CAN protocol allows for accurate and efficient transmission of data between control units in electric vehicles. This enables smooth integration and operation of various electrical systems, enhances human-machine interaction, allows for the integration of biometric sensors for improved driver monitoring, and facilitates autonomous control and coordination of different functions in electric vehicles.

Furthermore, the CAN protocol is known for its low cost, flexibility, and robustness, making it an ideal choice for electric vehicles. The CAN protocol in electric vehicles also allows for effective power management. For example, the CAN protocol allows for efficient communication between the battery management system and other electrical control units, facilitating optimal charging and discharging of the battery and maximizing overall energy efficiency. Moreover, the CAN protocol in electric vehicles enables effective fault detection and diagnostics.

This is achieved through the continuous exchange of status and diagnostic information between the various control units connected to the CAN network. The CAN protocol also supports different data rates, allowing for the segregation of critical and non-critical network segments in the vehicle. This enhances the overall reliability and safety of the electric vehicle system.

The Controller Area Network protocol plays a crucial role in the communication and coordination of various electrical systems in electric vehicles. Its robustness, flexibility, and low cost make it a widely used protocol in the automotive industry. Additionally, the CAN protocol enables efficient power management, fault detection, and diagnostics in electric vehicles. The Controller Area Network protocol is widely used in the electric vehicle industry due to its robustness, flexibility, and low cost. Moreover, the CAN protocol's ability to support multiple data rates and prioritize messages based on their ID field further adds to its effectiveness in electric vehicles. In conclusion, the CAN protocol is a vital component in the communication and coordination of electrical systems in electric vehicles.

In addition, the CAN protocol enables improved human-machine interaction in electric vehicles. By integrating human-machine interaction into vehicle systems, the CAN protocol allows for a more seamless and intuitive user experience. For example, the CAN protocol enables the transmission of information from various sensors and display units to the driver, providing real-time feedback on important vehicle parameters such as speed, battery level, and charging status. Furthermore, the CAN protocol allows for the integration of advanced driver assistance systems in electric vehicles. These systems can include features like adaptive cruise control, lane keeping assist, and collision avoidance, all of which rely on the exchange of data between sensors and control units via the CAN protocol. The CAN protocol in electric vehicles also plays a significant role in ensuring the safety and security of the vehicle. It allows for the implementation of security measures, such as encryption and authentication, to prevent unauthorized access and data tampering. Overall, the Controller Area Network protocol is extensively used in electric vehicles due to its robustness, flexibility, low cost, and ability to support various functionalities such as power management, fault detection, diagnostics, human-machine interaction, and safety measures.

## II. METHODOLOGY

CAN Protocol is a widely used methodology in Electric Vehicles that plays a crucial role in ensuring efficient communication and coordination among various components of the vehicle. The CAN protocol, or Controller Area Network protocol, was originally developed by Robert Bosch GmbH in 1983 and officially released in 1986 at the Society of Automotive Engineers congress in Detroit, Michigan (Ismail et al., 2015). This protocol has since become the de facto standard for communication within vehicles, including electric vehicles. The adoption of the CAN protocol in Electric Vehicles is primarily due to its robustness, reliability, low cost, flexibility, and support for multiple data rates. The CAN protocol is particularly beneficial for Electric Vehicles as it allows for the seamless integration of numerous Electrical Control Units that operate various functions within the vehicle. These ECUs, also known as controllers, are responsible for managing and coordinating the operation of different components such as the motor, battery, charging system, and other subsystems. The CAN protocol enables these ECUs to communicate and exchange information in a fast and efficient manner.

By implementing the CAN protocol, Electric Vehicles benefit from improved system performance, enhanced safety features, and simplified maintenance and diagnostics. One of the key advantages of the CAN protocol in Electric Vehicles is its ability to handle large amounts of data transmission without compromising performance. This is particularly important in Electric Vehicles, where multiple sensors and systems generate a vast amount of data that needs to be transmitted and processed quickly for efficient vehicle operation.

The CAN protocol provides a reliable and efficient means of transmitting data between ECUs, ensuring that critical information is communicated accurately and in real-time. Furthermore, the CAN protocol allows for easy integration of new components and functionalities into Electric Vehicles.

This flexibility is essential in the fast-paced development of Electric Vehicles, as new technologies and features are constantly being introduced. Another advantage of the CAN protocol in Electric Vehicles is its low cost. The CAN protocol is widely available and cost-effective, making it an ideal choice for manufacturers looking to implement communication within Electric Vehicles without incurring excessive expenses. In addition to its technical benefits, the CAN protocol also plays a crucial role in enabling human-machine interaction within Electric Vehicles.

To integrate human-machine interaction into vehicle systems, most studies have used a single bio-signal (Lee et al., 2021). However, the CAN protocol allows for more sophisticated and comprehensive human-machine interaction by enabling the integration of multiple bio-signals. These bio-signals can include inputs from various sensors in the vehicle, such as eye-tracking systems, heart rate monitors, and even brain wave sensors. By utilizing the CAN protocol, Electric Vehicles can not only transmit and receive signals for vehicle control and monitoring but also integrate human-machine interaction for a more personalized and intuitive driving experience. The CAN protocol is widely used as the primary network protocol for in-vehicle communication in Electric Vehicles due to various benefits it offers. The CAN protocol provides several advantages in the context of Electric Vehicles.

Firstly, the CAN protocol is known for its low cost and simplicity. It is a lightweight network that is easy to install, making it an efficient and cost-effective solution for in-vehicle communication. Furthermore, the CAN protocol operates at high speeds, allowing for real-time transmission and processing of data.

This is particularly important in Electric Vehicles, where accurate and timely communication between Electronic Control Units is essential for efficient vehicle operation and safety. Additionally, the CAN protocol is highly robust and reliable. It is designed to handle the harsh and dynamic automotive environment, where factors like temperature fluctuations, electromagnetic interference, and physical vibrations are common. The CAN protocol's robustness ensures that it can withstand these challenges and maintain reliable communication between different components of the Electric Vehicle. Moreover, the CAN protocol allows for prioritization and error handling capabilities, ensuring that critical messages are transmitted and received promptly and accurately. In the context of Electric Vehicles, the CAN protocol plays a crucial role in enabling efficient and reliable communication between various components.

This protocol allows for seamless integration and coordination between the different subsystems of an Electric Vehicle, such as the battery management system, motor control unit, and on-board diagnostics. These subsystems rely on the CAN protocol to exchange information and coordinate their actions, ensuring optimal performance and efficiency of the Electric Vehicle. Furthermore, the CAN protocol supports a peer-to-peer communication architecture, allowing for efficient and distributed processing of data within the Electric Vehicle. This decentralization of communication reduces the workload on a single central controller and improves the overall responsiveness and efficiency of the Electric Vehicle system.

Another advantage of the CAN protocol in the context of Electric Vehicles is its compatibility with other communication protocols and standards. For example, the ISO/IEC 15118 protocol is used for communication between electric vehicles and charging spots, while the IEC 61850 protocol is used for communication within the charging

infrastructure. The CAN protocol can seamlessly integrate with these protocols and enable smooth communication between the Electric Vehicle and the charging infrastructure, enhancing interoperability and compatibility. Additionally, the utilization of the CAN protocol in Electric Vehicles allows for easy integration with existing vehicle networks. This means that manufacturers can leverage their existing infrastructure and expertise in implementing the CAN protocol, reducing the cost and complexity of integrating new technologies into Electric Vehicles. Overall, the Controller Area Network protocol is integral to the communication and operation of Electric Vehicles.

The CAN protocol enables efficient and reliable communication between various components of an electric vehicle, facilitating seamless integration and coordination. This protocol allows for the exchange of information between different subsystems, such as the battery management system and motor control unit, ensuring optimal performance and efficiency. Furthermore, the CAN protocol supports a peer-to-peer communication architecture, allowing for efficient and distributed processing of data within the electric vehicle. This decentralized communication reduces the workload on a single central controller and improves the overall responsiveness and efficiency of the electric vehicle system. Moreover, the CAN protocol offers a high level of flexibility and robustness, making it suitable for the demanding automotive environment. It can operate in harsh conditions with high levels of electromagnetic interference, ensuring reliable and uninterrupted communication. The CAN protocol also plays a crucial role in ensuring the safety and security of Electric Vehicles.

It allows for the transmission of critical information, such as fault codes and diagnostic data, enabling timely detection and resolution of issues. In addition, the CAN protocol supports various levels of security measures, such as message authentication codes and encryption, to prevent unauthorized access and tampering of data.

The utilization of the CAN protocol in Electric Vehicles also contributes to improved energy efficiency. By enabling efficient communication and coordination between different subsystems, the CAN protocol helps optimize the energy consumption of Electric Vehicles, leading to increased range and reduced emissions. Additionally, the CAN protocol facilitates the integration of advanced features and technologies in Electric Vehicles. For example, the CAN protocol enables the implementation of advanced driver assistance systems in Electric Vehicles, improving safety and providing a more comfortable driving experience. Overall, the CAN protocol plays a vital role in the methodology of Electric Vehicles, ensuring accurate and efficient communication between various components.

The CAN protocol is widely used in the electric vehicle industry due to its numerous advantages including its robustness, reliability, flexibility, and cost-effectiveness. As the most widely used network protocol in automotive electric/electronic systems, the CAN protocol provides a low-cost solution for efficient communication within Electric Vehicles. Furthermore, the CAN protocol allows for seamless integration of different subsystems and components within an electric vehicle, enabling effective coordination and control. This results in improved overall performance and functionality of Electric Vehicles, ultimately enhancing the user experience and satisfaction. Moreover, the CAN protocol offers a high level of scalability, allowing for easy expansion and integration as Electric Vehicles evolve and incorporate new technologies. In addition, the CAN protocol has been widely adopted in Electric Vehicles due to its ability to support both critical and non-critical network segments. This allows for the transmission of important data related to vehicle diagnostics, informatics, and control in a reliable manner. Moreover, the CAN protocol's support for multiple data rates enables its use in various applications, including self-driving capabilities and advanced driver assistance systems. The CAN protocol also enhances the safety and reliability of Electric Vehicles. For instance, the CAN protocol incorporates error detection and correction mechanisms, ensuring the integrity of transmitted data. Furthermore, the CAN protocol is designed to operate in harsh automotive environments with high electromagnetic interference and temperature variations. These features make the CAN protocol well-suited for electric vehicle applications, where reliability and robustness are crucial. Overall, the CAN protocol is a critical component in the methodology of Electric Vehicles. Its use in electric vehicles ensures accurate and efficient communication between various components, allowing for seamless integration, improved performance, scalability, support for critical and non-critical network segments, enhanced safety and reliability, and adaptability to evolving technologies.

The Controller Area Network protocol is a vital communication standard in electric vehicle subsystems, such as Electrical Control Units. It enables the seamless integration of different components and subsystems within an electric vehicle, resulting in improved overall performance and functionality. One of the key reasons why the CAN protocol has been widely adopted in Electric Vehicles is its robustness and reliability. The CAN protocol's ability to withstand harsh automotive environments, such as high electromagnetic interference and temperature variations, ensures that communication within the electric vehicle is not compromised by external factors. Additionally, the CAN protocol's error detection and correction mechanisms contribute to the overall safety and reliability of Electric Vehicles.

These mechanisms help to ensure the integrity of transmitted data, reducing the risk of misinformation or system failures. Another advantage of the CAN protocol in Electric Vehicles is its support for multiple data rates. This allows for greater flexibility in terms of the speed at which different components communicate, accommodating varying data

transfer requirements. Furthermore, the CAN protocol's scalability enables the addition of new components or subsystems to an electric vehicle without significant modifications to the existing network infrastructure. This scalability is particularly important in the context of electric vehicles, which are constantly evolving and incorporating new technologies and features. Moreover, the CAN protocol's ability to support both critical and non-critical network segments is crucial in the context of electric vehicles. Electric vehicles rely on various network segments, such as those related to critical functions like powertrain control and safety systems, as well as non-critical functions like infotainment and climate control.

### III. BLOCK DIAGRAM

The Controller Area Network protocol plays a crucial role in the block diagram of an Electric Vehicle. It serves as the communication backbone, enabling seamless data transmission between the various components and subsystems of the vehicle. CAN, which stands for Controller Area Network, is a widely used serial communication protocol in the automotive industry. One of the main reasons for the popularity of CAN in the automotive industry is its robustness and reliability. In an Electric Vehicle, the CAN protocol is used to connect and coordinate the many Electrical Control Units that operate the vehicle. These ECUs have specific functionalities and tasks, such as managing the battery system, controlling the motor, and handling the various sensors and actuators. The CAN protocol allows for efficient and reliable communication between these ECUs, ensuring that they can exchange information and work together seamlessly.

The block diagram of an Electric Vehicle typically includes several key components, such as the battery management system, motor controller, power electronics, and various sensors and actuators. These components are interconnected using the CAN protocol, forming a network where data can be transmitted between them. This network architecture allows for efficient and real-time communication, enabling the different components to work together harmoniously.

The CAN protocol ensures that the data transmitted between these components is reliable and accurate, minimizing errors and ensuring that the vehicle operates smoothly and safely. By using a priority-based approach, the CAN protocol allows for effective prioritization of messages, ensuring that critical information is transmitted and received without delay. Additionally, the CAN protocol supports multi-master communication, allowing multiple ECUs to transmit and receive data simultaneously. The use of the CAN protocol in an Electric Vehicle block diagram provides several advantages. Firstly, the CAN protocol is highly robust and reliable, making it suitable for the demanding and complex environment of an Electric Vehicle. Secondly, the CAN protocol is highly efficient, allowing for fast and real-time communication between the various components. This is crucial for the proper functioning of an Electric Vehicle, as it allows for seamless coordination between the different systems and subsystems. Furthermore, the CAN protocol is cost-effective and easy to implement, making it an ideal choice for manufacturers in the automotive industry. In addition to its automotive applications, the CAN protocol has also found use in other industries such as satellite communication and supervisory control and data acquisition. The CAN protocol plays a vital role in the block diagram of Electric Vehicles. It enables efficient and reliable communication between the various electrical control units, allowing them to exchange information and work together seamlessly.

The Controller Area Network protocol is widely used in Electric Vehicle block diagrams to facilitate communication between different components of the vehicle. This protocol allows for efficient and reliable data transmission, ensuring that the vehicle operates smoothly and safely. The CAN protocol allows for the transmission of a large number of short messages with high reliability between electrical control units in the vehicle. These control units, also known as ECUs, are responsible for various functions within the vehicle, such as managing the powertrain, battery management system, and various other subsystems. The CAN protocol allows for seamless coordination and communication between these ECUs, ensuring that they can exchange information and work together effectively. Furthermore, the CAN protocol supports multi-master communication, which means that multiple ECUs can transmit and receive data simultaneously. This enables efficient and parallel processing of data within the Electric Vehicle block diagram. Moreover, the CAN protocol's broadcast nature and implicit priority using the ID field allow for effective prioritization of messages, ensuring that critical information is delivered in a timely manner. Additionally, the CAN protocol supports multiple data rates, allowing for the use of different network segments within the vehicle. This flexibility makes the CAN protocol suitable for both critical and non-critical communication in Electric Vehicles. Overall, the CAN protocol is a crucial component in Electric Vehicle block diagrams. It facilitates efficient and reliable communication between the various electrical control units, enabling them to work together seamlessly and ensuring the smooth and safe operation of the vehicle. The Controller Area Network protocol plays a vital role in the block

diagram of Electric Vehicles. It enables reliable communication between the different electrical control units, allowing them to exchange information and work together seamlessly.

The CAN protocol is widely used in Electric Vehicle block diagrams due to its robustness, reliability, and low cost. It supports efficient data transmission by allowing the transmission of a large number of short messages with high reliability. The CAN protocol's multi-master communication capability enables simultaneous data transmission and reception, facilitating parallel processing of data within the Electric Vehicle block diagram.

This ensures efficient and effective coordination between the various ECUs in an Electric Vehicle. Furthermore, the CAN protocol's broadcast nature and implicit priority using the ID field allow for effective prioritization of messages. Critical information can be delivered promptly, ensuring the safety and optimal performance of the vehicle. In conclusion, the CAN protocol plays a crucial role in the block diagram of Electric Vehicles. It enables efficient and reliable communication between the electrical control units, ensuring seamless integration and operation of the vehicle. The CAN protocol is a fundamental component in the block diagram of Electric Vehicles. It serves as a reliable and robust communication protocol, facilitating seamless integration and operation of the various electrical control units within the vehicle. The CAN protocol's widespread use in the automotive industry, its flexibility in allowing for different network segments, and its support for efficient data transmission make it an essential choice for Electric Vehicle block diagrams. The Controller Area Network protocol is highly utilized in Electric Vehicle block diagrams due to its numerous benefits. It is a widely adopted and preferred communication protocol for Electric Vehicle block diagrams due to its robustness, reliability, and low cost. Furthermore, the CAN protocol's multi-master communication capability allows for simultaneous data transmission and reception, enabling efficient parallel processing of data within the block diagram. Overall, the CAN protocol serves as a critical component in ensuring the seamless integration and operation of Electric Vehicles.

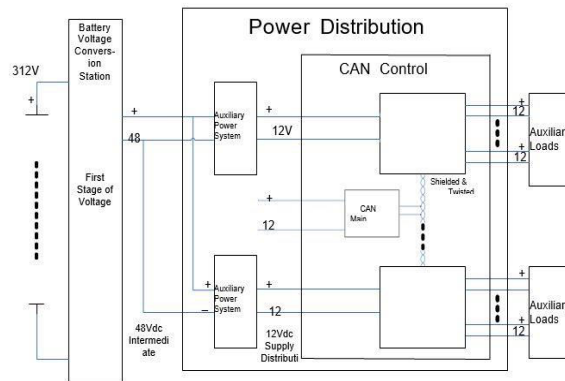


Fig 1. Overall Power Distribution Network Diagram

#### IV. CONCLUSION & FUTURE SCOPE

In conclusion, the CAN bus protocol plays a crucial role in enabling communication between microcontrollers and devices in electric vehicles. This protocol allows for efficient data transmission and coordination, facilitating the smooth operation of various systems such as power management, battery monitoring, motor control, and charging infrastructure. Furthermore, the integration of the Robotic Technology Kernel into an electric vehicle by-wire system using lidar and GPS sensors has proven to be a successful integration approach. The use of the CAN protocol in electric vehicles ensures reliable and real-time communication between different components, enhancing the overall efficiency and performance of the vehicle. In conclusion, the CAN bus protocol is an essential component in electric vehicles, facilitating effective communication between microcontrollers and devices. This protocol enables seamless coordination and data transmission, supporting the smooth operation of various systems in electric vehicles. The CAN bus protocol is a critical component in electric vehicles, enabling efficient and reliable communication between microcontrollers and devices. Without the CAN protocol, the integration and coordination of various systems would be challenging, leading to potential issues in power management, battery monitoring, motor control, and charging infrastructure.



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